Appendix A-1: IRWMP Coordinating Committee Chair and Vice Chair Roles (June 4, 2007)

Recommended roles and responsibilities for a Chair and Vice Chair for the IRWMP Coordinating Committee (CC) are listed below. These were crafted with the understanding that the CC will be evaluating a new governance structure over this next year and the selected Chair and Vice Chair will preside over the existing CC governance structure in the interim.

1. The IRWMP CC will have a Chair and Vice Chair. The Vice Chair assumes duties of the Chair when Chair is unavailable. In the event that the Chair and Vice Chair are not available to assume responsibility for a particular duty, they will jointly designate an acting Chair.

2. The Term for Chair and Vice Chair is two years. If a new governance structure is not in place within one year, the existing Chair and Vice Chair will continue to serve, or the positions will be rotated, as determined by consensus, or vote if necessary, of the Coordinating Committee.

3. The Chair and Vice Chair will be from different functional areas to ensure the most diverse representation. One should be from the Water or Wastewater functional areas and one from the Flood Control or Watershed functional areas.

4. The Chair and Vice Chair will be non-voting members of the CC. Other CC members from their agency or district shall retain the right to vote as a representative of their respective functional area.

5. The Chair and Vice Chair will represent all four functional areas and will work together to bring consensus among them.

6. The Chair will work with the Vice Chair to share the workload, including but not limited to:

   - Set monthly meeting agendas and associated administrative matters;

   - Facilitate meetings and discussions, work to address issues in-between meetings in consultation with representatives of the four functional areas;

   - Represent the CC to outside agencies and outside the CC meetings as necessary. This representation is limited to that authorized in advance by consensus (or vote) of the IRWMP-CC;

   - Meet with other regional agencies as needed to assure coordination with other regional planning and infrastructure programs; and

   - Identify significant decision points regarding IRWMP issues and matters which demand a manager or greater level of authority and involvement, and communicate this need to the CC.

Appendix A-2: Coordinating Committee Voting Principles

Coordinating Committee decisions do not supersede individual agency decisions regarding project scopes and schedules, and IRWMP participating agencies are consulted on over- arching policy issues. Through their adoption of the IRWM Plan, the governing bodies of the 24 participating organizations approve this IRWMP management structure:

- Decisions requiring voting shall be agendized.
- Agendas should be developed to communicate the desired outcome of the agenda item. All action items should be located in a separate action section, with the responsible lead person identified next to the action item. Every agenda item should begin with a verb, such as approve, report, discuss, etc. Information and discussion items should also be placed in a separate section on the agenda.
- Agendas should be prepared and emailed to the CC at least one week in advance, but no less than 72 hours in advance of the vote.
- If a functional area (FA), as a group, is not prepared to vote on the item, the vote can be postponed by a majority of all (from all 4 functional areas) of the FA representatives present (for example, if there were 10 FA reps in attendance, it would take an affirmative vote of 6 FA reps to postpone), but the Chair shall identify the timing of that postponed vote at that meeting.
- Ideally, votes will occur at regularly scheduled CC meetings, but special meetings or conference calls can be called and noticed by the Chair if necessary to facilitate timely decisions. If neither of those options (special meeting or conference call) is available, voting by email is a possible method to be employed by the Chair, but would need to be agreed upon by a majority of all of the FA representatives present.
- Voting outside of regular meetings, whether by email or phone call or special meeting, should have the same noticing requirements as a regular meeting. For example, a vote could not occur without 72 hours advance notice of the item and a description of the vote to be taken circulated to all Coordinating Committee members.
- As outlined above, there will be 3 appointed representatives per functional area. The minimum quorum should be at least one primary or alternate member from each functional area, for either voting or consensus decisions.
- Each of the 3 representatives within each FA has an individual vote (they do not need to vote in blocks), if they are in attendance at the meeting (or conference call) where and when the vote takes place. Proxy votes from an individual FA representative will only be allowed when the FA representative has so designated such a proxy to the Chair (or her/his designee) ahead of the meeting when the vote is scheduled to take place.
- A tie vote would result in a non vote. A tie vote would require the Coordinating Committee to work with the functional areas more to develop more alignment and work more towards a consensus. The Chair and Vice-Chair would not be allowed to break a

tie vote. If an item before the Coordinating Committee is so divisive that it is an even vote, then members need to consider and deliberate more collectively to come to a decision.

Meeting notes are generated from each monthly meeting in order to capture and memorialize these decisions, agreements and action items. Draft and final CC meeting notes are distributed to attendees and are posted on the SF Bay Area IRWMP web site.

South Westside Basin Groundwater Management Plan

July 2012

South Westside Basin Groundwater Management Plan

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

ACRONYMS AND ABBREVIATIONS

1999 Plan	proposed Westside Basin AB 3030 Groundwater Management Plan
AB	Assembly Bill
Advisory Committee	South Westside Basin GWMP Advisory Committee
AF	acre-feet
AFY	acre-feet per year
Basin Plan	San Francisco Bay Basin Water Quality Control Plan
BMO	Basin Management Objective
CalWater	California Water Service Company
cfs	cubic feet per second
DPH	California Department of Public Health
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
ft	feet
GAMA	Groundwater Ambient Monitoring Assessment
gpm	gallons per minute
GPS	global positioning satellites
Groundwater Task Force	South Westside Basin Groundwater Task Force
GSR	Regional Groundwater Storage and Recovery Project
GWMP	groundwater management plan
Groundwater Model	Westside Basin Groundwater Flow Model
ILPS	In-Lieu Pilot Study
InSAR	interferometric synthetic aperture radar
IRWMP	Integrated Regional Water Management Plan
JPA	joint powers agreement
MCL	maximum contaminant level

mgd	million gallons per day
µg/L	micrograms per liter
mg/L	milligrams per liter
MOU	Memorandum of Understanding
N	nitrogen
NAWQA	National Ambient Water Quality Assessment
NCCWD	North Coast County Water District
NPDES	National Pollutant Discharge Elimination System
NSMCSD	North San Mateo County Sanitation District
PCE	Tetrachloroethylene
Plan Area	area covered by South Westside Basin Groundwater Management Plan
ppm	parts per million
psi	pounds per square inch
RWQCB	Regional Water Quality Control Board, San Francisco Bay Region
SB	Senate Bill
SFIA	San Francisco International Airport
SFPUC	San Francisco Public Utilities Commission
SMCL	secondary maximum contaminant level
SVOCs	semi-volatile organic compounds
TCE	Trichloroethylene
TDS	total dissolved solids
USGS	United States Geological Survey
USDA-NRCS	United States Department of Agriculture Natural Resources Conservation Service
Water Board	California State Water Resources Control Board
Westside Basin	Westside Groundwater Subbasin
Wholesale Water Supply Agreement	Water Supply Agreement between The City And County of San Francisco And Wholesale Customers in Alameda County, San Mateo County, And Santa Clara County

1 INTRODUCTION AND BACKGROUND

1.1 PURPOSE OF THE GROUNDWATER MANAGEMENT PLAN

The purpose of the South Westside Basin Groundwater Management Plan (GWMP), including development of the plan and the plan document itself, is to provide a framework for regional groundwater management in the South Westside Basin that sustains the beneficial use of the groundwater resource. This includes:

- Informing the public of the importance of groundwater and of the challenges and opportunities presented by groundwater supplies;
- Developing consensus among stakeholders on issues and solutions related to groundwater;
- Building relationships among stakeholders within the basin and between state and federal agencies; and
- Defining actions to ensure the long-term sustainability of groundwater resources in the South Westside Basin.

This GWMP provides recommendations that, when implemented, are intended to maintain or enhance long-term groundwater levels and quality and minimize land subsidence.

The goal of the GWMP is to ensure a sustainable, high-quality, reliable water supply at a fair price for beneficial uses achieved through local groundwater management.

1.2 DESCRIPTION OF THE GROUNDWATER BASIN AND PLAN AREA

The South Westside Basin GWMP area (Plan Area) is the portion of the Westside Groundwater Subbasin (Westside Basin), Basin 2-35, as defined by the California Department of Water Resources (DWR), within the boundaries of San Mateo County. The Plan Area is shown in Figure 1.1. Areas within the northern portion of the DWR-defined Westside Basin, in the City and County of San Francisco, are described in the draft *North Westside Basin Groundwater Basin Management Plan* (SFPUC, 2005).

Overlying municipalities, shown in Figure 1.2, include Daly City, Colma, South San Francisco, San Bruno, Millbrae, and Burlingame. Water agencies serving the Plan Area are shown in Figure 1.3 and include Daly City, California Water Service Company (CalWater) – South San Francisco District, San Bruno, Millbrae, and Burlingame. Additionally, the San Francisco Public Utilities Commission (SFPUC) provides retail water service to the Golden Gate National Cemetery in San Bruno and wholesale water to the retail agencies.

Figure 1.1
Plan Area

Legend

- Highways
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

Source: Groundwater Basin: DWR, 2003

F:\215 - San Bruno\Figures\Figure 1.1 Plan Area.mxd, March 21, 2011

Figure 1.2
Municipalities

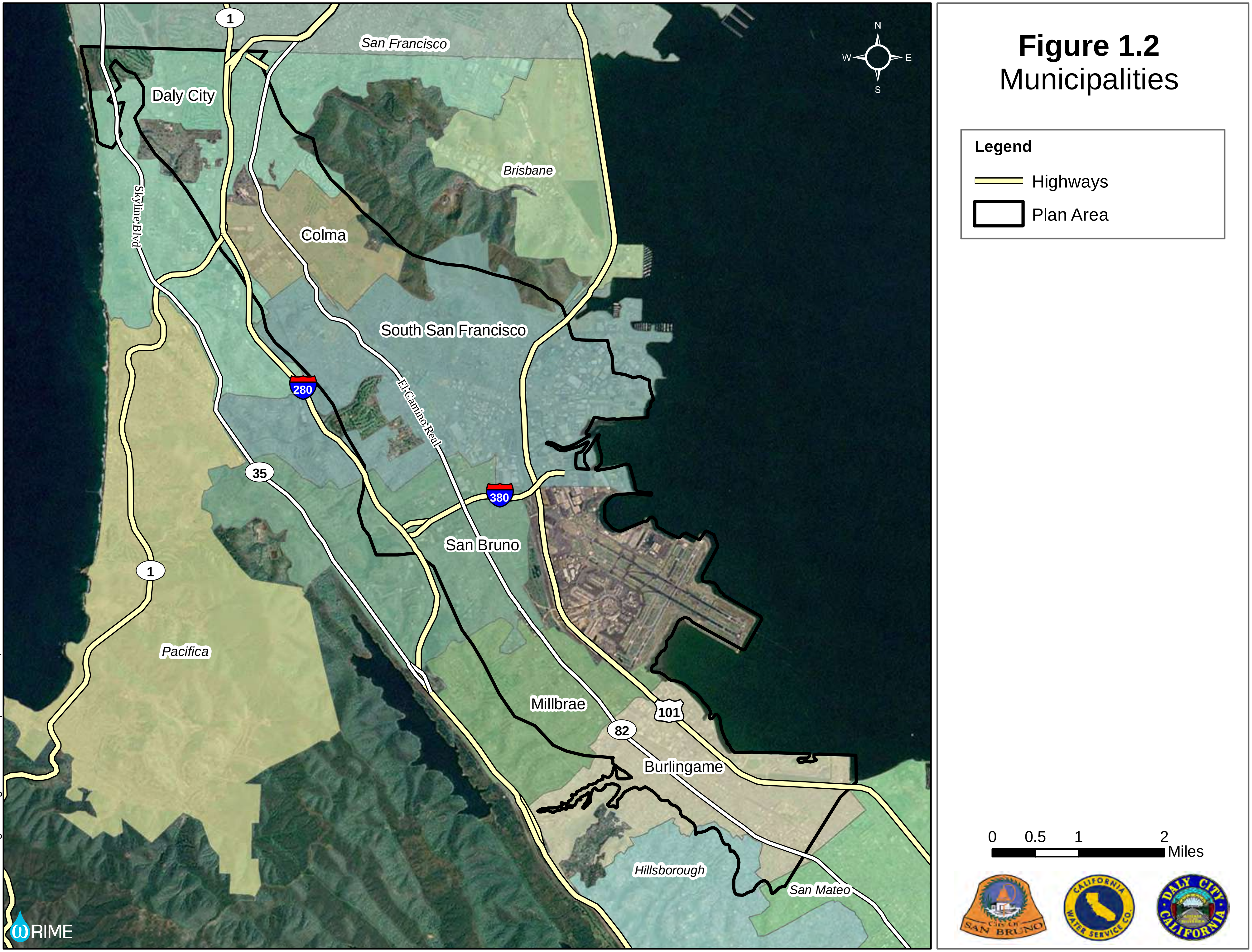
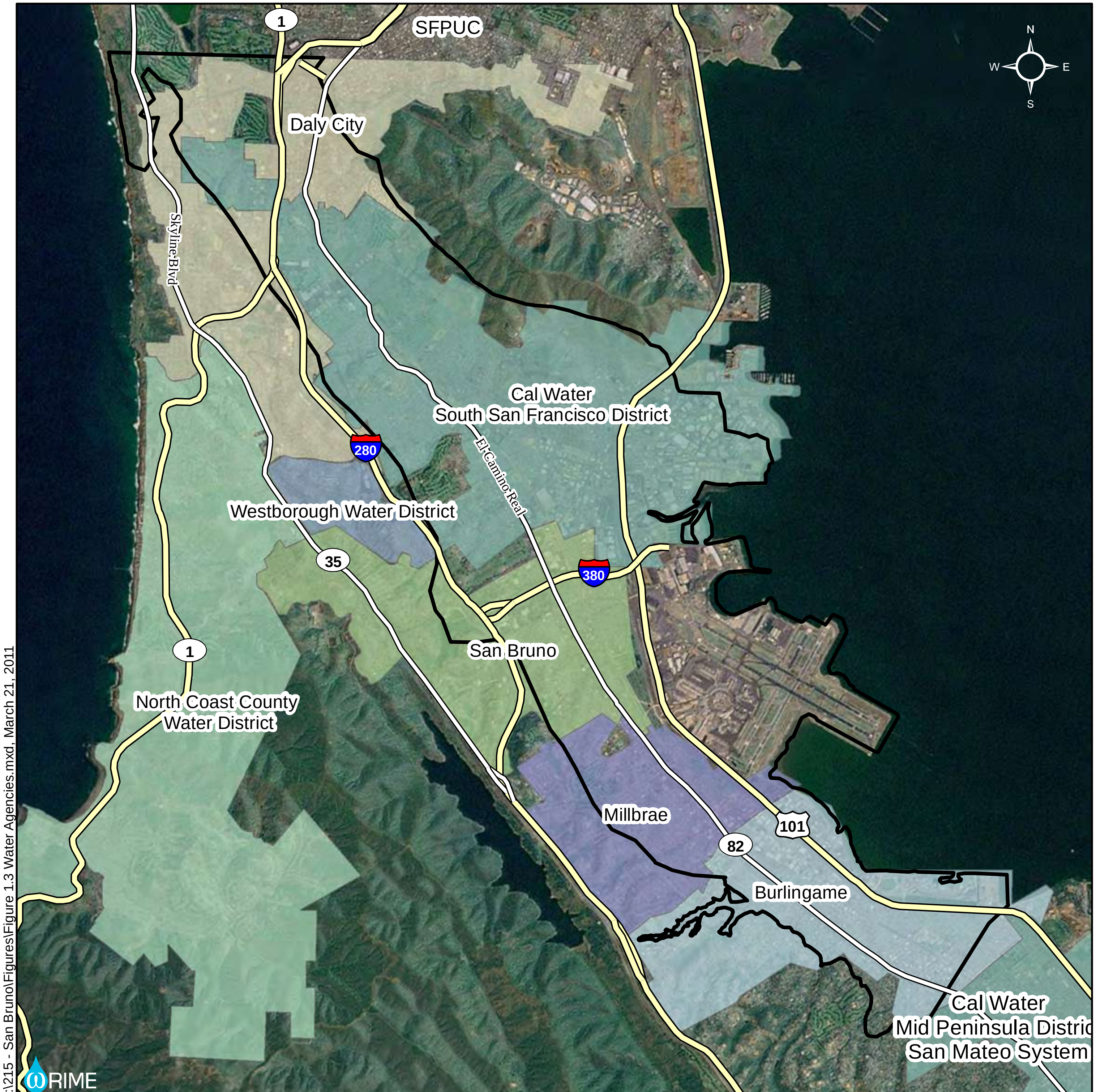


Figure 1.3
Water Agencies



Legend

Highways

Plan Area

0 0.5 1 2 Miles

F:\215 - San Bruno\Figures\Figure 1.3 Water Agencies.mxd, March 21, 2011

1.3 OVERVIEW OF WATER REQUIREMENTS AND SUPPLIES

Located on the San Francisco Peninsula, the South Westside Basin underlies approximately 25 square miles and provides groundwater to Colma, Daly City, San Bruno, South San Francisco, unincorporated areas, cemeteries, golf courses, and several smaller users.

The Plan Area is considered built-out, with very little undeveloped land available for development. Future growth will occur through infill, including increased density on existing developed parcels. Land use in the basin is approximately 80 percent urban; 15 percent irrigated parks, golf courses, and cemeteries; and 5 percent unirrigated open space, as shown in Figures 1.4a and 1.4b. Urban areas include large portions of the cities of Daly City, Colma, South San Francisco, San Bruno, Millbrae, and Burlingame, as well as urbanized unincorporated areas. The total 2010 water demand for the area was approximately 29,000 acre-feet (AF) (Bay Area Water Supply & Conservation Agency [BAWSCA] 2011; SFPUC, 2011).

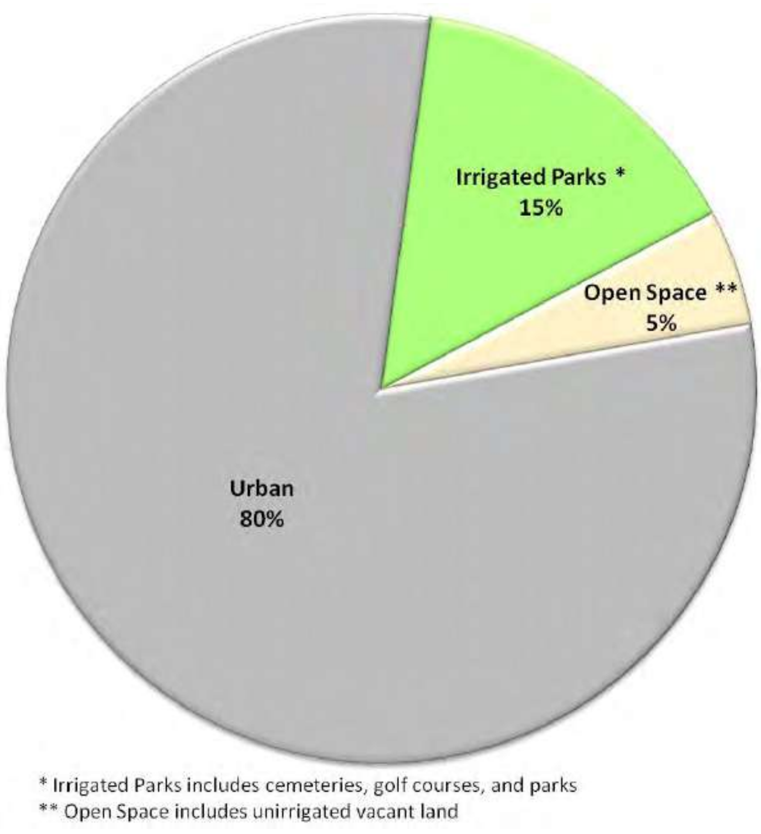
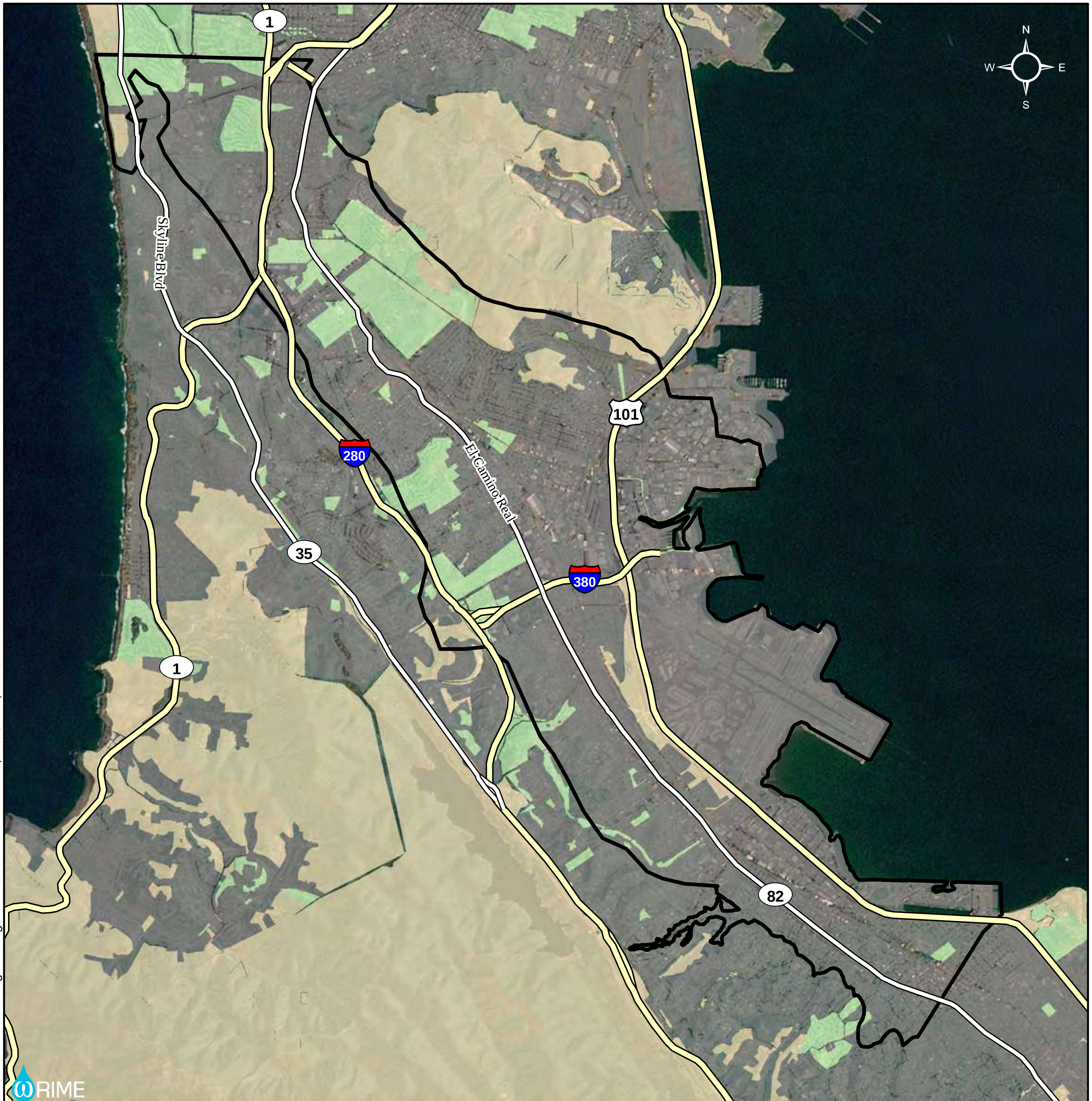


Figure1.4a Current Land Use Summary

Figure 1.4b
Current Land Use



Legend

Highways

Plan Area

Planned Land Use

Urban

Parks, Cemeteries, Golf Courses

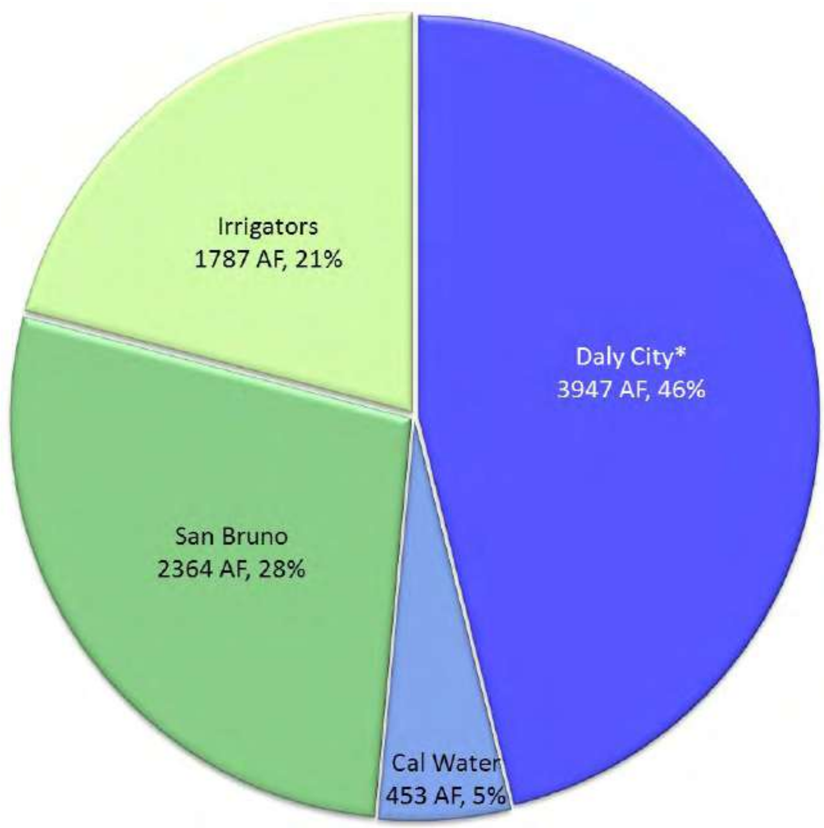
Open or Vacant Land

0 0.5 1 2 Miles

Source: Land Use - Based on ABAG, 2006

F:\215 - San Bruno\Figures\Figure 1.4b Current Land Use, March 21, 2011

In the South Westside Basin, groundwater plays a critical role, providing up to 50 percent of some localities' water supplies, making it an important resource for the future prosperity and sustainability of the region. Approximately 8,600 AF of groundwater was produced from the South Westside Basin in 2010 (SFPUC, 2011) including 2,200 AF of groundwater banked through in-lieu recharge under the In-Lieu Pilot Study (see Section 1.5.3). Figure 1.5 shows the breakdown of groundwater production by producer for 2010. Imported water from SFPUC's Hetch Hetchy system, along with small quantities of recycled water, provides the remaining supply.



*** Value includes 2,204 AF of banked in-lieu recharge water**

Figure 1.5 Groundwater Production by Entity, 2010

While the Plan Area and surrounding region are largely built-out, additional growth through infill is expected, along with associated increases in water demands. As demands for imported water supplies continue to rise, groundwater will continue to play a key role in delivering a cost-effective and reliable water supply to the South Westside Basin.

1.4 LEGISLATION RELATED TO GROUNDWATER MANAGEMENT PLANS

Groundwater is a resource shared by numerous users; it does not recognize or adhere to jurisdictional lines and cannot be tagged for use by certain users. Groundwater rights have evolved through case law since the late 1800s. Currently, three basic methods are available for managing groundwater resources in California:

- Local agency management under authority granted by the California Water Code or other applicable state statutes (such as through a GWMP);
- Local government groundwater ordinances or joint powers agreements (JPA); and
- Court adjudications.

No law requires that any of these forms be applied within a basin. As such, management is often instituted after local agencies or landowners recognize specific issues in groundwater conditions. The level of groundwater management in any basin or subbasin is often dependent on water availability and demand, as well as groundwater quality.

In an effort to standardize groundwater management, the California Legislature passed Assembly Bill (AB) 255 (Stats. 1991, Ch. 903) in 1991. This legislation authorized local agencies overlying basins subject to critical overdraft conditions, as defined in DWR's Bulletin 118-80 (DWR, 1980), to establish programs for groundwater management within their service areas. Water Code § 10750 et seq. provided these agencies with the powers of a water replenishment district to raise revenue for facilities to manage the basin for the purposes of extraction, recharge, conveyance, and water quality management. Seven local agencies adopted plans under this authority. The South Westside Basin has never been defined by DWR as being critically overdrafted, as such it was not subject to AB 255.

The provisions of AB 255 were repealed in 1992 with the passage of AB 3030 (Stats. 1992, Ch. 947). This legislation greatly increased the number of local agencies authorized to develop a GWMP and set forth a common management framework for local agencies throughout California. AB 3030, codified in Water Code § 10750 et seq., provides a systematic procedure to develop a groundwater management plan by local agencies overlying the groundwater basins defined by DWR's Bulletin 118 (DWR, 1975) and updates (DWR, 1980, 2003). Upon adoption of a plan, these agencies could possess the same authority as a water replenishment district to "fix and collect fees and assessments for groundwater management" (Water Code, § 10754). However, the authority to fix and collect these fees and assessments is contingent on receiving a majority of votes in favor of the proposal in a local election (Water Code, § 10754.3).

By 2003, more than 200 agencies (shown in Figure 1.6) had adopted an AB 3030 GWMP (DWR, 2003). None of these agencies is known to have exercised the authority of a water replenishment district.

Water Code § 10755.2 expands groundwater management opportunities by encouraging coordinated plans and authorizing public agencies to enter into a JPA or memorandum of understanding (MOU) with public or private entities providing water service. At least 20 coordinated plans have been prepared to date involving nearly 120 agencies, including cities and private water companies.

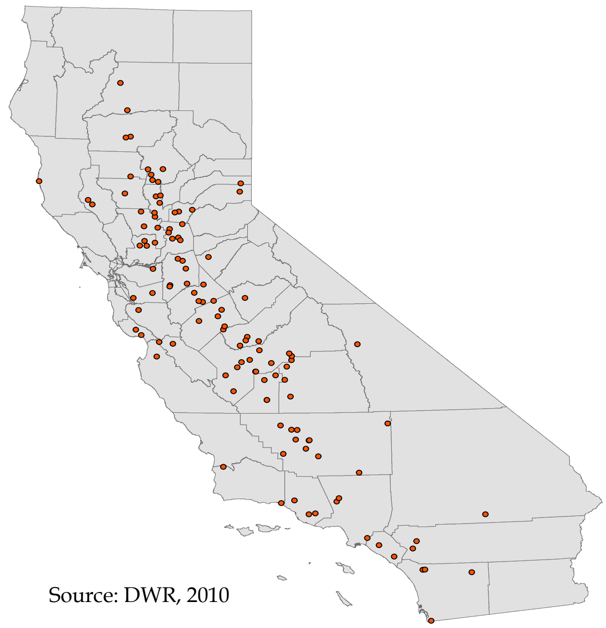


Figure 1.6. Location of areas with groundwater management plans

In 2002, the California Legislature passed Senate Bill (SB) 1938 (Stats. 2002, ch. 603), which provides local agencies with incentives for improved groundwater management. While not providing a new vehicle for groundwater management, SB 1938 modified the Water Code by requiring specific elements be included in a GWMP for an agency to be eligible for certain funding administered by DWR for groundwater projects.

Through AB 3030 and SB 1938, local agencies can now develop GWMPs that guide the sustainable use of the groundwater resource while also providing access to certain DWR funding sources.

1.5 PRIOR AND CURRENT WATER MANAGEMENT PLANNING EFFORTS

The South Westside Basin has an extensive history of management of groundwater and surface water resources. This document builds upon those efforts, described below.

1.5.1 DRAFT WESTSIDE BASIN GROUNDWATER MANAGEMENT PLAN

In 1999, cities and water purveyors overlying much of the Westside Basin (Daly City, CalWater, San Bruno, and SFPUC) cooperatively developed a proposed Westside Basin AB 3030 Groundwater Management Plan (1999 Plan; Bookman-Edmonston, 1999), pursuant to the guidelines in AB 3030. Although not adopted by the cities due to data gaps and other concerns at the time, the four cities and water purveyors have voluntarily implemented much of the recommendations and other aspects of the 1999 Plan.

The 1999 Plan established a goal of protecting water quality and enhancing water supply reliability in the Westside Basin. This goal was supported by five plan elements:

- **Groundwater Storage and Quality Monitoring –** development of a basin-wide monitoring program
- **Saline Water Intrusion –** use of monitoring data to indicate any occurrence of saltwater intrusion and to provide technical information needed to develop appropriate management responses if intrusion occurs
- **Conjunctive Use –** development of a multi-agency conjunctive use program, including monitoring
- **Recycled Water –** development of a recycled water program for landscape irrigation and other non-potable uses
- **Source Water and Wellhead Protection –** protection of groundwater from contamination from methyl tert-butyl ether (MTBE) and other contaminants through source water assessment methodologies

1.5.2 Regional Groundwater Storage and Recovery Project

The proposed Regional Groundwater Storage and Recovery (GSR) Project is designed to balance the use of both groundwater and surface water to increase water supply reliability during dry years or in emergencies. Located in the South Westside Basin, the proposed project is sponsored by SFPUC in coordination with partner agencies: CalWater, Daly City, and San Bruno. The partner agencies currently purchase wholesale surface water from SFPUC and also independently operate groundwater production wells for drinking water and irrigation.

The project would consist of installing up to 16 new recovery well facilities in the South Westside Basin to pump stored groundwater during a drought. During years of normal or above normal precipitation, the proposed project would provide surface water to the partner agencies to reduce the amount of groundwater pumped. The reduced pumping is estimated to result in the storage of approximately 61,000 AF of water in the long-term. This is estimated to allow recovery of stored water at a rate of up to 7.2 million gallons per day (mgd) for a 7.5-year drought period, if the full 61,000 AF is stored prior to the drought period (MWH, 2007). The storage of water in the basin was analyzed through the In-Lieu Pilot Study (ILPS), which is described in the following section.

The GSR Project is in the design and environmental review phases and is envisioned to coordinate management of groundwater supplies through an Operating Committee. The development of the GSR Project includes extensive study of the hydrogeology of the South

Westside Basin and was documented in the Alternatives Analysis Report (MWH, 2007) and in reports documenting monitoring well installation (Kennedy/Jenks, 2009 and 2010).

The parties are working to develop an operating agreement in connection with the proposed GSR Project. To-date, the SFPUC has installed ten multi-level monitoring wells in the South Westside Basin (each consisting of 4 nested monitoring wells). The Proposed Project Draft EIR is scheduled to be circulated in 2012.

1.5.3 IN-LIEU PILOT STUDY

Beginning in 2002, SFPUC delivered surface water in-lieu of groundwater through the ILPS to Daly City, San Bruno and CalWater - South San Francisco District. The ILPS demonstrated that SFPUC system water can be stored in the Basin through the delivery of in-lieu water to replace groundwater that Daly City, San Bruno, and CalWater refrained from pumping (Luhdorff & Scalmanini Consulting Engineers [LSCE], 2005).

During the ILPS, significant quantities of water were banked as shown in Figure 1.7 and discussed below:

- **Daly City -** Through May 7, 2007, SFPUC delivered 13,077 AF of in-lieu water to Daly City. Beginning in May 2009, SFPUC resumed delivery of in-lieu water to Daly City, resulting in additional banking of water. In 2009 and 2010, 1,921 AF and 2,204 AF of water was banked by Daly City, respectively.
- **CalWater – South San Francisco District -** Between February 1, 2003 and November 1, 2003, SFPUC delivered 802 AF of in-lieu water to CalWater – South San Francisco District. When the ILPS restarted on April 1, 2004, CalWater did not participate and did not resume pumping, but continued to rely on wholesale water for all of its water needs in its South San Francisco service area. This resulted in an increase in basin water levels as if CalWater had continued to participate in the ILPS, and a corresponding increase in stored water of 930 AF between April 1, 2004 and March 1, 2005.
- **San Bruno –** From January 28, 2003 through March 1, 2005, SFPUC delivered 3,915 AF of in-lieu water to San Bruno.

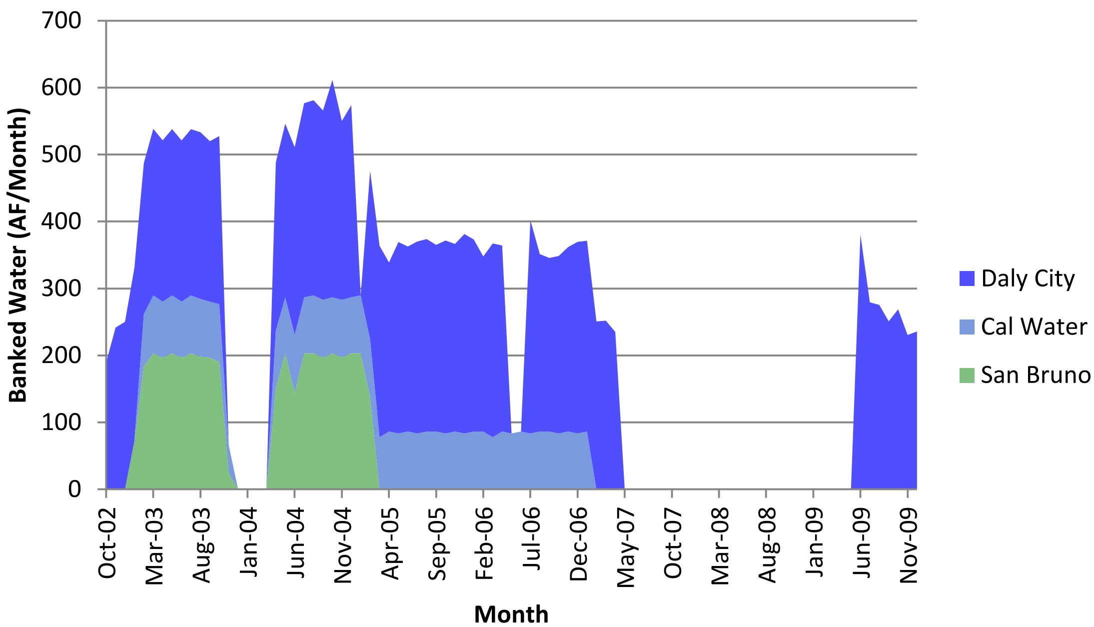


Figure 1.7 Banked Groundwater in In-Lieu Pilot Study

1.5.4 San Francisco Bay Basin Water Quality Control Plan

The *San Francisco Bay Basin Water Quality Control Plan* (Basin Plan) (California Regional Water Quality Control Board, San Francisco Bay Region [RWQCB], 2010) was developed by the RWQCB to provide positive and firm direction for future water quality control.

The Basin Plan fulfills the following needs:

- Requirements from the U.S. Environmental Protection Agency (EPA) for such a plan to allocate federal grants to cities and districts for construction of wastewater treatment facilities.
- A basis for establishing priorities for disbursing both state and federal grants for constructing and upgrading wastewater treatment facilities.
- Requirements of the Porter-Cologne Act that call for water quality control plans in California.
- A basis for the RWQCB to establish or revise waste discharge requirements and for the State Water Resources Control Board (Water Board) to establish or revise water rights permits.
- Conditions (discharge prohibitions) that must be met at all times.
- Water quality standards applicable to waters of the Region, as required by the federal Clean Water Act.

- Water quality attainment strategies, including total maximum daily loads required by the Clean Water Act, for pollutants and water bodies where water quality standards are not currently met.

While the Basin Plan has a definite focus on surface water resources, groundwater quality is included as well, particularly through the watershed management approach. This approach includes groundwater as well as surface water bodies (e.g., streams, rivers, lakes, reservoirs, wetlands, and the surrounding landscape) in an effort to develop unique, integrated solutions for individual watersheds through a stakeholder process.

As with surface water, the Basin Plan establishes beneficial uses for groundwater throughout the San Francisco Bay Region. For the South Westside Basin, the Basin Plan identifies two areas: Westside C (2-35C), extending from the San Francisco County line to the City of South San Francisco, and Westside D (2-35D), extending from South San Francisco to the southern extent of the South Westside Basin. The designated beneficial uses for groundwater within these areas, and within areas in the North Westside Basin, are shown in Table 1.1.

Table 1.1 Basin Plan Beneficial Uses for Groundwater

Basin Plan Basin	Location	Beneficial Uses			
		Municipal and Domestic Water Supply	Industrial Process Water Supply	Industrial Service Water Supply	Agricultural Water Supply
Westside C	South Westside Basin	Existing	Potential	Potential	Existing
Westside D	South Westside Basin	Existing	Existing	Existing	Potential
Westside A	North Westside Basin	Existing	Potential	Potential	Existing
Westside B	North Westside Basin	Potential	Potential	Potential	Existing

The Basin Plan sets objectives for groundwater, with maintenance of existing high-quality of groundwater being the primary objective. In addition, at a minimum, groundwater shall not contain concentrations of bacteria, chemical constituents, radioactivity, or substances producing taste and odor in excess of the objectives unless naturally occurring background concentrations are greater. Under existing law, the Water Board regulates waste discharges to land that could affect water quality, including both groundwater and surface water quality. Waste discharges that reach groundwater are regulated to protect both groundwater and any surface water in continuity with groundwater. Waste discharges that affect groundwater in continuity with surface water cannot cause violations of any applicable surface water standards.

For implementation, the RWQCB focuses on 28 groundwater basins and 7 sub-basins in the Bay Area that serve, or could serve, as sources of high quality drinking water. The Westside Basin is one of these basins. The Basin Plan establishes the following groundwater protection and management goals for the Bay Area region:

- Identify and update beneficial uses and water quality objectives for each groundwater basin.
- Regulate activities that impact or have the potential to impact the beneficial uses of groundwater of the region.
- Prevent future impacts to the groundwater resource through local and regional planning, management, education, and monitoring.

1.5.5 San Francisco and Northern San Mateo County Pilot Beneficial Use Designation Project

RWQCB staff, with contributions from local agencies, evaluated existing groundwater protection programs and beneficial uses of groundwater in San Francisco and northern San Mateo County (RWQCB, 1996). Extensive research was conducted and numerous references were compiled to complete the project. The project included the following goals:

- Describe the hydrogeology and groundwater uses for the groundwater basins
- Identify major threats to groundwater and groundwater protection programs
- Identify locations where groundwater is vulnerable to contamination
- Identify locations where groundwater monitoring is needed
- Use GIS to compile complex data sets to use as a decision-making tool for groundwater protection
- Refine beneficial use designations for some groundwater basins
- Identify inactive well locations
- Describe groundwater extraction for municipal, agricultural, and industrial water supply
- Summarize statewide initiatives for groundwater protection and data sharing

- o Evaluate special problem areas not typically addressed by groundwater protection programs

The results of the project identified the Westside Basin as a valuable resource deserving of full protection and restoration, including aggressive remediation of contaminated groundwater, enhanced source control and groundwater protection to prevent additional pollution, and groundwater basin management to prevent overdraft.

1.5.6 Groundwater Ambient Monitoring and Assessment Program: San Francisco Bay Study Unit

The Groundwater Ambient Monitoring and Assessment (GAMA) program is a comprehensive assessment of statewide groundwater quality implemented by the Water Board in coordination with the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory. The program is designed to help better understand and identify risks to groundwater resources. The South Westside Basin was included in the study through the investigation of the San Francisco Bay study unit, which includes portions of San Francisco, San Mateo, Santa Clara, and Alameda Counties, with sampling from April through June 2007.

Groundwater was sampled from 79 wells within the San Francisco Bay study unit to characterize its constituents and identify trends in groundwater quality through a spatially unbiased assessment of raw groundwater quality. Four grid cell wells (SF-03, SF-04, SF-05, and SF-06) and seven understanding wells (SFM-A1, SFM-A2, SFM-A3 SFM-A4, SFM-B1, SFM-B2, and SFU-01) are located in or near the South Westside Basin. The focus on raw water quality rather than treated water quality and the spatially unbiased nature of the program set it apart from other sampling programs that typically use available data from existing wells that are biased toward better water quality and have data intended to meet regulatory requirements for drinking water supplies.

The test results provide information to address a variety of issues ranging in scale from local water supply to statewide resource management. Full analysis of the results will be included in a future USGS report.

1.5.7 Bay Area Integrated Regional Water Management Plan

The Bay Area Integrated Regional Water Management Plan (IRWMP) (RMC and Jones & Stokes, 2006) was developed through a Letter of Mutual Understanding by San Francisco Bay Area water, wastewater, flood protection, and stormwater management agencies; cities and counties represented by the Association of Bay Area Governments; and watershed management interests represented by the California Coastal Conservancy and non-governmental environmental organizations. The IRWMP outlines the region's water resource management needs and objectives, and presents innovative strategies and a detailed implementation plan to achieve these objectives, contributing to sustainable water resources management in the Bay Area.

The following are the overall objectives of the Bay Area IRWMP:

1) Foster coordination, collaboration and communication among Bay Area agencies responsible for water and habitat-related issues.
2) Achieve greater efficiencies and build public support for vital projects.
3) Improve regional competitiveness for project funding.

The Bay Area IRWMP identifies regional priority projects, including two in the South Westside Basin: the Lomita Canal / Cupid Row Canal Upgrades at San Francisco International Airport and SFPUC Groundwater Projects (including Lake Merced Project, Local Groundwater Projects, and the Regional Groundwater Storage and Recovery Project).

The Bay Area IRWMP will be going through an update during 2011 – 2012 to ensure that the IRWMP is in compliance with Proposition 84 requirements, including a climate change impact assessment and integrated flood management.

1.5.8 Water Supply Agreement between The City and County of San Francisco and Wholesale Customers in Alameda County, San Mateo County, and Santa Clara County

The Water Supply Agreement between the City and County of San Francisco and Wholesale Customers in Alameda County, San Mateo County, and Santa Clara County (Wholesale Water Supply Agreement) (July, 2009) defines the agreement for San Francisco to deliver, up to a defined quantity (Supply Assurance), water to the wholesale customers, including the water agencies in the South Westside Basin. The Supply Assurance includes the wholesale customers as a group, while Individual Supply Guarantees are defined for each agency (Table 1.2). These quantities are expressed in terms of daily deliveries on an annual average basis, although San Francisco agrees to operate the system to meet peak requirements to the extent possible without adversely impacting the ability to meet peak demands of retail customers.

The Wholesale Water Supply Agreement includes details on allocation, service areas, permanent transfers, resale, conservation, other supplies, water quality, maintenance, operation, shortages, wheeling, new customers, metering, the proposed conjunctive use program for the South Westside Basin, implementation of interim supply limitations, wholesale revenues, accounting, and other agreements.

Table 1.2 Individual Supply Guarantees

Wholesale Customer	Individual Supply Guarantee (mgd)	Water Purchases Fiscal Year 2009-2010 (mgd)*
California Water Services Company	35.68 (includes South San Francisco and areas outside the South Westside Basin)	32.6 (7.2 mgd for South San Francisco District)
City of Burlingame	5.234	3.9
City of Daly City	4.292	3.2**
City of Millbrae	3.152	2.2
City of San Bruno	3.246	1.5
Town of Hillsborough	4.090	3.0

* BAWSCA, 2011
** Amount shown does not include 1.9 mgd of in-lieu water purchases

1.5.9 URBAN WATER MANAGEMENT PLANS

Urban water management plans (UWMP) include descriptions and evaluations of historical, current, and future sources of water supply; efficient uses of water; demand management measures; implementation strategies and schedules; and other information as required by the Urban Water Management Planning Act. They are important components for the planning process of each agency and values from these plans are used extensively in Section 3, Water Requirements and Supplies, of this GWMP.

A UWMP is required for water agencies with more than 3,000 customers or that provide over 3,000 AF of water annually. Within the South Westside Basin, UWMPs have been developed and adopted by Burlingame, Daly City, Hillsborough, Millbrae, San Bruno, and CalWater. In the North Westside Basin, SFPUC has developed a UWMP.

1.6 PUBLIC PROCESS IN DEVELOPING THE GROUNDWATER MANAGEMENT PLAN

The development of any GWMP is a collaborative process involving all interested stakeholders. Public input is critical to the success of the South Westside Basin GWMP and was a key component of its development.

The public was informed and encouraged to provide input and participate in the development of the GWMP in the following ways:

- GWMP web site: **www.southwestsideplan.com** provided information to the public regarding the GWMP. Details about groundwater management in general and specific to the South Westside Basin were provided. Meeting dates, locations, and materials were posted along with details of the South Westside Basin GWMP Advisory Committee (Advisory Committee) and contact information.
- Newspaper advertisements in the San Mateo County Times gave notice of public hearings.
- Public hearings provided opportunities for personal communications captured in the public record on specific topics, including resolution of intent to draft a GWMP and resolution of adoption of the GWMP.
- Public meetings provided details on the GWMP process and solicited input.
- Advisory Committee meetings provided detailed technical information on the GWMP and solicited input.
- Direct communication by telephone, email, and mail was encouraged at meetings and on the web site. Comments could be sent to the City of San Bruno project manager, local water agency staff, or the consultant project manager.

1.6.1 JUNE 2009 PRESENTATION TO IRRIGATION PUMPERS IN THE SOUTH WESTSIDE BASIN

A presentation on the South Westside Basin GWMP was given on June 25, 2009 to cemetery and golf course interests as part of a SFPUC meeting on the proposed GSR and its potential impacts and benefits for cemeteries and golf courses. The meeting was held at 10:30 a.m. at the Colma Town Hall. The presentation gave an overview of groundwater planning, the proposed GWMP, and the process of developing the GWMP. Attendees were invited to provide contact information and to continue to provide guidance as the GWMP is developed and implemented. Copies of the presentation were provided to interested parties via email. Attendees included representatives from the following:

- Holy Cross Cemetery
- Lake Merced area golf courses
- Town of Colma

- City of Daly City
- City of San Bruno
- SFPUC

1.6.2 Public Hearings

1.6.2.1 Intent to Adopt

A public hearing of Intent to Adopt a Groundwater Management Plan was held at the regular meeting of the San Bruno City Council at 7 p.m. on August 24, 2010 at the San Bruno Senior Center. The hearing was advertised in the *San Mateo Times*, on August 10, 2010 and August 17, 2010. A resolution was adopted by the City Council and subsequently was published in the San Mateo Times on September 8, 2010 and September 15, 2010. The advertisements and the resolution are included in Appendix A.

1.6.2.2 Adoption

A public hearing to adopt the Groundwater Management Plan was held at the regular meeting of the San Bruno City Council at 7 p.m. on July 10, 2012 at the San Bruno Senior Center. The hearing was advertised in the *San Mateo Tim*es twice prior to the hearing. The advertisements and the resolution are included in Appendix A.

1.6.3 Public Meetings

A total of five public meetings were held to inform the public on the development of the groundwater management plan.

1.6.3.1 Background, Components, and Process

Three public meetings were held at locations across the South Westside Basin to provide information on the importance of groundwater as a water supply, the need for management of the groundwater resource, the role of a GWMP, the role of the public in the development and implementation of the GWMP, and the preliminary goals, objectives, and elements of the groundwater management plan.

1.6.3.1.1 San Bruno Presentation

The presentation in the southern portion of the South Westside Basin was given at San Bruno City Hall on Thursday September 9, 2010 at 5:30 pm. The meeting was advertised on San Bruno's cable television station, noticed at City Hall, and advertised in the *San Mateo Times* on September 4, 2010.

1.6.3.1.2 Daly City Presentation

A presentation in the northern portion of the South Westside Basin at was given at Daly City City Hall on Thursday September 23, 2010 at 7:00 pm. The meeting was noticed at City Hall, on the city's web page, and on the city's cable television station. Interviews were provided to a student from San Francisco State University for airing on the campus radio station, KSFS.

1.6.3.1.3 Colma Presentation

The presentation in the central portion of the South Westside Basin was given at Colma Town Hall on Thursday October 13, 2010 at 11:30 am. The meeting was noticed at Town Hall. Extensive personal outreach was conducted to inform the numerous cemeteries that utilize private groundwater wells for their irrigation supply.

1.6.3.2 Draft Plan Presentation

The fourth public meeting was held at Colma Town Hall on May 24, 2011 at 11:30am. The meeting was noticed at Town Hall and outreach was performed to inform the cemeteries. The draft Groundwater Management Plan was presented and stakeholders were provided an opportunity to discuss the draft Plan and provide comments either in person or at a later date.

1.6.3.3 Distribution of Draft GWMP

The draft text of the GWMP was distributed to the public for comment on May 10, 2012. The comment period extended until June 9, 2012. One email was received with comments, which were addressed.

1.6.3.4 Final Draft Plan Presentation

The fifth public meeting was held at San Bruno City Hall on May 23, 2012 at 5:30 pm. The meeting was noticed at City Hall and advertised in the *San Mateo Times* on May 20, 2012. The final draft Groundwater Management Plan and the activities moving forward were discussed.

1.7 SOUTH WESTSIDE BASIN GWMP ADVISORY COMMITTEE

The Advisory Committee was organized to solicit input and direct the development of the GWMP. Agencies and key stakeholders were provided written invitations to send to their representatives to invite them to participate in the Advisory Committee. Other stakeholders were invited to join through the public notification process, hearings, the web site, and public meetings. Table 1.3 lists the Advisory Committee members and their affiliations. Meetings were held from 2009 through 2011 to coordinate stakeholder input and incrementally build the GWMP. Agendas and minutes are included in Appendix A.

During implementation of the GWMP, it is anticipated that most of the members of the Advisory Committee will join the Groundwater Task Force. The Groundwater Task Force will guide the implementation of the GWMP and is described in more detail in Section 6.1.

Table 1.3 Advisory Committee Members

Entity	Representative
Bay Area Water Supply and Conservation Agency	Anona Dutton
City of Brisbane	Randy L. Breault
City of Burlingame	Phil Monaghan
California Water Services Company	Tom Salzano
DWR	Mark Nordberg
Cemeteries	Roger Appleby
Town of Colma	Brad Donohue
City of Daly City	Patrick Sweetland
RWQCB	Kevin D. Brown
City of San Bruno	Will Anderson
SFPUC	Greg Bartow
City of South San Francisco	Terry White
Interested citizens	Robert Riechel

1.7.1 December 18, 2009 Advisory Committee Meeting 1

An Advisory Committee meeting was held on December 18, 2009 to coordinate the Advisory Committee, develop a common understanding of basin conditions and groundwater management plans, and to develop a goal or goals for the basin. The meeting was held at San Bruno City Hall and was well attended, including representatives of the following:

- California Water Services Company
- City of Brisbane
- City of Burlingame
- City of Daly City
- City of San Bruno
- RWQCB
- SFPUC
- Town of Colma
- Private citizens
- Cemeteries

The meeting minutes are included in Appendix A.

1.7.2 March 11, 2010 Advisory Committee Meeting 2

The second Advisory Committee meeting was held on March 11, 2010 to discuss Basin Management Objectives (BMOs), both in general and specific to the South Westside Basin. The meeting was held at San Bruno City Hall and was attended by representatives of the following:

- Bay Area Water Supply and Conservation Agency
- DWR
- California Water Services Company
- City of Daly City
- City of San Bruno
- RWQCB
- SFPUC
- Town of Colma
- Cemeteries

The meeting minutes are included in Appendix A.

1.7.3 June 24, 2010 Advisory Committee Meeting 3

An Advisory Committee meeting was held on June 24, 2010 to discuss comments received on the BMOs and to discuss the Elements of the Plan. The meeting was held at San Bruno City Hall and was attended by representatives of:

- Bay Area Water Supply and Conservation Agency
- DWR
- California Water Services Company
- City of Daly City
- City of San Bruno
- SFPUC
- Town of Colma

The meeting minutes are included in Appendix A.

1.7.4 August 16, 2010 Advisory Committee Meeting 4

An Advisory Committee meeting was held on August 16, 2010 to discuss basin governance and financing of the implementation of the groundwater management plan. The meeting was held at San Bruno City Hall and was attended by representatives of:

- DWR
- California Water Services Company
- City of Daly City
- City of San Bruno
- RWQCB
- SFPUC

- Town of Colma

The meeting minutes are included in Appendix A.

1.7.5 February 3, 2011 Advisory Committee Meeting 5

An Advisory Committee meeting was held on February 3, 2011 to discuss the recent completion of a revision to the Westside Basin Groundwater Flow Model and the utility of the model in the development of the GWMP. The discussion included using the model to estimate the basin yield. The meeting was held at San Bruno City Hall and was attended by representatives of:

- California Water Services Company
- City of Daly City
- City of San Bruno
- SFPUC
- Town of Colma
- Cemeteries

The meeting minutes are included in Appendix A.

1.7.6 April 28, 2011 Advisory Committee Meeting 6

An Advisory Committee meeting was held on April 28, 2011 to update the current status of the Groundwater Management Plan to provide information to focus the review to be performed by the Advisory Committee. Progress toward participation in the CASGEM program was also discussed.

The meeting was held at San Bruno City Hall and was attended by representatives of:

- DWR
- California Water Services Company
- City of Daly City
- City of San Bruno
- SFPUC
- Town of Colma
- Cemeteries

The meeting minutes are included in Appendix A.

1.7.7 April 15, 2011 Distribution of Draft GWMP

The draft text of the GWMP was distributed to the Advisory Committee for comment on April 15, 2011. Comments were received from BAWSCA, CalWater, San Bruno, SFPUC, and Steve Lawrence and incorporated into the text as appropriate.

1.8 GROUNDWATER MANANGEMENT PLAN AND CONSISTENCY WITH CALIFORNIA WATER CODE

Groundwater management is the planned and coordinated local effort of sustaining the groundwater basin in order to meet future water supply needs. With the passage of AB 3030 in 1992, local water agencies were provided a systematic way of formulating GWMPs (California Water Code, § 10750 et. seq.). SB 1938, passed in 2002, further emphasizes the need for groundwater management in California. SB 1938 requires AB 3030 GWMPs to contain specific plan components in order to receive state funding for water projects.

The South Westside Basin Groundwater Management Plan is prepared consistent with the provisions of California Water Code § 10750 et seq. as amended January 1, 2003. The South Westside Basin GWMP includes the seven components that are required to be eligible for DWR funds for the construction of groundwater projects or groundwater quality projects. The GWMP also addresses the 12 specific technical issues identified in the Water Code along with the seven recommended components identified in DWR Bulletin 118-03 (DWR, 2003). Table 1.4 lists the required and recommended components and identifies the specific section of this GWMP in which the components are discussed.

Table 1.4 South Westside Basin GWMP Components

Component	GWMP Section(s)
SB 1938 Mandatory	
1. Documentation of public involvement	1.6, 1.7, App. A
2. BMOs	4.3
3. Monitoring and management of groundwater elevations, groundwater quality, inelastic land subsidence, and changes in surface water flows and quality that directly affect groundwater levels or quality	5.2
4. Plan to involve other agencies located in the groundwater basin	5.1
5. Adoption of monitoring protocols	5.2, App. C
6. Map of groundwater basin boundary, as delineated by DWR Bulletin 118, with boundaries of agencies subject to the GWMP	Figures 1.1, 1.2, and 1.3
7. For agencies not overlying groundwater basins, GWMP prepared using appropriate geologic and hydrogeologic principles	n/a
AB 3030 and SB 1938 Voluntary	
1. Control of saline water intrusion	5.4.1
2. Identification and management of well protection and recharge areas	5.4.2
3. Regulation of the migration of contaminated groundwater	5.4.3
4. Administration of well abandonment and destruction program	5.4.4
5. Control and mitigation of groundwater overdraft	5.3.1
6. Replenishment of groundwater	5.3.2
7. Monitoring of groundwater levels	5.2.1, App. C
8. Development and operation of conjunctive use projects	5.3.3
9. Identification of well construction policies	5.4.5
10. Construction and operation of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects	5.5
11. Development of relationships with state and federal regulatory agencies	5.6.1
12. Review of land use plans and coordination with land use planning agencies to assess activities that create reasonable risk of groundwater contamination	5.6.3
DWR Bulletin 118 Recommended	
1. Management with guidance of advisory committee	1.7, 5.1
2. Description of area to be managed under GWMP	1.1, Figures 1.1, 1.2, and 1.3
3. Links between BMOs and goals and actions of GWMP	4, 6
4. Description of GWMP monitoring programs	5.2, App. C
5. Description of integrated water management planning efforts	1.5, 5.6.2
6. Report of implementation of GWMP	5.7
7. Periodic evaluation of GWMP	5.7

2.1 CLIMATE

The South Westside Basin's location in a valley between the Pacific Ocean and San Francisco Bay gives it a variable, but mild, marine climate. Winters are mild and moderately wet and summers are cool and dry (National Oceanic and Atmospheric Administration, 2009). The valley serves as a gap in the coast range, allowing cool, moist marine air into the central Bay Area. Generally, areas closer to the Pacific Ocean or closer to the valley experience the most marine effects, notably lower summer temperatures and lower evapotranspiration, while those areas in the south of the basin, such as Burlingame, experience less marine influence and have more sunshine, higher summer temperatures, and higher evapotranspiration rates.

This climate, along with limited outdoor water use, contributes to water demand that is only somewhat higher in the summer than in the winter. Average monthly temperature and reference evapotranspiration data are shown in Table 2.1. Temperature data are from San Francisco International Airport (SFIA), within the Plan Area; however, the closest reference evapotranspiration data is from Woodside, south of the Plan Area. Temperature, evapotranspiration, and rainfall are variable in the basin and are driven by proximity to the Pacific Ocean and local topography. Areas closer to the ocean are cooler and cloudier, with lower evapotranspiration. Higher elevation areas have more rainfall.

Table 2.1 Average Monthly Temperature and Reference Evapotranspiration

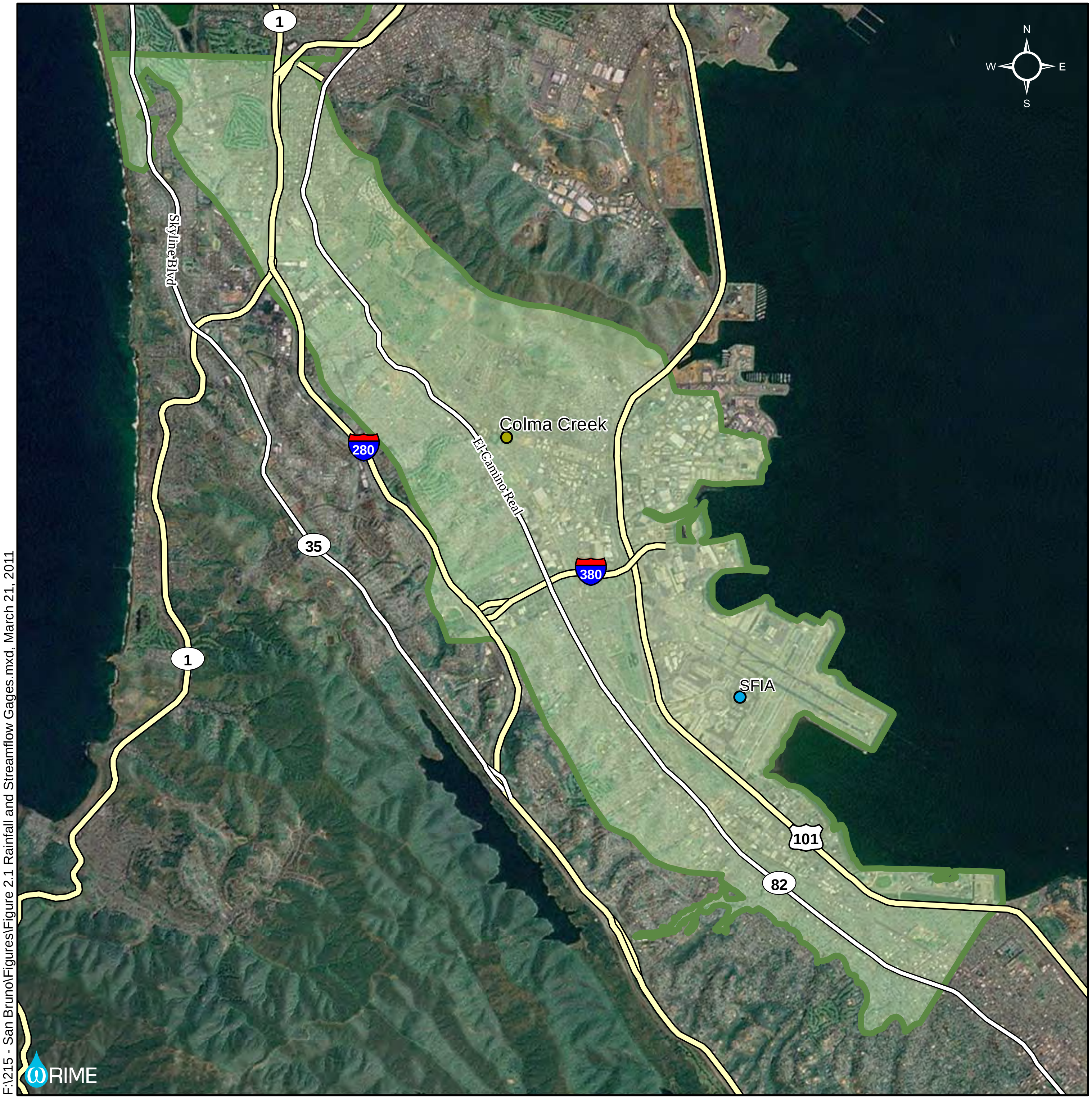
Parameter	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Average maximum temperature (°F)*	55.8	59.1	61.2	63.8	66.8	70.0	71.4	72.1	73.5	70.1	62.9	56.4	65.3
Average minimum temperature (°F)*	42.5	45.0	46.2	47.7	50.3	52.7	54.1	55.0	54.9	51.9	47.4	43.2	49.2
Precipitation (inches)**	4.4	3.6	2.8	1.4	0.4	0.1	0.0	0.1	0.2	1.0	2.3	3.7	20.0
Average reference evapotranspiration (inches)***	1.83	2.21	3.42	4.84	5.61	6.26	6.47	6.22	4.84	3.66	2.36	1.83	49.54

* Source: Western Regional Climate Center, 2011. San Francisco WSO AP, California (047769). Period of record 7/1948 – 9/2010.
** Source: NOAA-NCDC, 2007, 2009, 2011
*** Source: California Irrigation Management Information System (CIMIS), 2009. 96 Woodside. Period of record 10/1990 – 1/1994

The National Weather Service through its Cooperative Network collects rainfall data at SFIA: Coop ID #047769 (see Figure 2.1). Data are available from May 1928 through present.

The historical record of annual rainfall and the cumulative departure from annual mean at SFIA are shown in Figure 2.2. The long-term average annual precipitation for the period from 1949 to 2010 is 20 inches. Figure 2.3 shows the long-term average monthly precipitation at SFIA. Most precipitation occurs as rainfall during the mild winters, from November through April. A map of the spatial distribution of precipitation by HydroFocus (2011) is shown in Figure 2.4. Across the basin, annual precipitation ranges from less than 20 inches along San Francisco Bay near SFIA and along the Pacific Ocean in Daly City to approximately 24 inches in the center of the valley near Colma and South San Francisco to approximately 30 inches in the hills above the valley.

Figure 2.1
Rainfall and Streamflow Gages



Legend

- Highways
- Groundwater Basin
- Plan Area
- NOAA Precipitation Gage
- USGS Streamflow Gage

0 0.5 1 2 Miles

F:\215 - San Bruno\Figures\Figure 2.1 Rainfall and Streamflow Gages.mxd, March 21, 2011

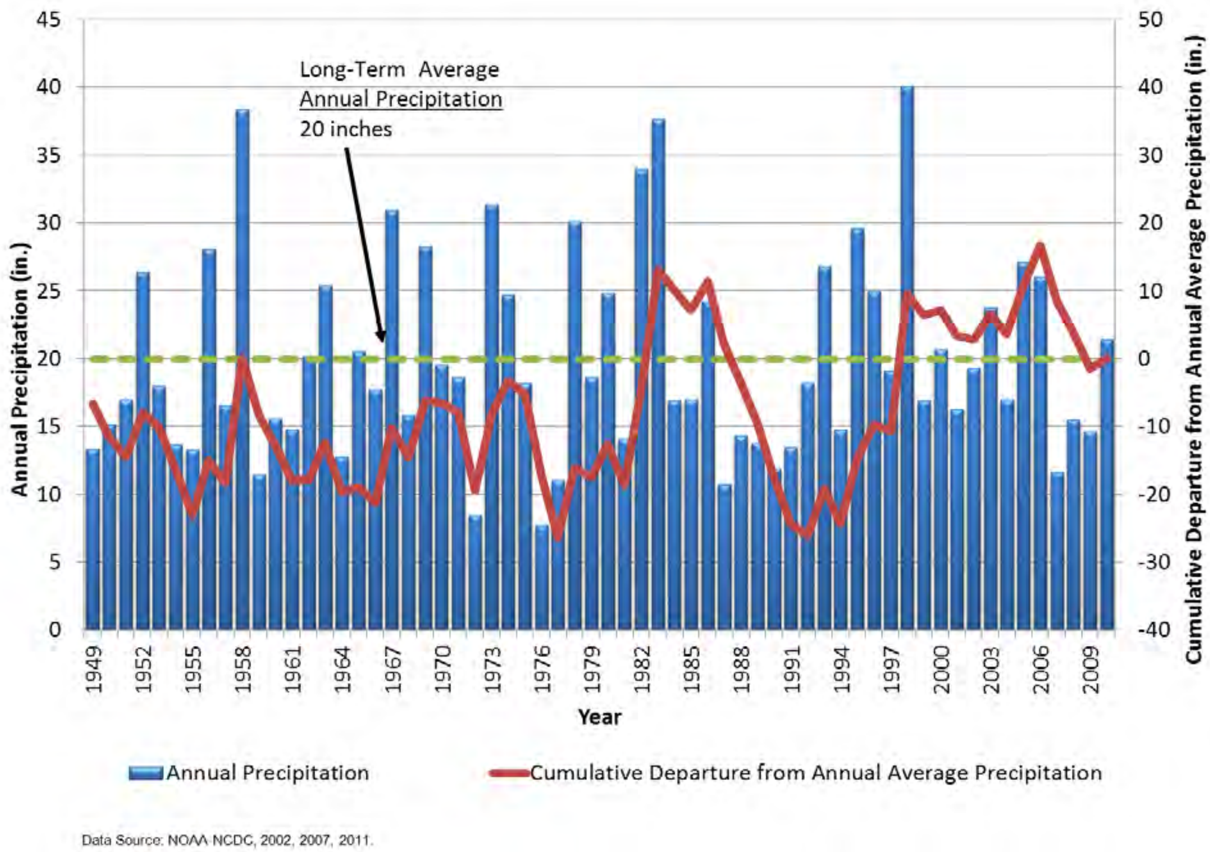


Figure 2.2 Historical Annual Precipitation and Cumulative Departure from Mean Precipitation

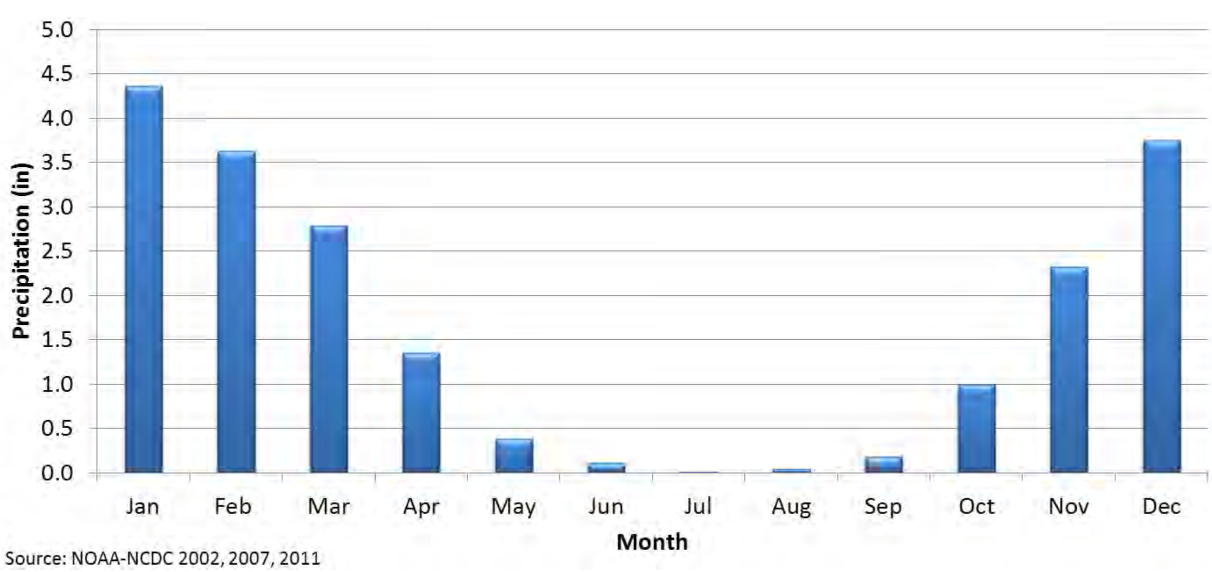
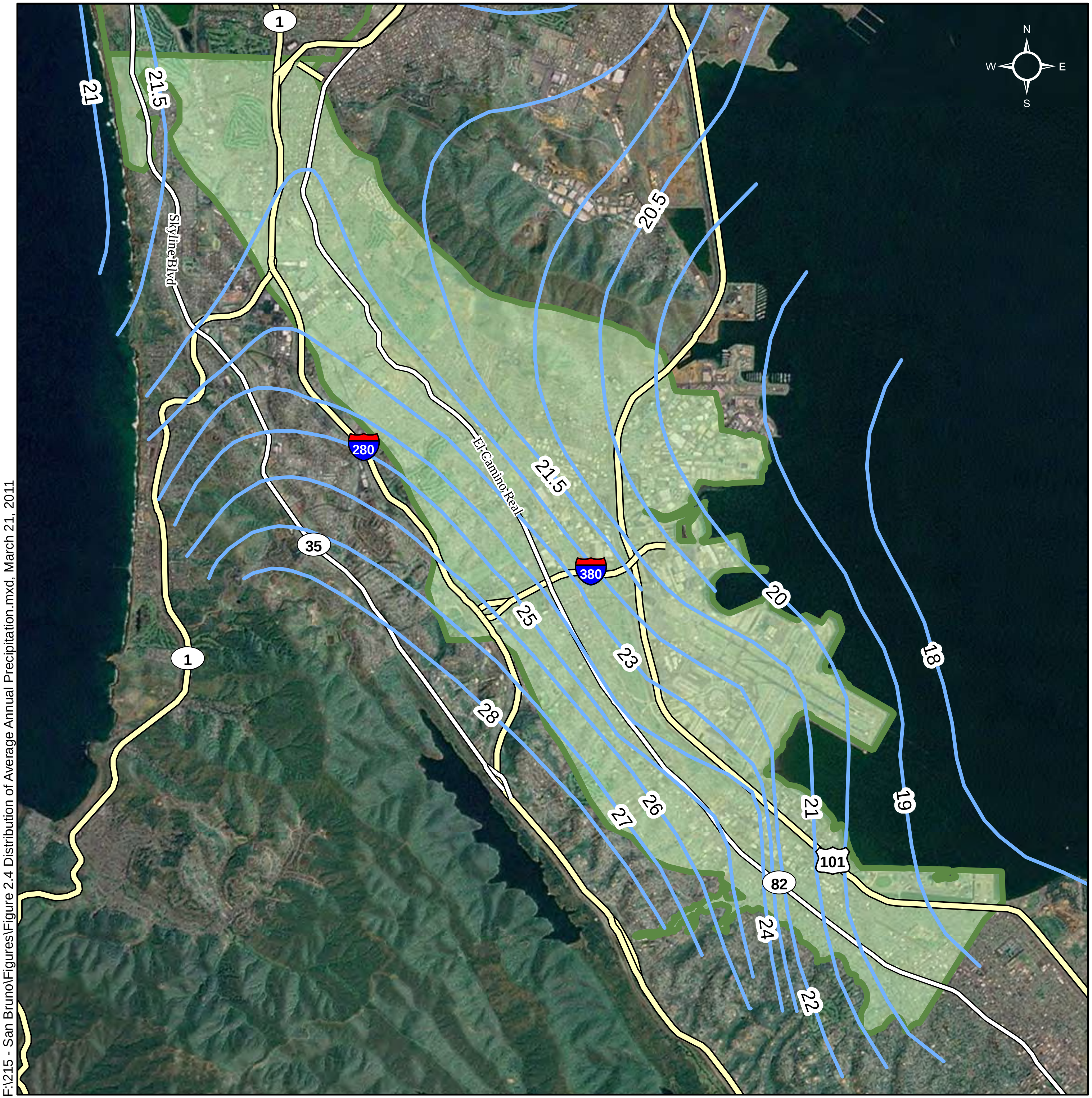


Figure 2.3 Average Monthly Precipitation

Figure 2.4
Distribution of Average Annual Precipitation



Legend

- Precipitation (in)
- Highways
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

Source: Precipitation - HydroFocus, 2011

F:\215 - San Bruno\Figures\Figure 2.4 Distribution of Average Annual Precipitation.mxd, March 21, 2011

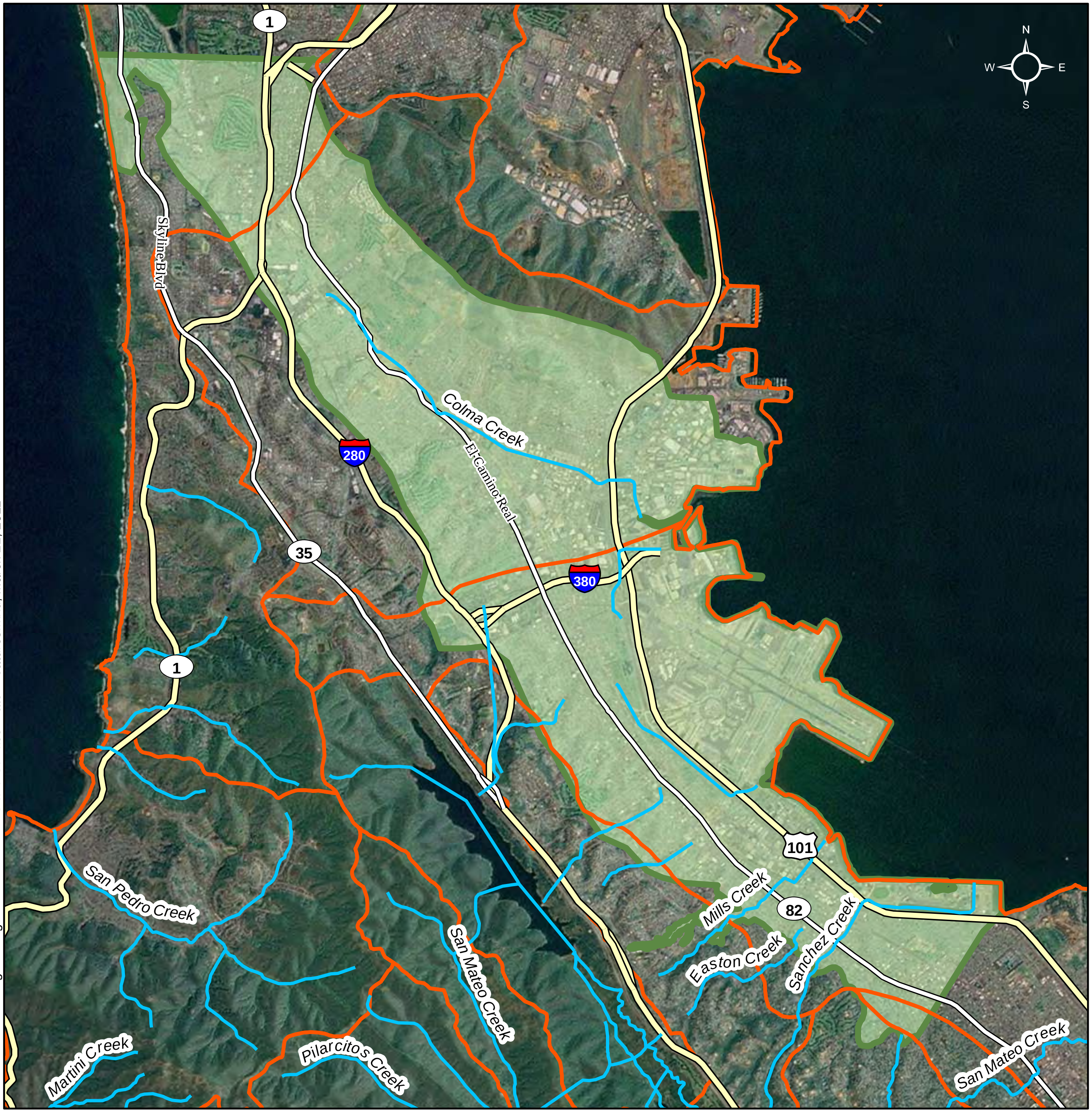
2.2 SURFACE WATER

Major watersheds and surface water features are shown in Figure 2.5. The largest watersheds are Colma Creek Watershed and Vista Grande Watershed.

Colma Creek is a small creek draining much of South San Francisco and the surrounding area before entering into San Francisco Bay just north of SFIA and the eastern terminus of Interstate 380. Within the valley portion of the watershed, Colma Creek is an open engineered channel from the bay to near the Colma/South San Francisco city line. Much of the area upstream of South San Francisco and some small tributaries within South San Francisco drains through underground storm drains. Some of the uppermost reaches of the creek are natural channels, particularly on the slopes of San Bruno Mountain (Oakland Museum of California, 2011).

The only USGS streamflow gage in the South Westside Basin was located on Colma Creek (Figure 2.1). No longer active, the gage has recorded data from 1963 until 1996. Average monthly flows from the gage are presented on Figure 2.6a and the percent exceedance of daily streamflow is shown in Figure 2.6b. Average monthly streamflow is low, less than 5 cubic feet per second (cfs) in the summer and less than 20 cfs in the winter. High flow conditions are typically below 200 cfs. Work has been performed on the stream channel to reduce flooding in the area, particularly near Holy Cross Cemetery.

Figure 2.5
Watersheds and Surface Water Features



Legend
- Creeks/Streams
- Highways
- Watersheds
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

Source: NHD database and USGS

F:\215 - San Bruno\Figures\Figure 2.5 Watersheds and Surface Water Features.mxd, March 21, 2011

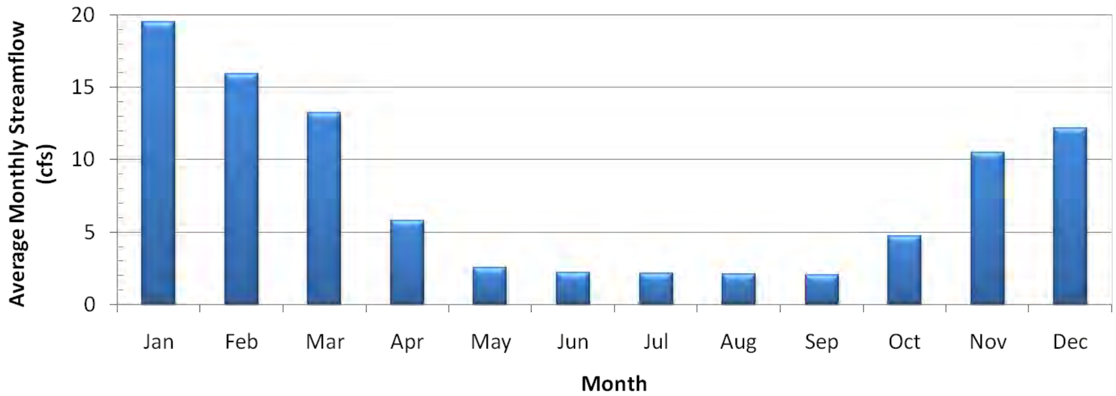


Figure 2.6a Average Monthly Colma Creek Streamflow, 1963-1996

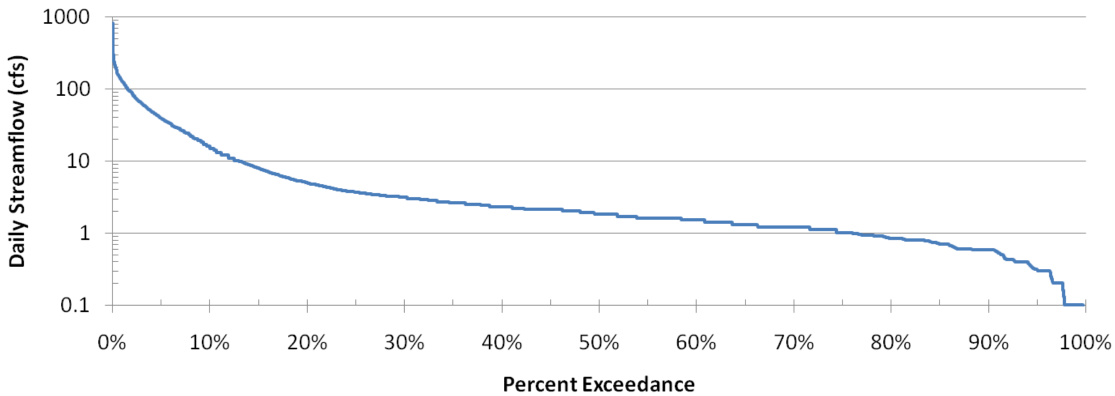


Figure 2.6b Daily Colma Creek Streamflow Exceedance, 1963-1996

The Vista Grande Watershed historically drained into Lake Merced, but has since been altered to flow to the Pacific Ocean. The 2.5 square mile watershed includes portions of Daly City as well as portions of unincorporated San Mateo County. Stormwater flows through the Vista Grande Canal for about 3,500 feet before flowing into the Vista Grande Outfall Tunnel. The tunnel discharges to the Pacific Ocean through an outfall beach structure below Fort Funston in Golden Gate National Recreation Area. (RMC, 2006)

Other creeks in the South Westside Basin include:

- San Bruno Creek in San Bruno
- Millbrae Creek in Millbrae
- Mills Creek in Burlingame
- Sanchez Creek in Burlingame

- San Mateo Creek, just south of the South Westside Basin in San Mateo

The major water features in the North Westside Basin are Lake Merced and several smaller lakes. These features, as they relate to groundwater, are discussed in the draft North Westside Basin GWMP.

2.3 GROUNDWATER

2.3.1 GEOLOGIC SETTING

The South Westside Basin is a structural basin within the Coast Ranges province of California. The Coast Ranges are dominated by northwest oriented mountain ranges and valleys. The mountains are steep but modest in elevation. Locally, the Santa Cruz Mountains and the valley that makes up the South Westside Basin are part of these features. Highest elevations include the following:

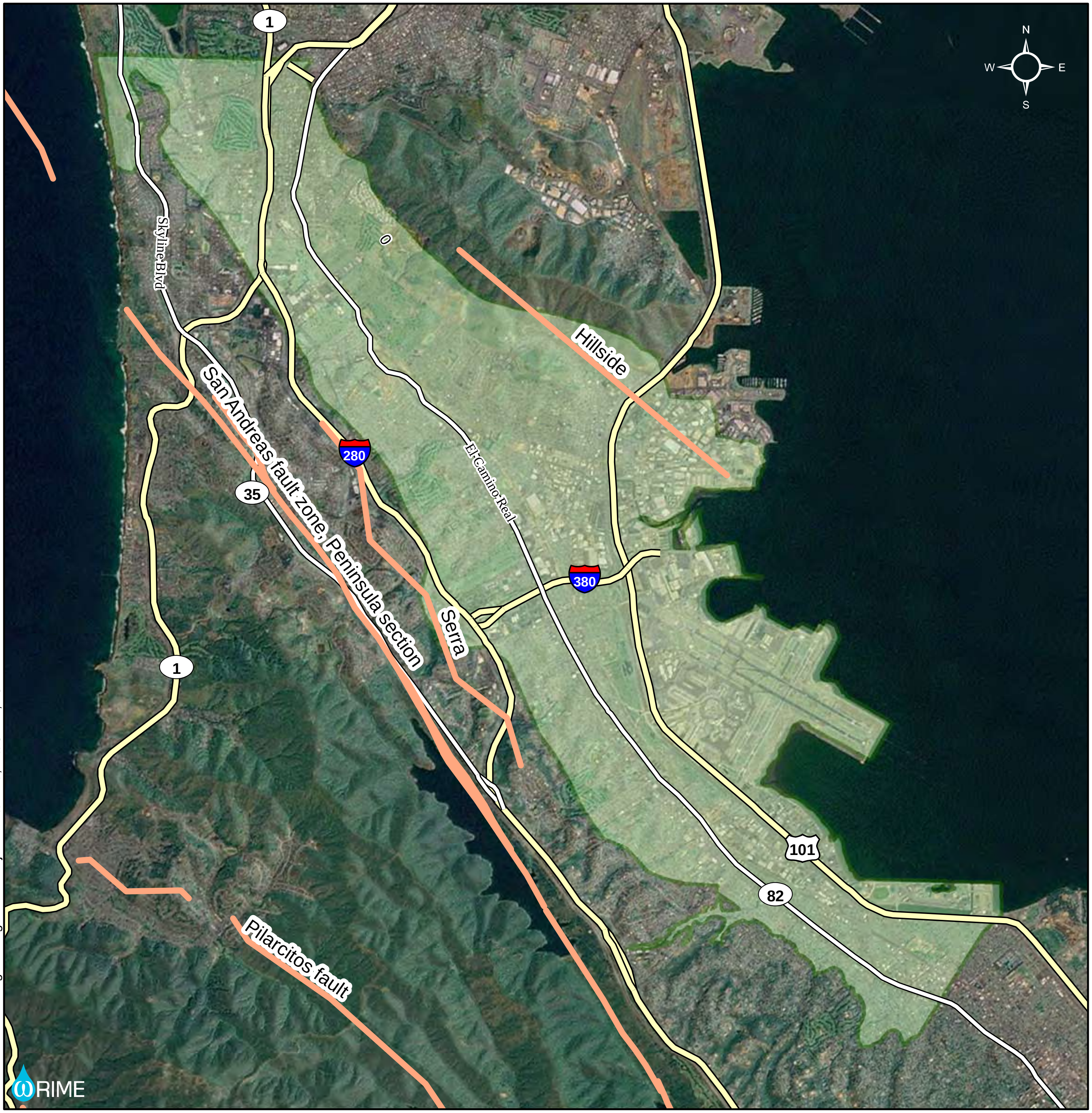
- Scarpet Peak southwest of the basin, 1,944 feet (ft)
- San Bruno Mountain northeast of the basin, 1,316 ft
- Mount Davidson in San Francisco, 927 ft

The northwest trend is a result of tectonics, with major northwest trending faults in the vicinity of the South Westside Basin: San Andreas Fault, Serra Fault, and the Hillside Fault (Figure 2.7)

The Franciscan Formation forms the basement underlying the unconsolidated sediments that are the primary sources of groundwater for the area and forms most of the mountains surrounding the South Westside Basin (Burns & McDonnell and ERM-West, 2006; Bonilla 1998). A map of bedrock elevation is presented on Figure 2.8 based on HydroFocus (2003). The Mesozoic-age formation is highly deformed and comprised of a unique mix of rocks related to tectonic subduction. This subduction resulted in materials from the oceanic plate being scraped off and accreted onto the continental materials as well as low-temperature, high-pressure metamorphism. The scraping results in the presence of deep-ocean materials such as chert, while metamorphism results in rocks such as serpentine and blueshist. The most common materials are greywacke (a poorly sorted sandstone containing angular clasts) and shale, resulting from deep ocean deposition in a method similar to a landslide. Composition of the Franciscan Formation is variable; locally the Franciscan has significant greywacke and shale in what is known as the San Bruno Mountain terrane to the northeast of the South Westside Basin and pillow basalts, minor chert, limestone, and greywacke in what is known as the Permanente terrane to the southwest (Sloan, 2006).

The Merced Formation and the Colma Formation are the major unconsolidated units in the South Westside Basin and are the primary sources of groundwater. These formations were

Figure 2.7
Major Faults



Legend

- Highways
- Plan Area
- Faults

0 0.5 1 2 Miles

Source: USGS

F:\215 - San Bruno\Figures\Figure 2.7 Major Faults.mxd, March 21, 2011

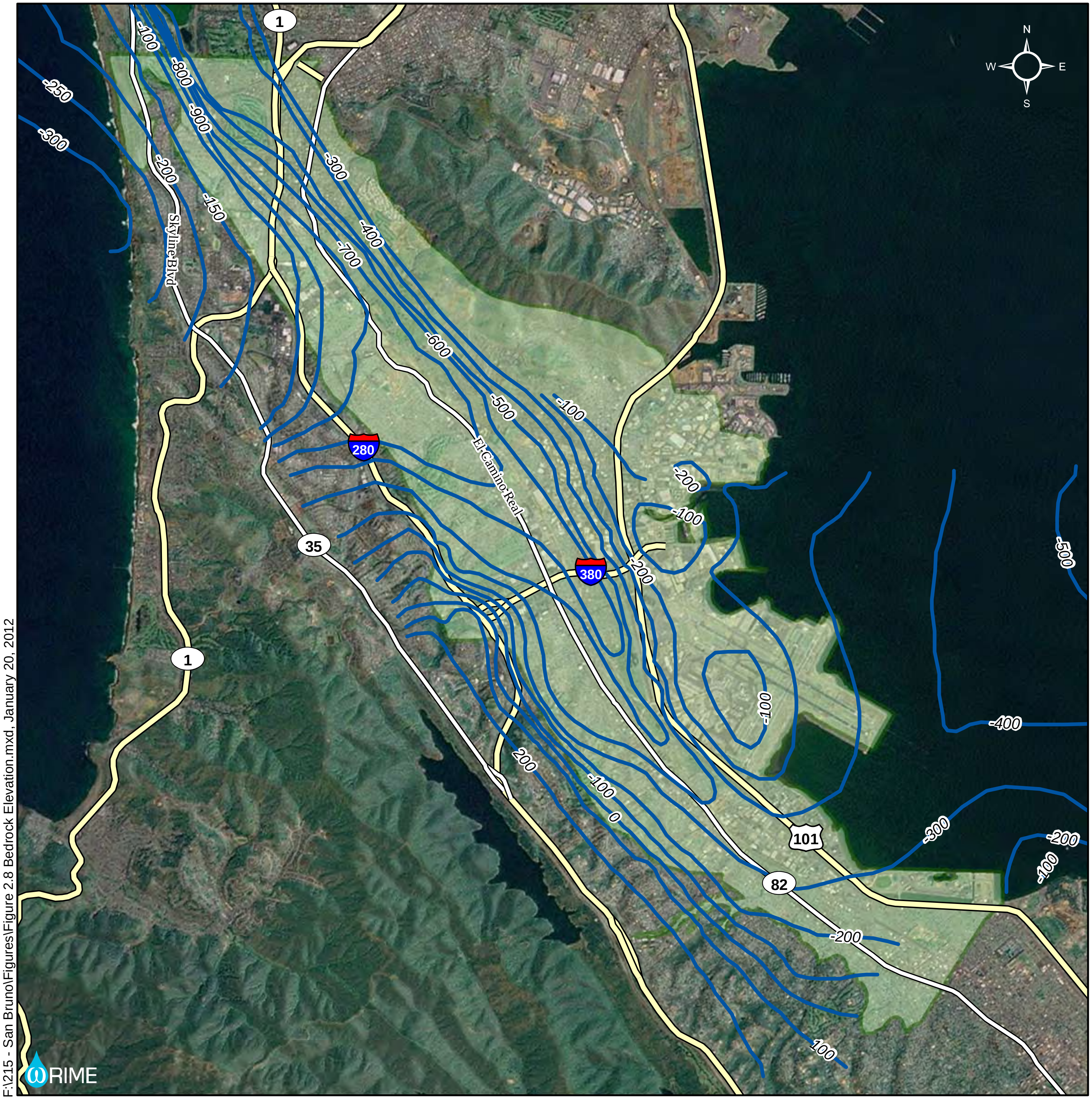


Figure 2.8
Bedrock Elevation

Legend

- Highways
- Plan Area
- Bedrock Elevation (ft)

0 0.5 1 2 Miles

Source: Bedrock Elevation - Phillips et al., 1993 and Hensolt and Brabb, 1990 as cited in HydroFocus, 2003

City of San Bruno · California Water Service Co. · Daly City California

F:\215 - San Bruno\Figures\Figure 2.8 Bedrock Elevation.mxd, January 20, 2012 deposited on top of the Franciscan. During recent geologic history, the South Westside Basin alternated between being submerged below the Pacific Ocean and being above sea level, the result of tectonic subsidence, changes in sea level due to global climatic conditions, and tectonic uplift. At least 30 episodes of transgression and regression are recorded in the Merced and Colma Formations near Daly City (Clifton and Hunter, 1987, 1991) as changes from shallow marine to non-marine sediments. These episodes resulted in the layers of clays and sands seen in the subsurface today.

The Merced Formation contains several major beds of sands and clays. The lower portion of the formation contains locally derived materials from the Coast Ranges, while the upper portion contains sediment from the Sierra Nevada and Cascades identifying the movement of the outlet of the Sacramento and San Joaquin rivers near their current outlet at the Golden Gate.

Beds in the vicinity of coastal Daly City dip to the northeast at 45 to 70 degrees in the lower 4,000 ft; 25 to 45 degrees in the middle 600 ft; and 5 to 20 degrees in the upper 500 ft (LSCE, 2004). The Merced Formation dips more than 40 degrees to the northeast in the portion of the South Westside Basin from San Bruno to Daly City (Fio and Leighton, 1995). From San Bruno into Millbrae and between the Serra and San Andreas faults, the Merced dips to the southwest and to the northeast, depending on location, due to faulting and folding (Rogge, 2003). East of the Serra Fault, the Merced appears to dip to the northeast based on observations by Rogge.

The Colma Formation has a very similar mineral composition to the underlying Merced Formation. The Colma Formation is younger (Pleistocene-age) than the Merced and was deposited on top of the tilted Merced Formation. The layering in the Colma Formation remains primarily horizontal (Sloan, 2006).

Bay Muds are also present along the margins of San Francisco Bay at ground surface or below artificial fill. These recently deposited materials are fine-grained clays and silts with organic matter and minor sand lenses that were deposited in still waters and accumulated as sea levels rose (Lee and Praszker, 1969).

2.3.2 WATER-BEARING FORMATIONS

Groundwater used for water supply within the South Westside Basin is found in the Merced and Colma formations discussed above. Water is produced from the coarse-grained layers within these complex, layered formations. Grain size typically decreases from the northwest to the southeast.

The elevation of the bedrock surface is shown in Figure 2.8; the deepest portions of the basin is in the northwest, becoming thin in Millbrae and south into Burlingame. Water bearing formations are also thin near San Francisco Bay due to a bedrock ridge extending in a north-south orientation near SFIA, which, together with surficial deposits of Bay muds in these areas, reduces the potential for seawater intrusion in this area (WRIME, 2007).

The "W" clay is a major aquitard in the Daly City area, with municipal production occurring below the "W" clay. The "W" clay is not present south of Daly City, but a fine grained unit at 300 ft below mean sea level is present in the South San Francisco area (LSCE, 2004) and several clay units are in the upper portion of the aquifer in the San Bruno area. Perched aquifer conditions occur throughout the Plan Area. Numerous shallow wells installed for remediation or monitoring of contaminants nearly always encounter the water table within 30 feet of ground surface (HydroFocus, 2003).

The characteristics of the water bearing formations have been studied through several aquifer tests outlined in the *Alternatives Analysis Report* (MWH, 2007) and are summarized below. These tests provide estimates of transmissivity, a measure of the ability of an aquifer to transmit groundwater. For the South Westside Basin as a whole, previous studies have shown a range of transmissivities of 668 to 4,100 ft^2/day (CH2M HILL, 1997 *as referenced in* MWH, 2007). More specifically, transmissivities have been estimated for the following:

- Daly City area at the Jefferson Well as 2,190 ft^2/day
- CalWater wellfield area as 1,000 to 20,000 ft^2/day
- San Bruno area at SB-16 as 1,890 ft^2/day (LSCE, 2004; MWH, 2007)

2.3.3 PARTIAL BARRIERS TO SEAWATER INTRUSION

The lack of historical seawater intrusion despite historical data of groundwater levels below sea level near both the Pacific Ocean and San Francisco Bay is likely due to natural hydrogeologic conditions that act as partial barriers and inhibit the flow of water from these saltwater bodies into the freshwater aquifer.

2.3.3.1 Pacific Ocean

Significant faulting and folding of the Merced Formation near the Pacific Ocean has been shown to be a barrier to seawater intrusion from the Pacific Ocean. It has been concluded that groundwater extraction within the South Westside Basin largely occurs within sequences with no direct connection with the Pacific Ocean (LSCE, 2010). Monitoring wells at Thornton Beach and Fort Funston exhibit groundwater levels above sea level. The potential for seawater intrusion is more likely to the north of Fort Funston, in the vicinity of LMMW-6D, where the faulted and folded conditions do not exist and there is a potential pathway into the South Westside Basin from the northwest. This area, however, is farther from the influence of active production wells and water levels are thus higher than elsewhere in the South Westside Basin. A network of monitoring wells are used to collect groundwater data along the Pacific Ocean: at the Old Great Highway, the northwestern part of Golden Gate Park, the Oceanside Wastewater Treatment Plan, the San Francisco Zoo, Fort Funston, and Thornton Beach.

2.3.3.2 San Francisco Bay

Relatively thick Bay Mud deposits and a buried bedrock ridge within 50 to 300 ft of the land surface provide some protection to the southern portion of the South Westside Basin from seawater intrusion from San Francisco Bay. Previous efforts have identified areas where the depth to bedrock is deepest and installed monitoring well clusters in the two most likely locations for seawater intrusion. These wells (SFO-S, SFO-D, Burlingame-S, Burlingame-M, and Burlingame-D) provide water level and water quality data. While this barrier has been historically effective, hydraulic connections between the main pumping aquifer and shallower wells closer to the Bay have been shown through water level impacts when San Bruno groundwater production wells are turned on (impacts at SFIA monitoring wells; ERM (2005)) and through depressed water levels near the bayshore (including SFO-S, SFO-D, Burlingame-S, Burlingame-M, and Burlingame-D). While not a completely understood pathway from San Francisco Bay into the main pumping aquifer, this hydraulic connection indicates that there is some potential for seawater intrusion in the future in this area. Risks of seawater intrusion increase with greater gradients between depressed groundwater levels in the drinking water aquifer and sea level at San Francisco Bay. Such risks can be reduced through increasing groundwater levels by increased recharge or decreased groundwater production.

2.3.4 SOILS

Surface soils impact the amount of water that infiltrates to groundwater rather than contributing to surface runoff. The characteristics of surface soils thus play a role in groundwater recharge. Due to the urban nature of the area, the U.S. Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) does not have a comprehensive classification of these soils according to their infiltration capacity. However, USDA-NRCS does summarize the general soils for the area (Figure 2.9). Generally, soils in the northwest (Daly City and Colma) are well drained soils associated with former sand dunes (categorized as "Urban land-Orthents, smoothed"). Soils in the southeast (San Bruno, Millbrae, and Burlingame) have variable drainage properties in the low elevations near and to the east of El Camino Real (categorized as "Urban land-Orthents, reclaimed" and "Urban land-Orthents") and are well drained in the uplands to the west of El Camino (categorized as "Urban land-Orthents, cut and fill").

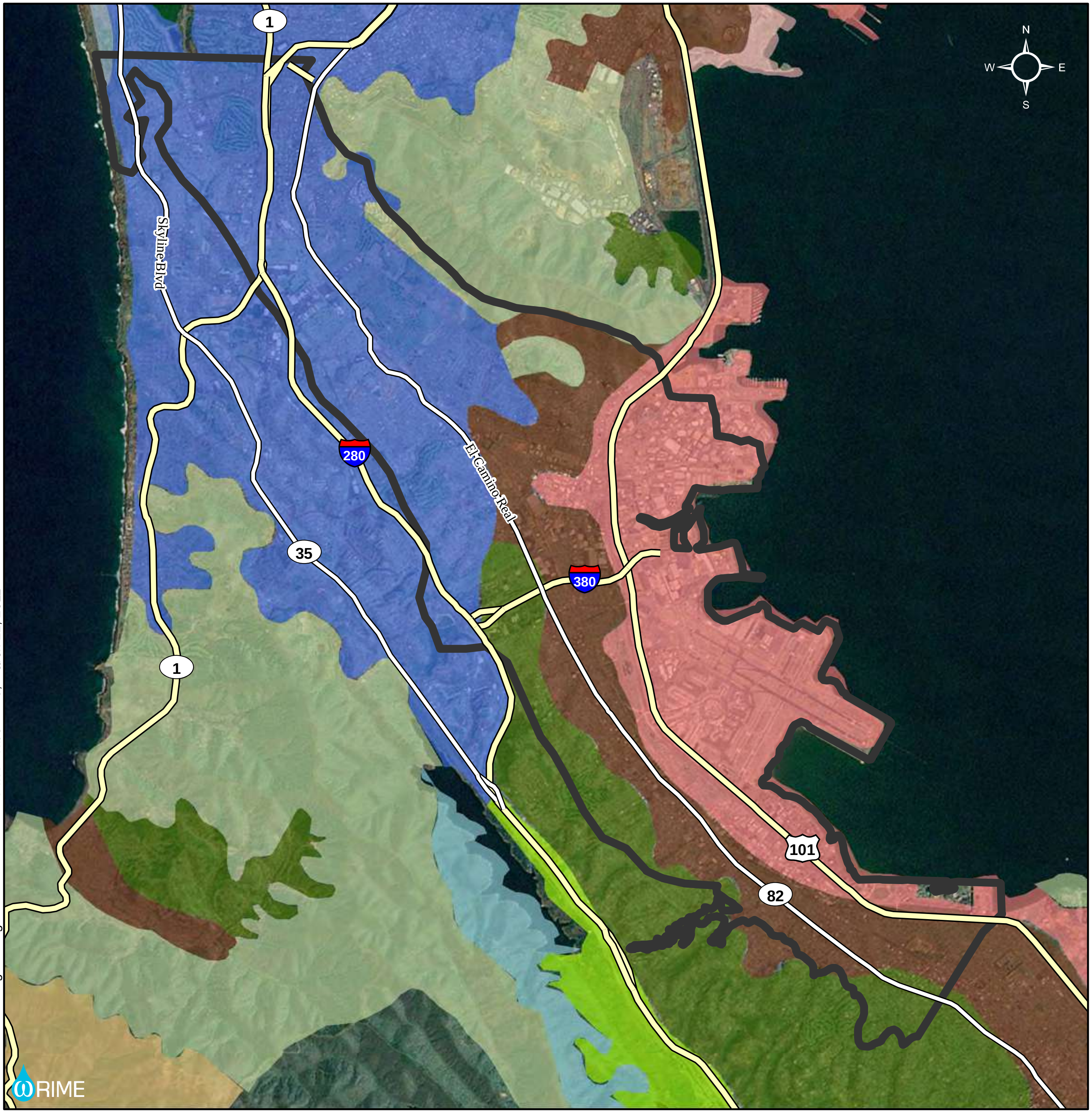
2.3.5 RECHARGE

Additional water is added to the aquifer system through recharge, the percolation of water downward from the ground surface through unsaturated sediments into the aquifer. The amount of recharge is controlled by

- Climate, including precipitation and evapotranspiration
- The slope of the ground surface, which impacts whether water seeps into the ground or becomes runoff into surface drainages
- Land use, including the amount of impervious surfaces, plant types, and usage of irrigation
- Leakage from water and sewer pipes
- Soil characteristics
- Subsurface characteristics

Estimates of recharge for the South Westside Basin were developed for the Groundwater Model (HydroFocus, 2011) and are summarized in Figure 2.10. The recharge estimates show that groundwater recharge is highest in the northwestern portions of the basin, corresponding to areas of sandy soils, and in areas with significant unpaved, irrigated land, such as golf courses and cemeteries. Recharge is lowest along the margins of San Francisco Bay, corresponding to areas with Bay Muds, and along the steep slopes of San Bruno Mountain.

Figure 2.9
General Soil Classification



Legend

- Highways
- Plan Area

Soil Types

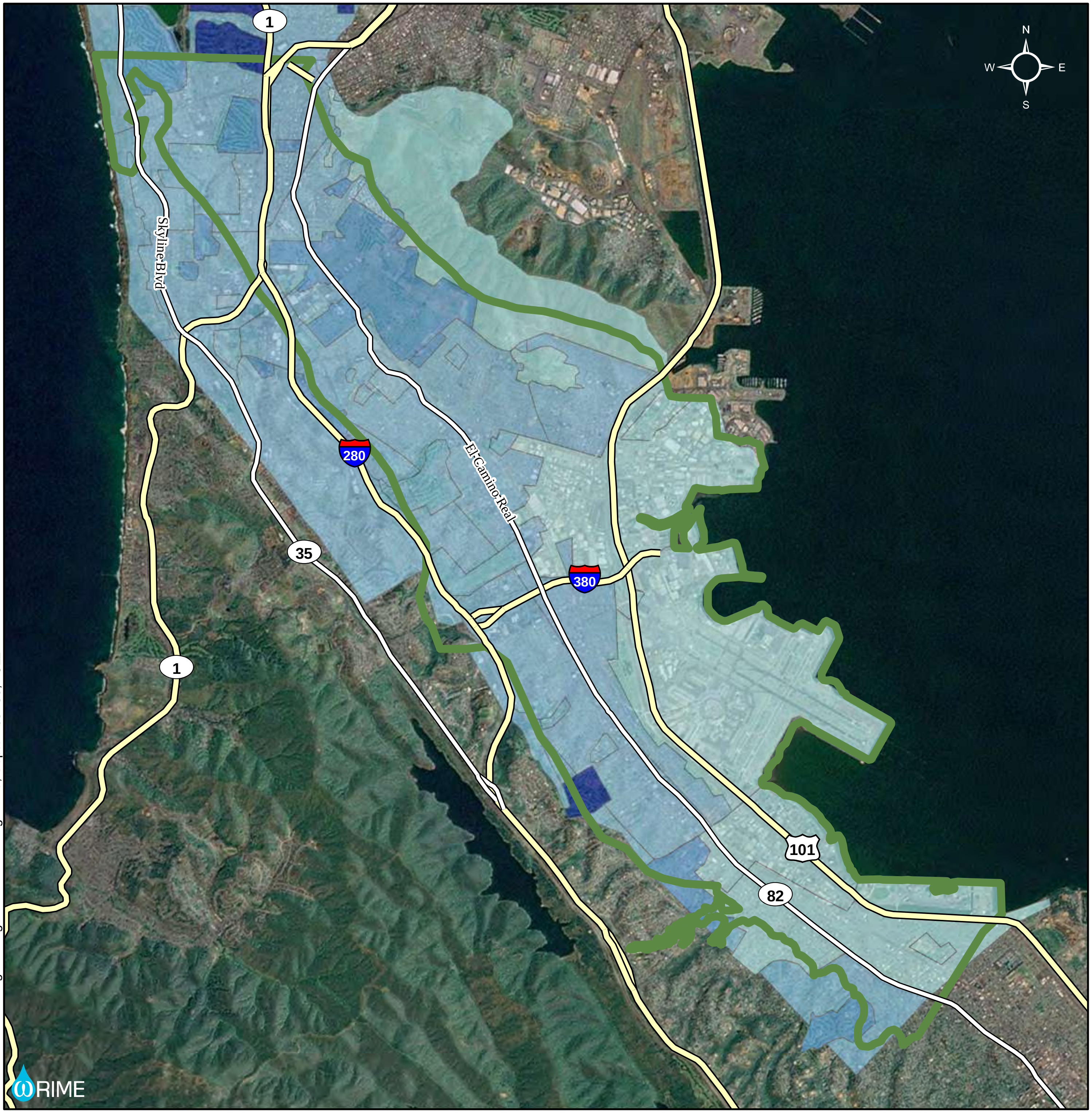
- Urban Land-Sirdrak
- Urban Land-Orthents, smoothed
- Alambique-McGarvey
- Scarper-Miramar
- Barnabe-Candlestick-Buriburi
- Fagan-Obispo
- Urban Land-Orthents, cut and fill
- Alambique-Zeni-Zeni Variant
- Novato-Reyes
- Urban Land-Orthents, reclaimed
- Urban Land-Orthents

0 0.5 1 2 Miles

Source: Soils - USDA - SCS, 1991

F:\215 - San Bruno\Figures\Figure 2.9 General Soil Classification.mxd, March 21, 2011

Figure 2.10
Estimated Recharge



Legend

Highways

Recharge (inches per year)

0 - 4

4 - 8

8 - 12

12 - 16

Plan Area

0 0.5 1 2 Miles

Source: Recharge - HydroFocus, 2011

F:\215 - San Bruno\Figures\Figure 2.10 Recharge.mxd, September 30, 2011

2.3.6 EARLY DEVELOPMENT AND GROUNDWATER USAGE

Early development in the South Westside Basin was primarily agricultural, with dairy cattle operations serving the nearby cities. Development of the type seen today began around the turn of the 20th century. Burials within the City of San Francisco were prohibited in 1900 and existing cemeteries were evicted in 1937. These events resulted in the establishment of the cemeteries in Colma. The 1906 earthquake resulted in the migration of people out of the damaged cities and into the undeveloped and newly developed areas in the South Westside Basin, particularly along the streetcar line that extended from San Francisco south through Daly City, San Bruno and beyond, as far as San Mateo by the late 1890s (Gillespie and Gillespie, 2009). San Francisco International Airport began operating in 1927, further driving urban growth. The most significant urban growth occurred during World War II as numerous industrial facilities operated out of South San Francisco, resulting in demand for area housing and commercial space. This growth continued until the area approached build-out. Historical population growth for the cities in the South Westside Basin (right axis), as well as for San Francisco (left axis), is shown in Figure 2.11.

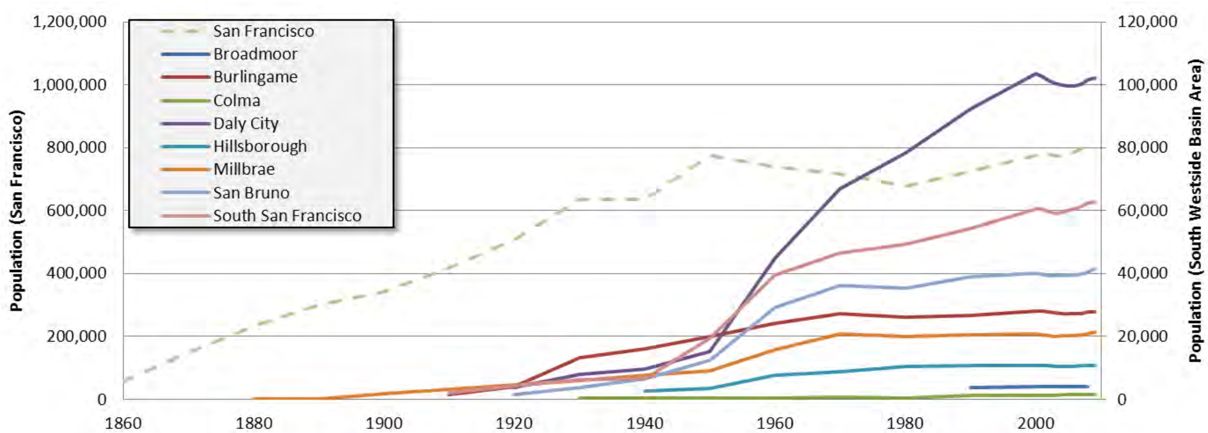


Figure 2.11. Historical Population Growth in the South Westside Basin

Historical groundwater use increased with development of the South Westside Basin through the 1960s. Beginning in the 1960s, groundwater use by municipal users began to decline (Figure 2.12), a result of conservation by customers as well as operational decisions as the water agencies have access to both groundwater and imported water through SFPUC's Hetch Hetchy system. Since the early 1960s, municipal groundwater use in the South Westside Basin has declined by approximately 25 percent, while imported water use has increased by approximately 40 percent.

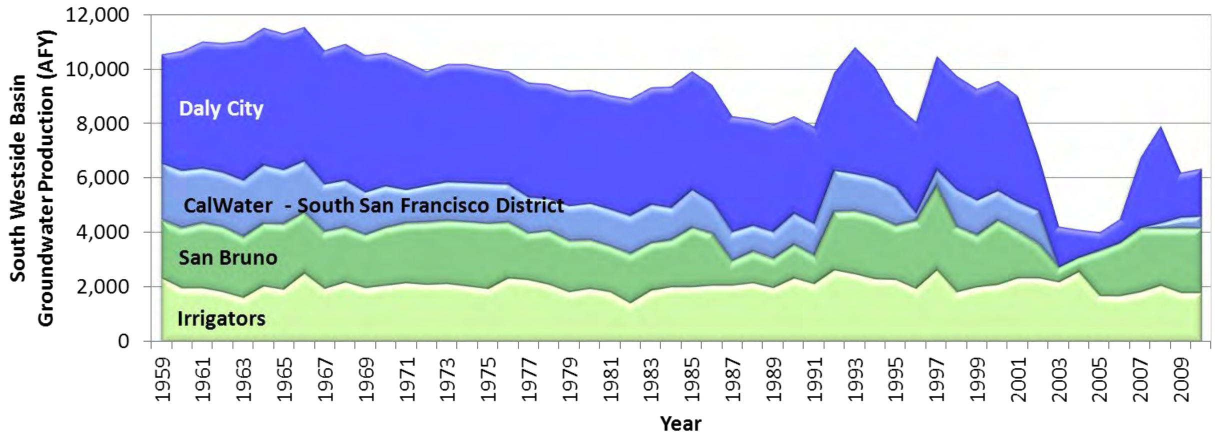


Figure 2.12. Historical Municipal Groundwater Production, South Westside Basin

2.3.7 GROUNDWATER LEVELS

There are little data on groundwater levels from the early development period of the South Westside Basin. Before groundwater production began, groundwater levels were likely close to the surface within the valley, draining to the Pacific Ocean in the west and to Colma Creek, San Francisco Bay, and other drainages to the east. A report from 1914 (Bartell, 1914) noted that San Bruno produced water from three artesian wells, which, when turned off, overflowed approximately 1 inch above the top of casing. Artesian flow was noted as being maintained through the previous two dry seasons. The same report noted pumping water levels in South San Francisco's nine wells of 55 to 60 ft below ground surface.

Through the early 1940s, groundwater levels remained above sea level in the Daly City area, although in the South San Francisco area groundwater levels were already 100 ft below sea level by that time (Kirker, Chapman & Associates, 1972). Groundwater levels remained relatively stable throughout the basin from the 1970s until the implementation of the ILPS in late 2002, which resulted in rising groundwater levels. Hydrographs present historical groundwater levels on Figures 2.13a-e (locations are presented on Figure 2.14). Current groundwater level conditions are shown in Figure 2.15.

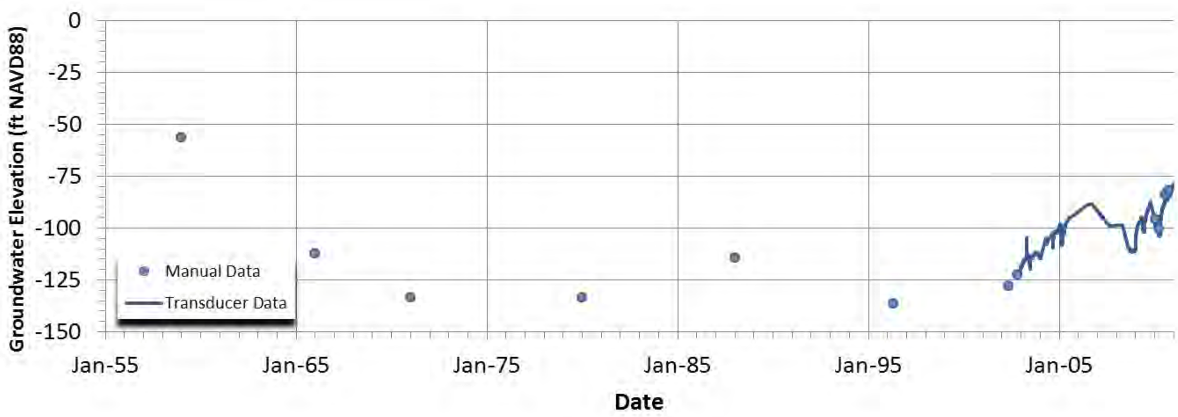


Figure 2.13a. Historical Groundwater Elevation, DC-8

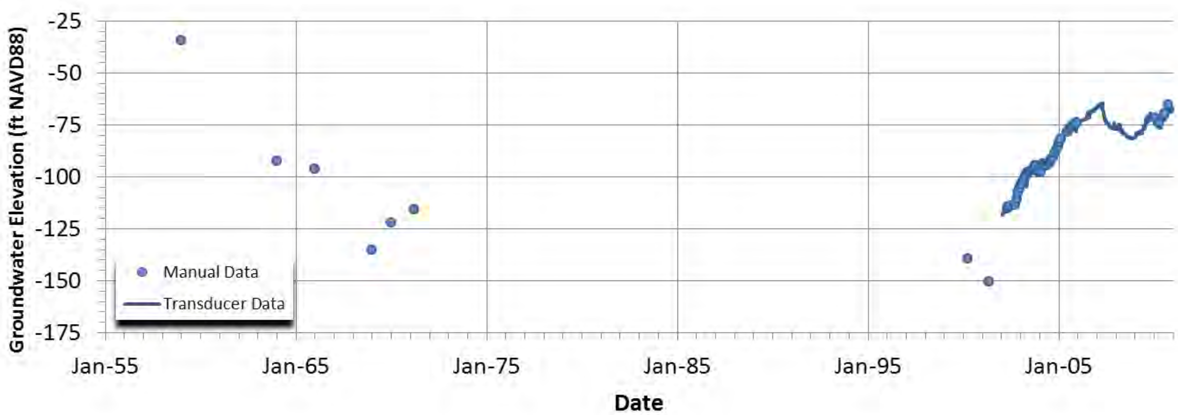


Figure 2.13b. Historical Groundwater Elevation, DC-1

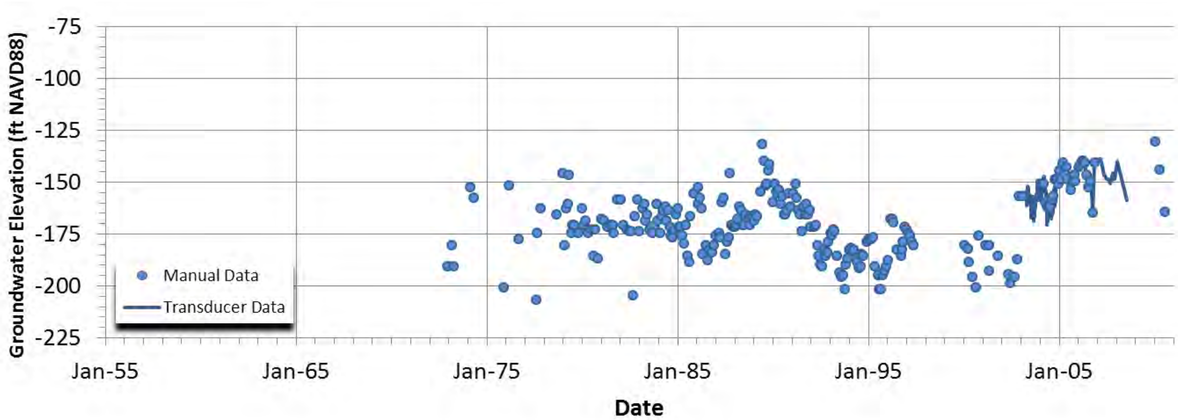


Figure 2.13c. Historical Groundwater Elevation, SS 1-20

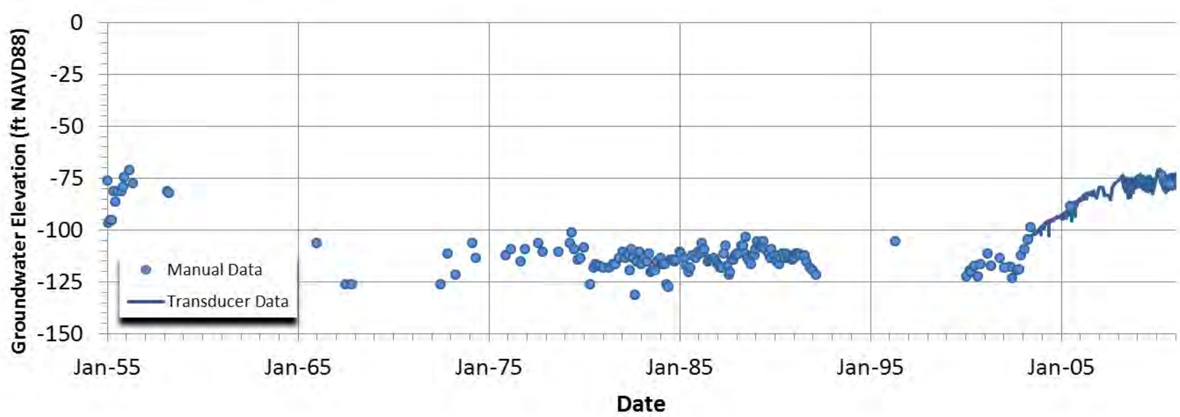


Figure 2.13d. Historical Groundwater Elevation, SS 1-02

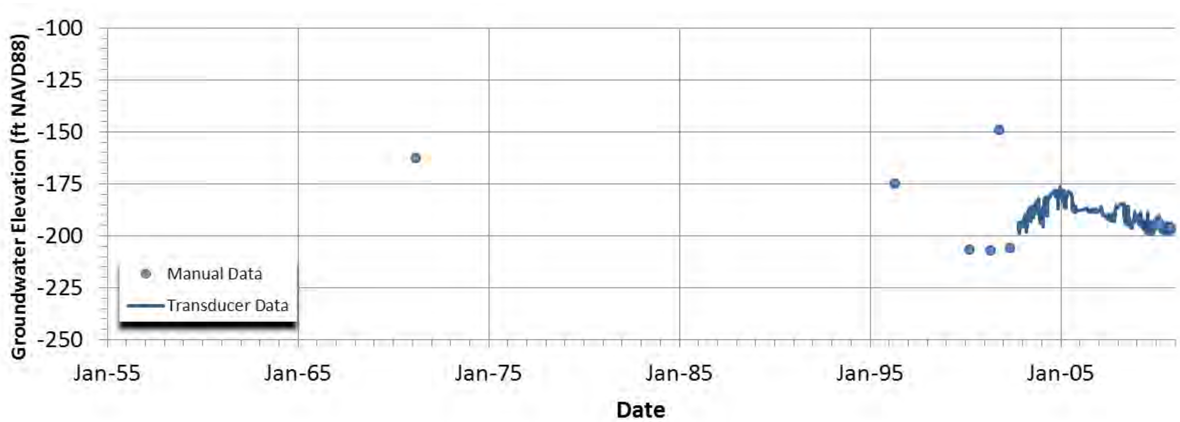


Figure 2.13e. Historical Groundwater Elevation, SB 12

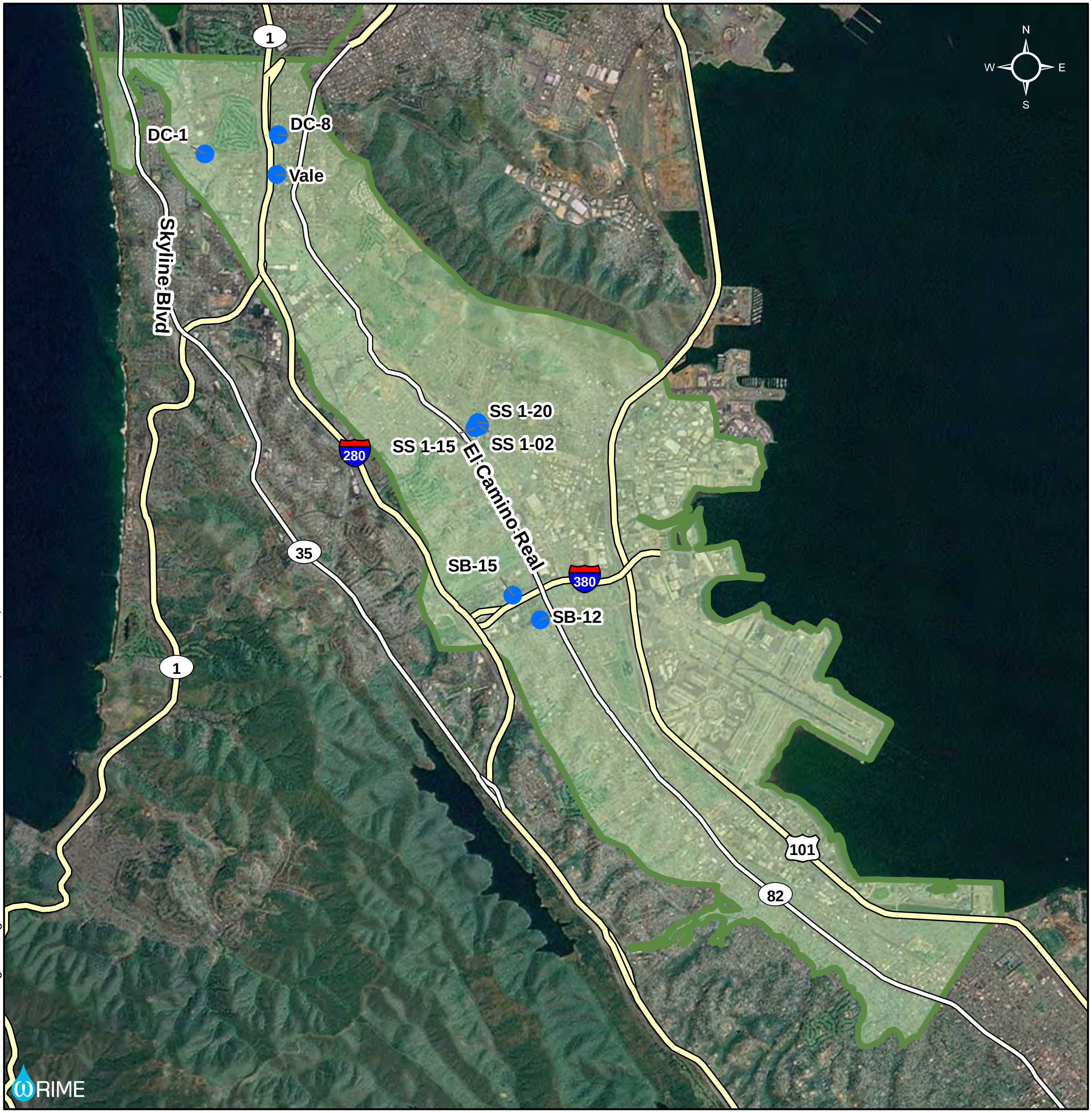


Figure 2.14
Location of Selected Wells

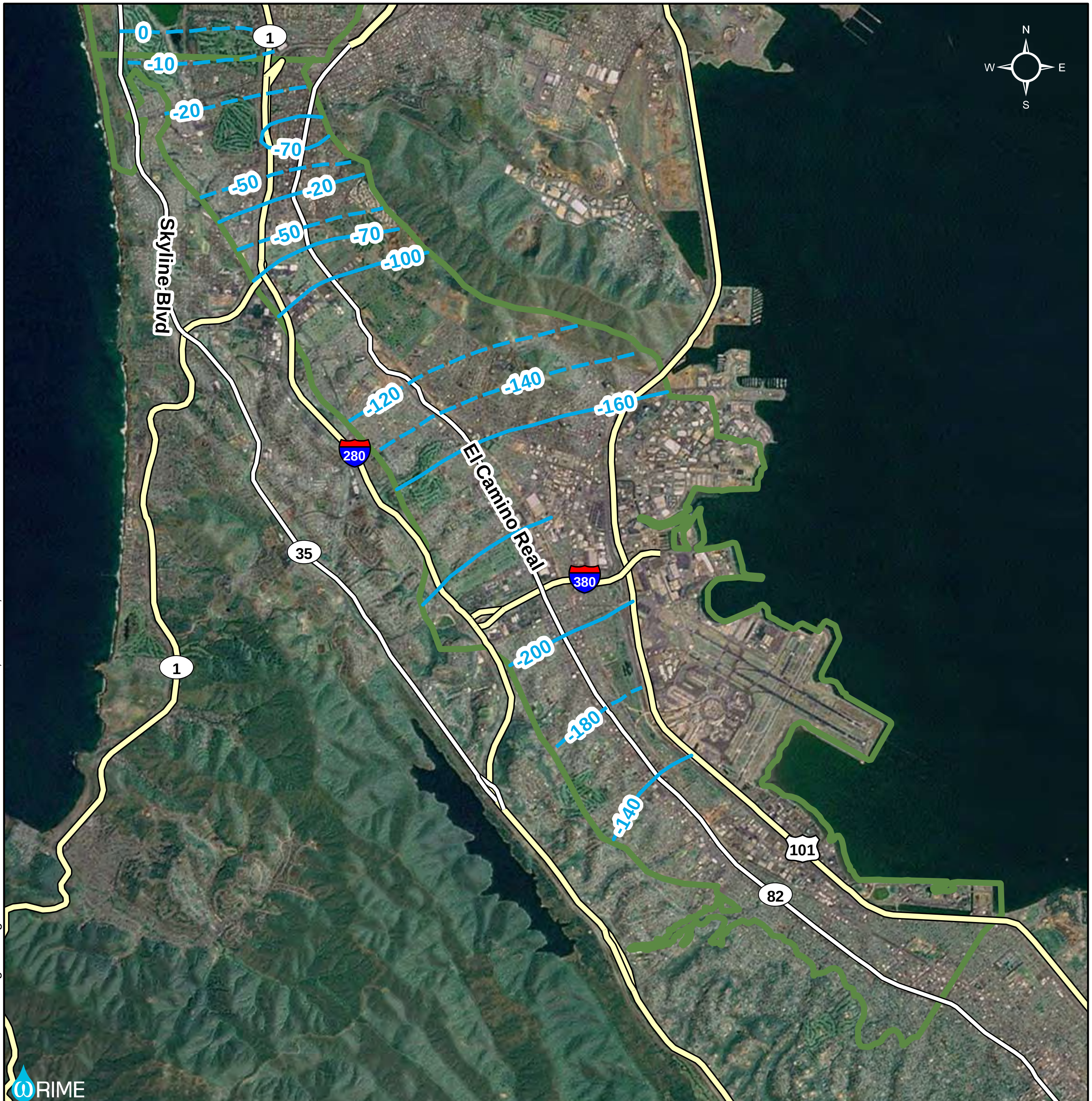
Legend

- Selected Wells
- Highways
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

F:\215 - San Bruno\Figures\Figure 2.13 Location of Selected Wells.mxd, March 21, 2011

Figure 2.15
Groundwater Elevation Contours Primary Production Aquifer, Fall 2010



Legend

- Groundwater Elevation Contour (ft) (dashed where inferred)
- Highways
- Groundwater Basin

0 0.5 1 2 Miles

Source: Groundwater Levels: SFPUC, 2011

F:\215 - San Bruno\Figures\Figure 2.14 Groundwater Contours 2010.mxd, March 31, 2011

2.3.8 GROUNDWATER QUALITY

Groundwater used for water supply in the South Westside Basin is generally good and delivered water meets all state and federal regulations. However, the quality of untreated groundwater in the basin is variable. Lower quality groundwater increases the cost of treatment for use as a drinking water source. Poor quality groundwater may not be economically, technically, or politically feasible for use as a water supply source.

2.3.8.1 Ambient Groundwater Quality

Ambient groundwater quality reflects the general groundwater quality on a regional scale. Most water quality data is available from existing municipal production wells, whose operators maintain a testing schedule to meet the requirements of the California Department of Public Health (DPH). Analysis of ambient water quality was performed based on raw groundwater quality data in a DPH database (2010).

Differences in the general chemistry of groundwater across the basin are shown through the Piper diagram on Figure 2.16. This diagram plots the relative concentrations of cations and anions. Similar waters will plot close to each other; different waters will plot farther apart. The close proximity of the plotted points shows the similarity of water across the South Westside Basin, however, there are noticeable differences between the water of the three agencies.

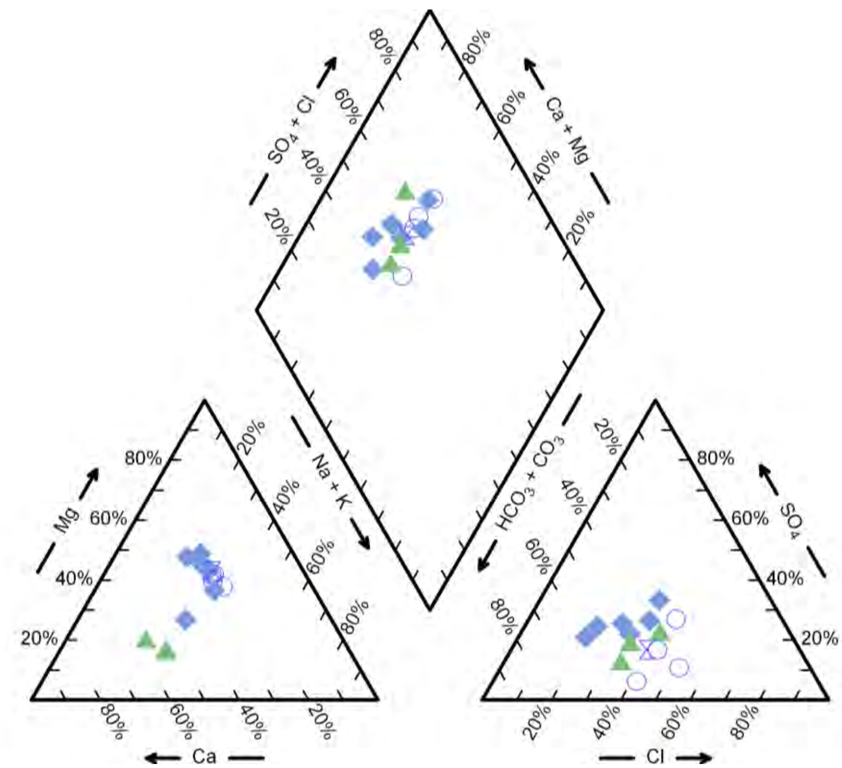


Figure 2.16. Piper Diagram of General Groundwater Chemistry for Wells Operated by Daly City (open blue), CalWater (filled blue), and San Bruno (filled green)

Analysis of the most prominent ambient water quality concerns, iron, manganese, nitrate, and total dissolved solids (TDS), was also performed based on raw groundwater quality data contained in the DPH database (2010). While these data are presented along with regulatory standards, it must be noted that a single detection of a contaminant may not indicate contamination. DPH would not consider a single detection of a contaminant, if unconfirmed with a follow-up detection, to be an actual finding. As another example, the presence of a contaminant in raw water does not necessarily mean that the water (and contaminant) was served by the water system to its customers, or, if served, that the contaminant was present at that concentration. Water systems may choose not use certain sources or may treat or blend them prior to service (DPH, 2010). While water containing higher concentrations of iron, manganese, nitrate, and TDS can be used following treatment, it is more economical to use water that does not require treatment.

Iron and manganese do not pose a risk to human health, but are an aesthetic concern for water users. High concentrations of iron and manganese can result in poor tasting water or water that stains fixtures. The source of iron and manganese in groundwater is typically naturally occurring soils and rocks containing iron and manganese. Secondary maximum contaminant levels (SMCL) are enforceable standards established by DPH based on consumer acceptance, rather than health risk. The SMCL is 300 micrograms per liter (μg/L) for iron and 50 μg/L for manganese. Figures 2.17 and 2.18 show the distribution of iron and manganese, respectively, over the Plan Area based on average 2005-2010 data from DPH. Generally, concentrations of iron and manganese are variable even within short distances. Figures 2.19a-c present historical trends in iron and manganese concentration for selected wells with locations shown in Figure 2.14. These figures show generally stable iron and manganese concentrations. The apparent increase in concentrations in the Vale Well is the result of higher detection limits for the later measurements and does not necessarily indicate increasing concentrations.

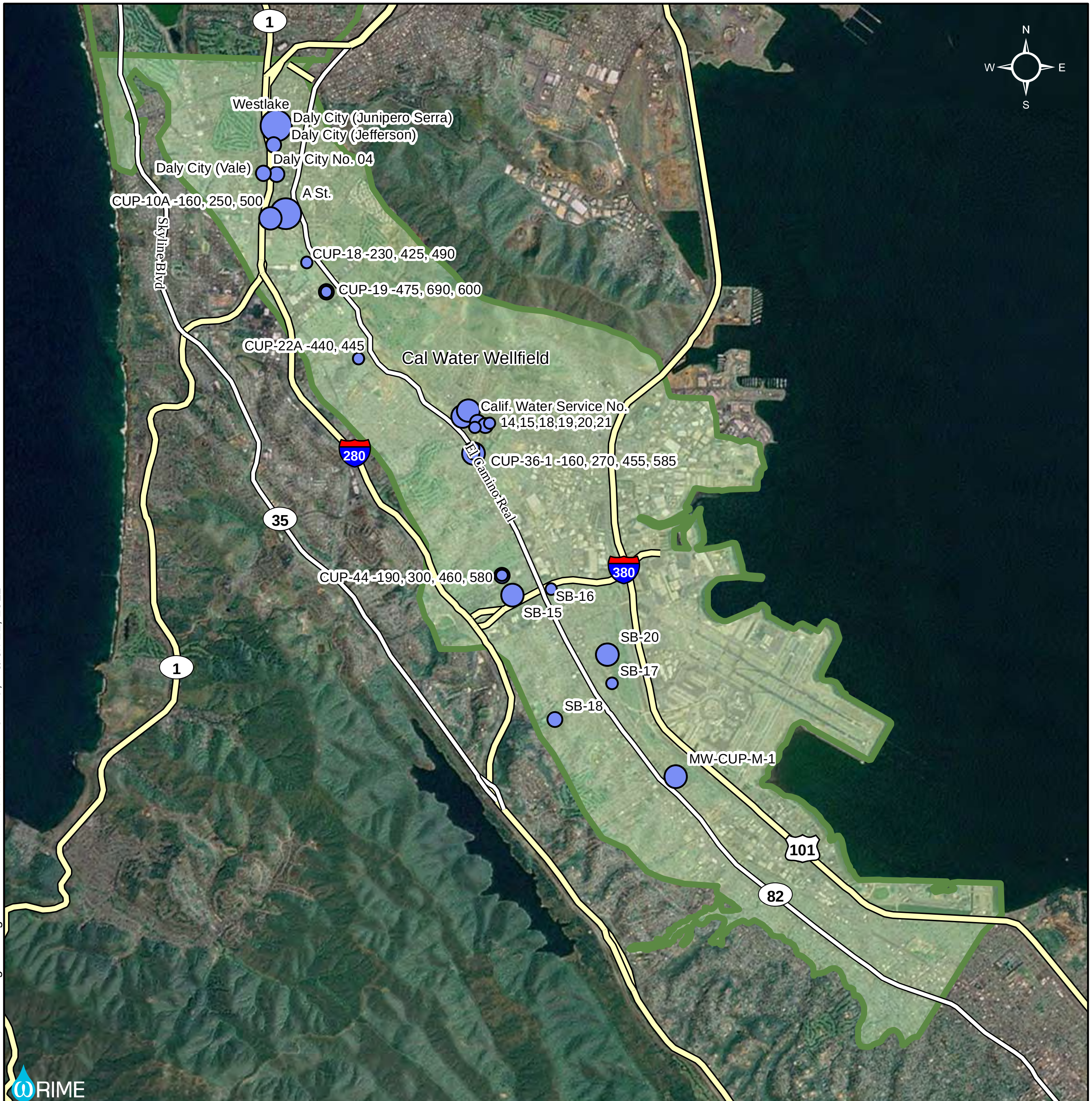


Figure 2.17

Iron Concentrations in Groundwater

Legend

Concentration (ug/L)

Iron (SMCL = 300)

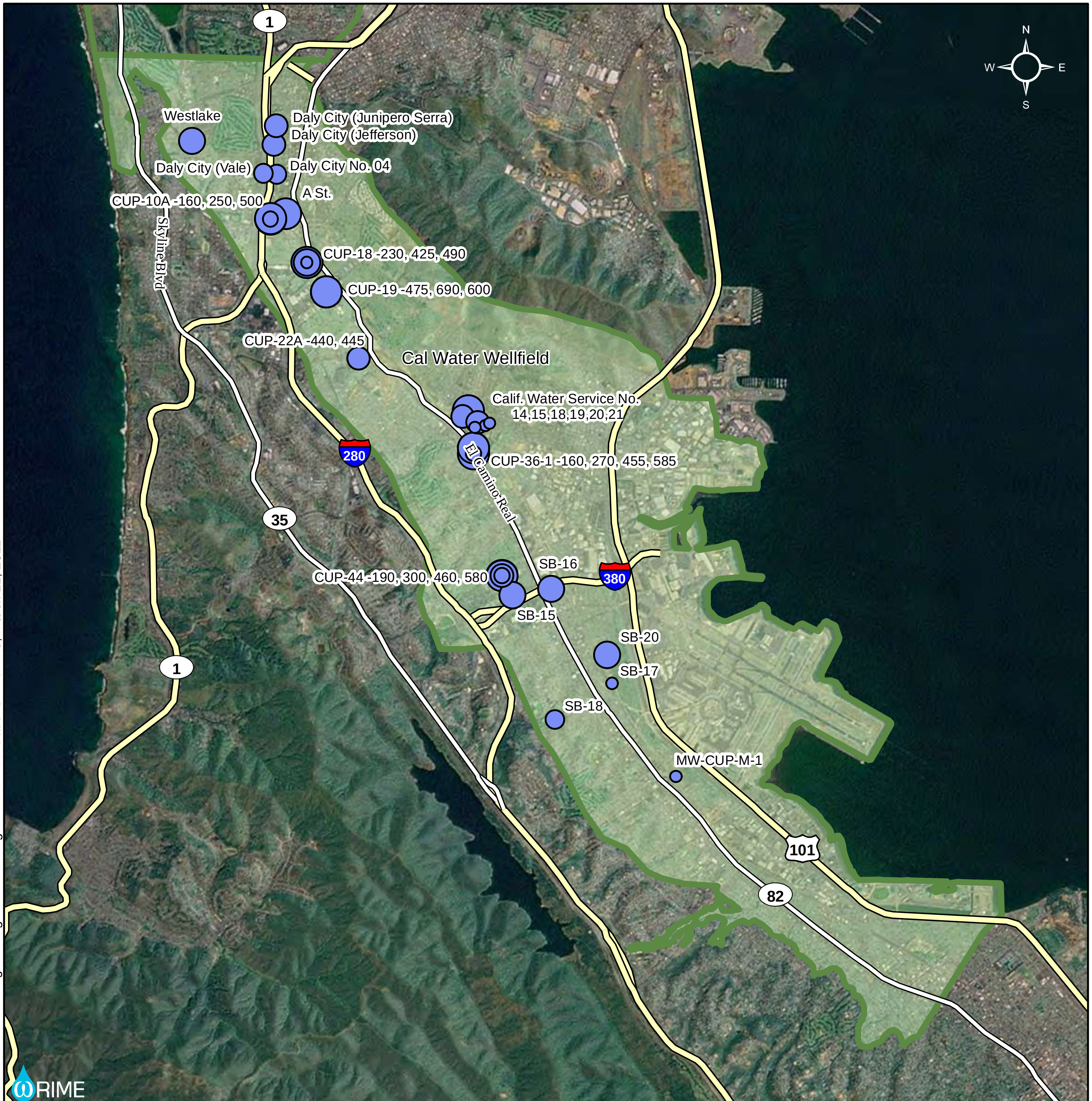
- 0 - 50
- 51 - 100
- 101 - 200
- 201 - 300
- Highways
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

Source: DPH, 2010

F:\2.16 - San Bruno\Figures\Figure 2.16 Iron Concentrations.mxd.mxd, March 21, 2011

Figure 2.18
Manganese Concentrations in Groundwater



Legend

Concentration (ug/L)

Manganese (SMCL = 50)

- 1 - 5
- 5.01 - 10
- 10.01 - 20
- 20.01 - 50
- 50.01 - 100
- 100+
- Highways
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

Source: DPH, 2010

F:\2.17 - San Bruno\Figures\Figure 2.16 Manganese Concentrations.mxd.mxd, March 21, 2011

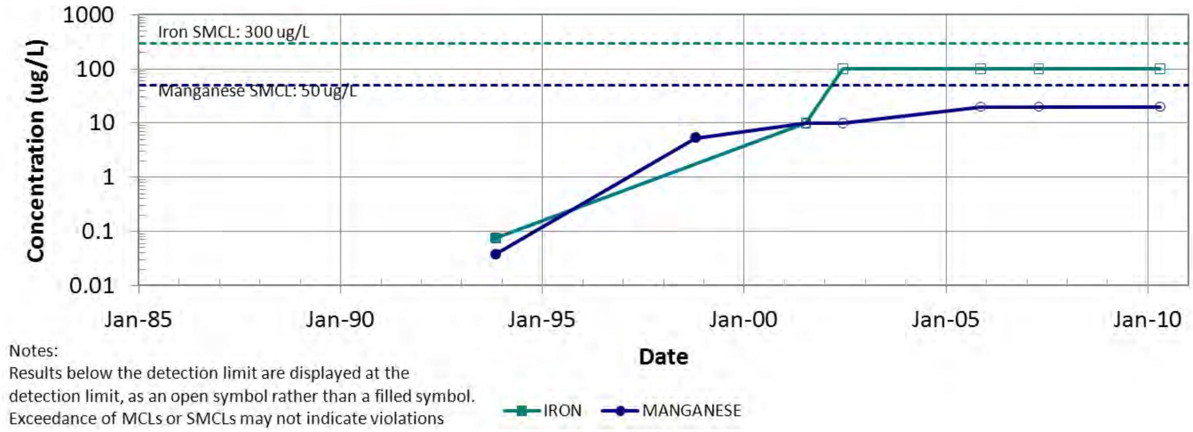


Figure 2.19a. Historical Iron and Manganese Concentrations, Vale Well

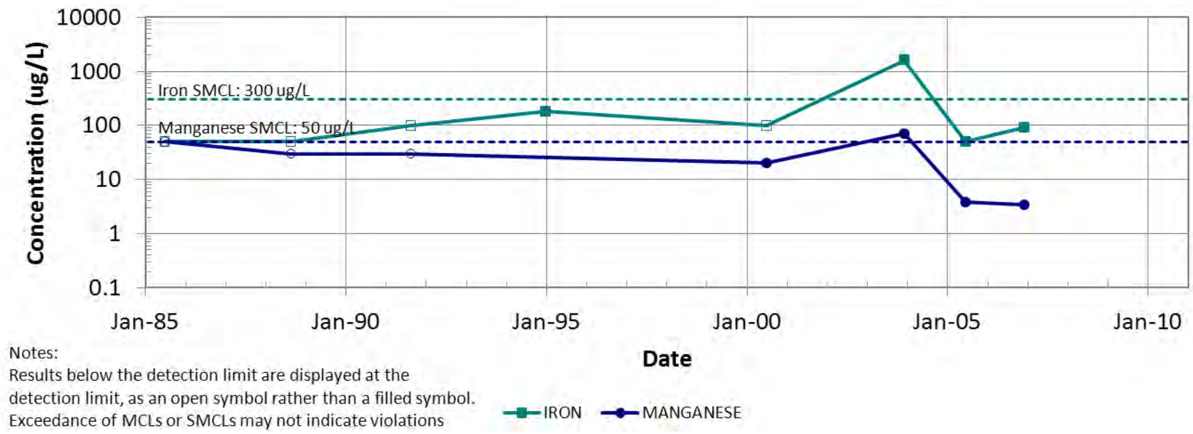


Figure 2.19b. Historical Iron and Manganese Concentrations, Well 01-15

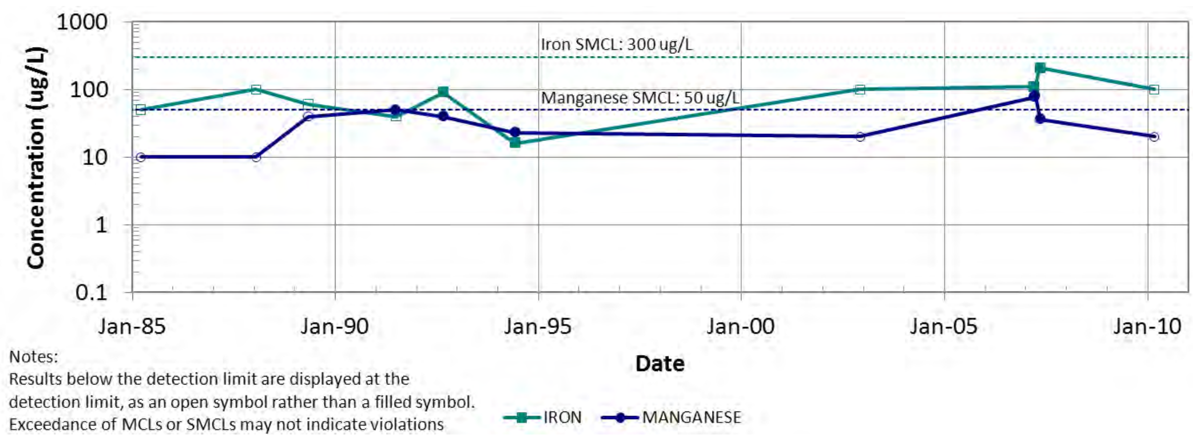


Figure 2.19c. Historical Iron and Manganese Concentrations, SB-15

Nitrate in groundwater poses a health risk if concentrations are too high and the water is not properly treated. Low levels of nitrate are naturally occurring, but higher levels are almost always the result of human activity, such as inorganic fertilizer, animal manure, septic systems, and deposition of airborne compounds from industry and automobiles. Maximum contaminant levels (MCL) are enforceable standards established by EPA and DPH to set the highest level of a contaminant allowed in drinking water. MCLs are set as close as feasible to the level below which there is no known or expected health risk using the best available treatment technology and taking cost into consideration (EPA, 2009). The MCL for nitrate is 45 milligrams per liter (mg/L) (as NO_3). Figure 2.20 shows the distribution of nitrate over the Plan Area based on average 2005-2010 data from DPH. Generally, nitrate concentrations are highest in the central portion of the Plan Area, South San Francisco, and lowest in the southern portion of the South Westside Basin, San Bruno. Some of this trend is due to the depth of the wells as the wells in South San Francisco are generally shallower than the other municipal wells in the basin and thus are more likely to show influences of contaminating activities at the surface. Figures 2.21a-c present historical trends in nitrate concentrations for selected wells with locations shown in Figure 2.14.

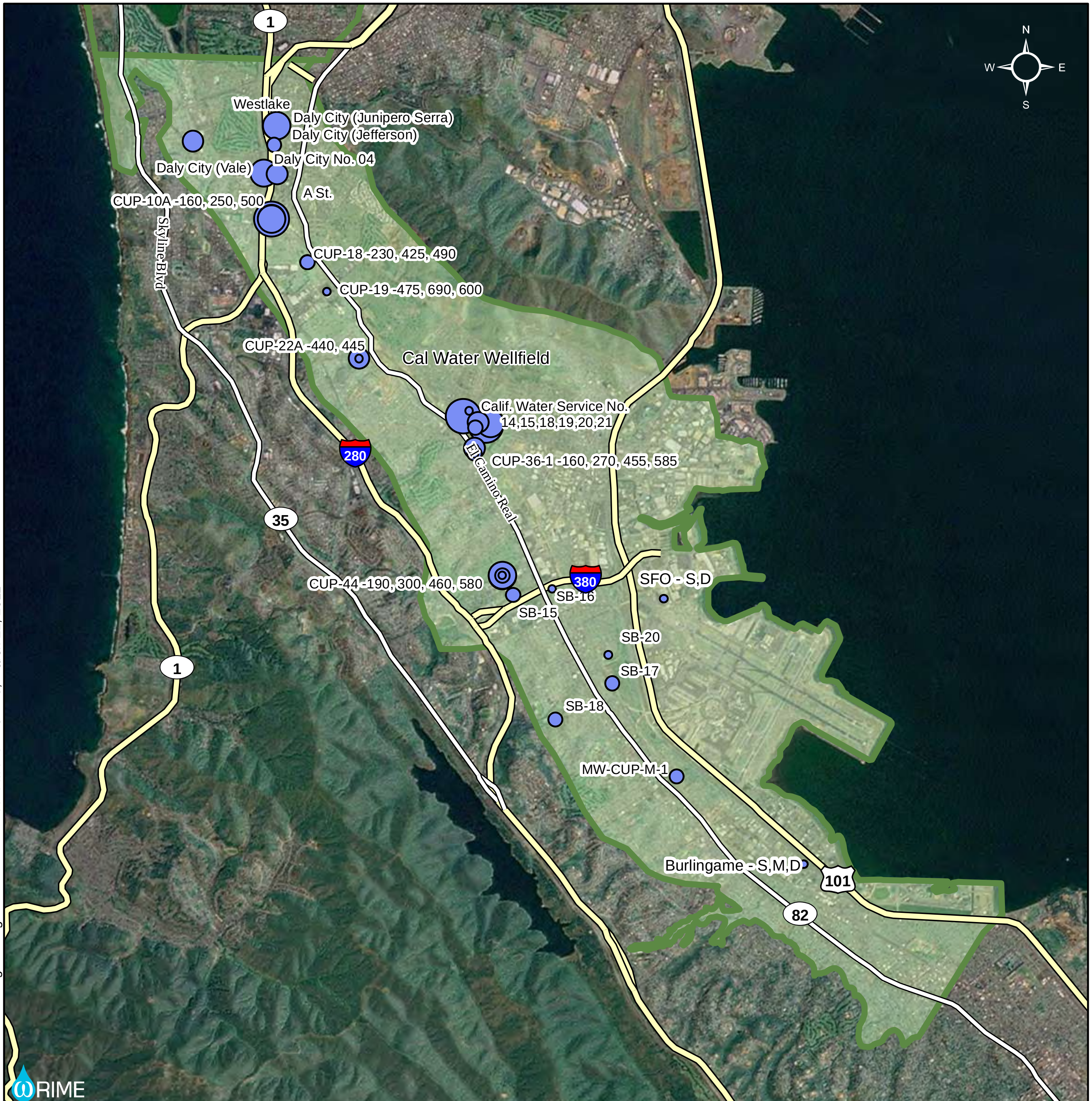


Figure 2.20

Nitrate as NO_3 Concentrations in Groundwater

Legend

Concentration (mg/L)

NO_3 (MCL = 45)

- 0.1 - 1.5
- 1.6 - 15
- 16 - 30
- 31 - 45
- 46 - 80
- Highways
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

Source: DPH, 2010

F:\2.19 - San Bruno\Figures\Figure 2.16 No3 Concentrations.mxd.mxd, March 21, 2011

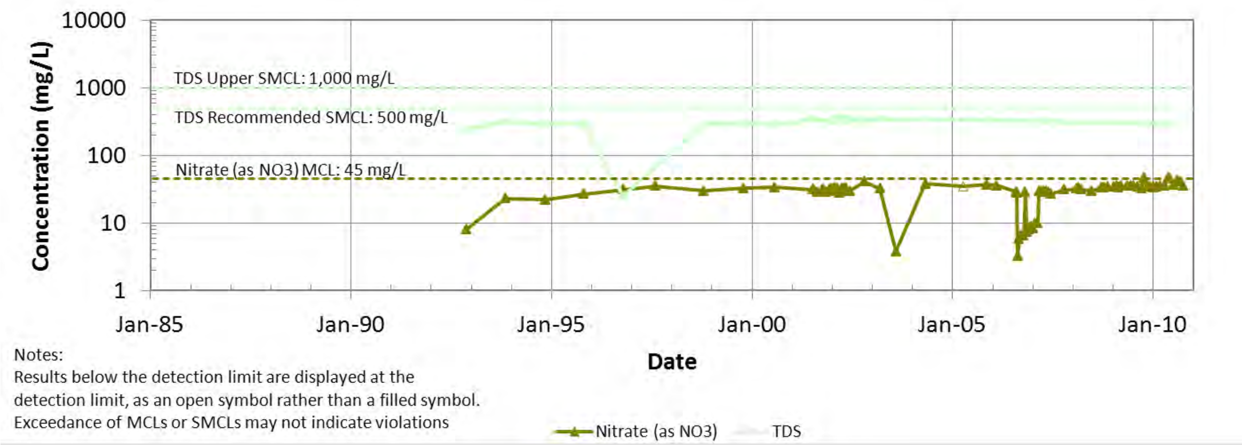


Figure 2.21a. Historical Nitrate and TDS Concentrations, Vale Well

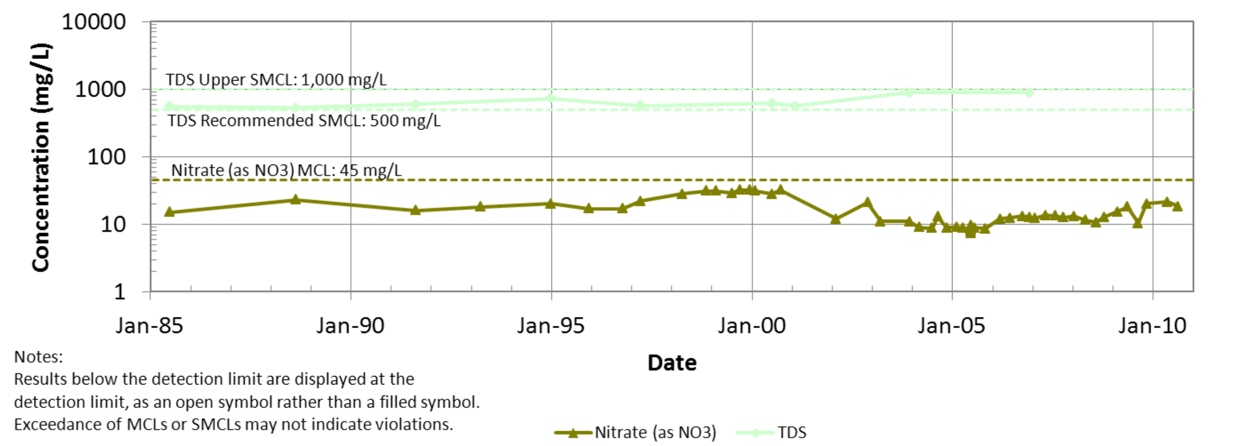


Figure 2.21b. Historical Nitrate and TDS Concentrations, Well 01-15

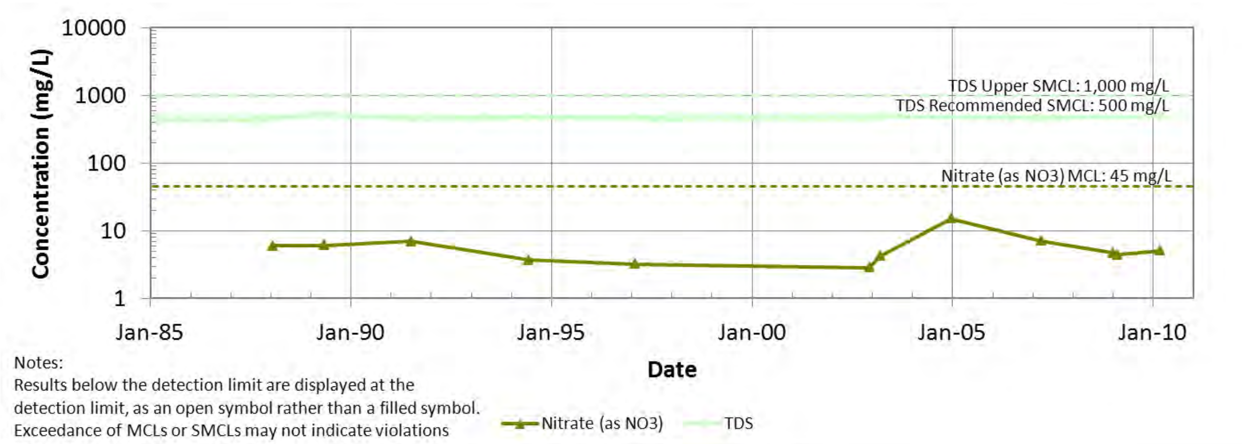


Figure 2.21c. Historical Nitrate and TDS Concentrations, SB-15

TDS do not pose a risk to health, but are an aesthetic concern for water users. High concentrations of TDS can cause scale buildup or hard water that is poor tasting. As TDS is a combined measurement of all dissolved compounds in the water, there are many naturally occurring sources as well as sources resulting from human activities. Irrigation often increases TDS as irrigation water collects salts that contribute to TDS as they percolate to the groundwater. This groundwater may be pumped back to the surface and used for irrigation again, further increasing TDS. Allowing water to leave the system or treating the water at the surface can break this cycle. Seawater intrusion can rapidly increase TDS in an aquifer. TDS has the following three SMCLs:

- Recommended: 500 mg/L. Constituent concentrations lower than the recommended contaminant level are desirable for a higher degree of consumer acceptance.
- Upper: 1000 mg/L. Constituent concentrations ranging to the upper contaminant level are acceptable if it is neither reasonable nor feasible to provide more suitable water.
- Short term: 1500 mg/L. Constituent concentrations ranging to the short term contaminant level are acceptable only for existing community water systems on a temporary basis pending construction of treatment facilities or development of acceptable new water sources. (DPH, 2009)

Figure 2.22 shows the distribution of TDS over the Plan Area based on average 2005-2010 data from DPH. Generally, TDS concentrations are highest in the central portion of the Plan Area, South San Francisco, and lowest in the northern portion of the South Westside Basin, Daly City. Some of this trend is due to the depth of the wells as the wells in South San Francisco are generally shallower than the other municipal wells in the basin and thus are more likely to show influences of contaminating activities at the surface. Figure 2.21a-c presents historical trends in TDS concentrations for selected wells with locations presented on Figure 2.14.

2.3.8.2 Point Source Contamination

In addition to ambient water quality concerns, contaminated groundwater from point sources can quickly remove wells from service and thus requires close coordination with regulatory agencies such as EPA, RWQCB, the California Department of Toxic Substances Control (DTSC), and local oversight programs, including San Mateo County Groundwater Protection Program. Based on a search of DTSC's Envirostor database and the Water Board's GeoTracker database, the sites summarized on Table 2.4 have been identified as federal, state, or voluntary cleanup sites potentially affecting the aquifer used for drinking water supply.

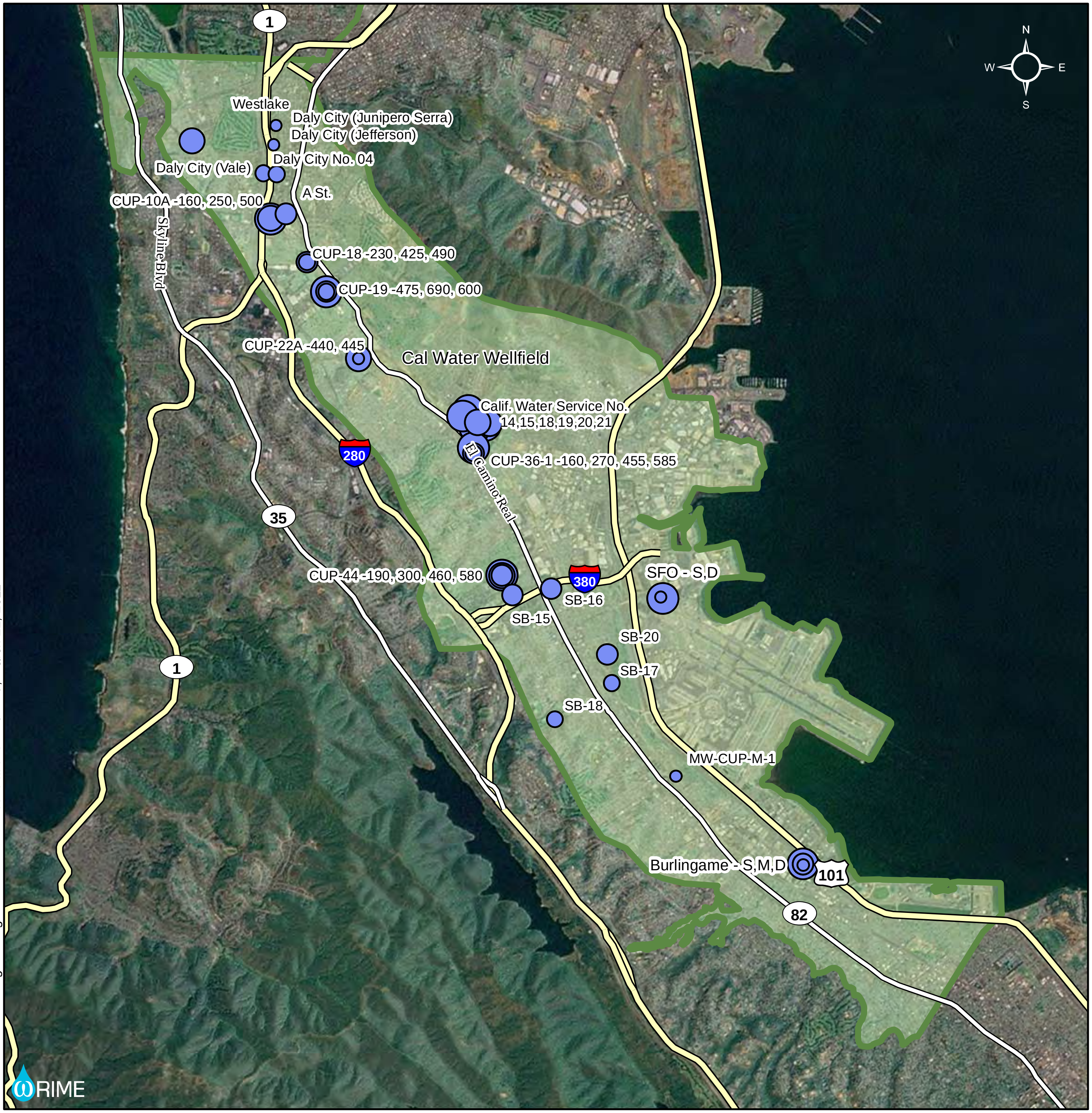


Figure 2.22

TDS Concentrations in Groundwater

Legend

Concentration (mg/L)

TDS (SMCL = 500/1000/1500)

- 250 - 300
- 301 - 400
- 401 - 500
- 501 - 600
- 600 +
- Highways
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

Source: DPH, 2010

F:\2.19 - San Bruno\Figures\Figure 2.21 TDS Concentrations.mxd.mxd, March 21, 2011

Table 2.4
Open Contaminated Sites Potentially Impacting the Aquifer Used for Drinking Water Supply

Name	Address	ID	Potential Contaminants of Concern	Lead Agency
ARCO #0465	151 Southgate Avenue, Daly City	T0608100027	Benzene, Toluene, Xylene, Fuel Oxygenates, Gasoline	County of San Mateo Health Services Agency
Chevron 9-6982	892 John Daly Blvd, Daly City	T0608100148	Gasoline	County of San Mateo Health Services Agency
Agbayani Construction	88 Dixon Ct., Daly City	T10000002674	Tetrachloroethylene (PCE), Trichloroethylene (TCE), Vinyl chloride	County of San Mateo Health Services Agency
Gas & Wash Partners	247 87th St., Daly City	T10000003031	Benzene, Toluene, Xylene, Gasoline	County of San Mateo Health Services Agency
United Airlines Maintenance Center	San Francisco International Airport, South San Francisco	SL0608106162	Solvents	RWQCB
Chevron 9-5584, former	1770 El Camino Real, San Bruno	T0608179897	Gasoline	County of San Mateo Health Services Agency
1245 Montgomery Ave	1245 Montgomery Ave., San Bruno	SL0608187730	Benzene, Other Solvent or Non-Petroleum Hydrocarbon, TCE	RWQCB

As with all urban areas in the state, numerous Leaking Underground Fuel Tanks and Spills Leaks Investigation and Cleanup sites are present in the South Westside Basin and are being monitored and/or remediated under the regulatory lead of the RWQCB or the local oversight program. Leaking underground fuel tanks are typically at gas stations, while spills leaks investigation and cleanup sites have a variety of sources, but all involve hazardous wastes that have impacted soil and/or groundwater.

Many, but not all, of these point-source contaminants occur at the surface and tend to remain near the surface due to the chemical properties of the contaminants and the geologic conditions that slow the migration of these contaminants into the deep aquifer used by municipal groundwater producers in the basin and most private producers. Detailed coordination is required to ensure that corrective action on point sources is sufficient to protect groundwater quality. A map of known, active contaminated sites that have affected or could potentially affect groundwater, soils, or other environmental media is shown in Figure 2.23, as detailed by the Water Board's GeoTracker database system. Sites on Figure 2.23 are classified as follows:

- **Drinking Water Aquifer:** Sites listed on GeoTracker as Potentially Affecting Aquifer Used for Drinking Water Supply or Potentially Affecting Well Used for Drinking Water Supply
- **Shallow Groundwater:** Sites listed on GeoTracker as Potentially Affecting Other Groundwater (Uses Other Than Drinking Water)
- **Other Impact:** Sites listed on GeoTracker as Potentially Affecting Indoor Air, Sediments, Soils, Soil Vapor, Surface Water, or Under Investigation

Note that, in the South Westside Basin, only the United Airlines Maintenance Facility is listed as Potentially Affecting Well Used for Drinking Water Supply, and this site, like many others, is extensively monitored and actively undergoing remediation activities.

Groundwater here includes shallow, perched groundwater not directly used for water supply (Other Groundwater). The distinction between shallow, perched groundwater not directly used for water supply and groundwater used for drinking water supply is to some degree based on professional judgment by the preparers of the GeoTracker system; Section 5.4.3 contains recommendations for coordination with regulatory agencies to improve the accuracy and usefulness of these classifications for regional planning and public outreach.

2.3.9 Desalter Infrastructure

There is currently no desalination infrastructure in the South Westside Basin.

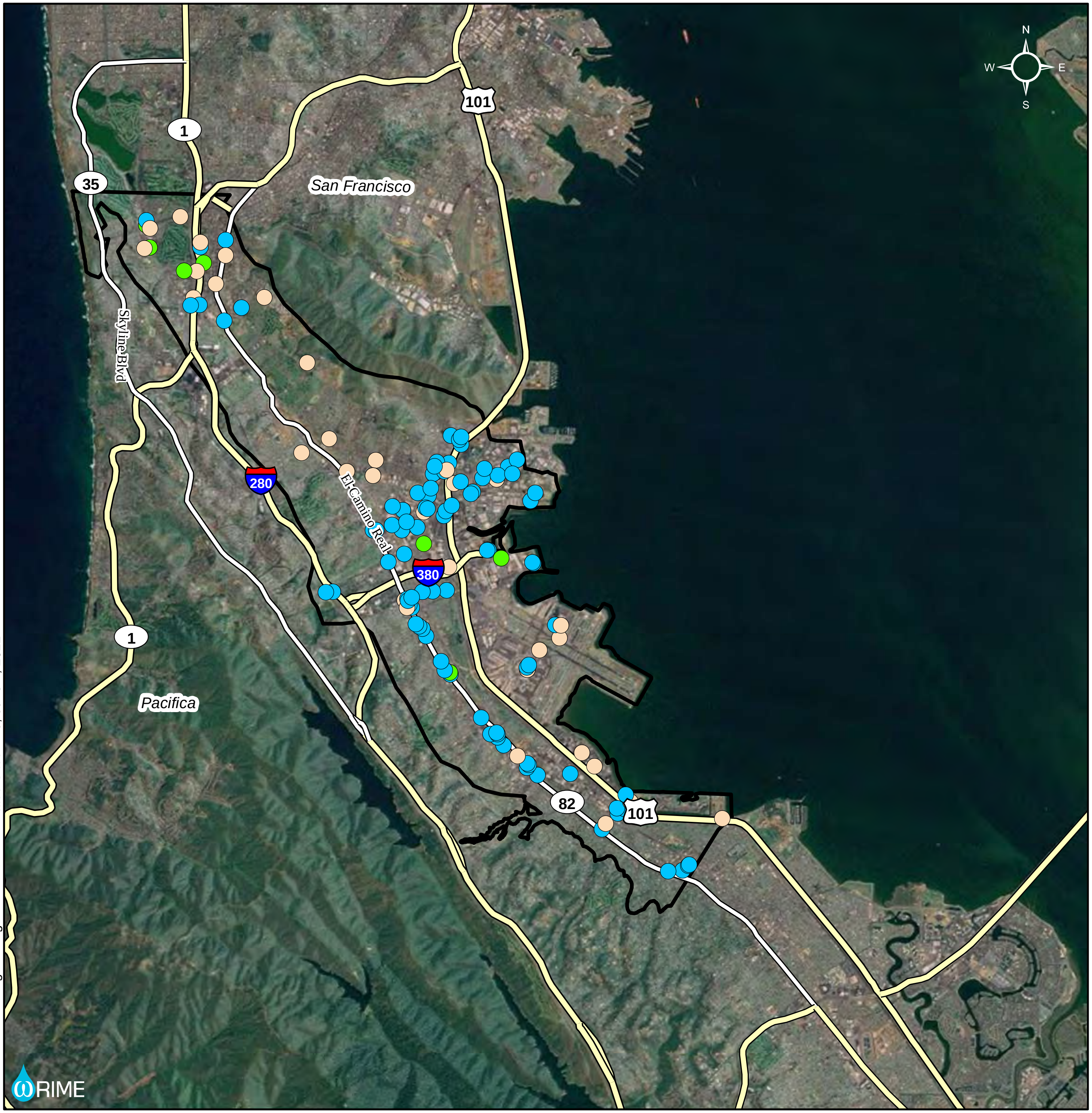


Figure 2.23
Contaminated Sites

Legend

Contaminated Sites by Potential Impact

- Drinking Water Aquifer
- Shallow Groundwater
- Other Impact
- Highways
- Plan Area

0 0.5 1 2 Miles

Source: Water Board, 2010

F:\215 - San Bruno\Figures\Figure 2.23 Contaminated Sites.mxd, June 4, 2012

2.3.10 Groundwater/Surface Water Interaction

Interaction between groundwater and surface water in the Plan Area is limited due to the significant depth to groundwater used for water supply, numerous clay layers that slow vertical migration of water through the subsurface, and the presence of only minor surface water features, such as Colma Creek, which are often channelized. The perched water table above the upper clay units interacts with local surface water courses, such as Colma Creek and smaller creeks. Groundwater tends to seep into the surface water courses near the Bay and the surface water recharges the groundwater at higher elevations. The perched aquifer, which is not used as a water supply, slowly recharges the deeper aquifer through the clay layers.

Lake Merced is an important surface water feature just north of the Plan Area. The draft North Westside Basin GWMP addresses issues with groundwater interaction with Lake Merced.

2.3.11 Subsidence and Liquefaction

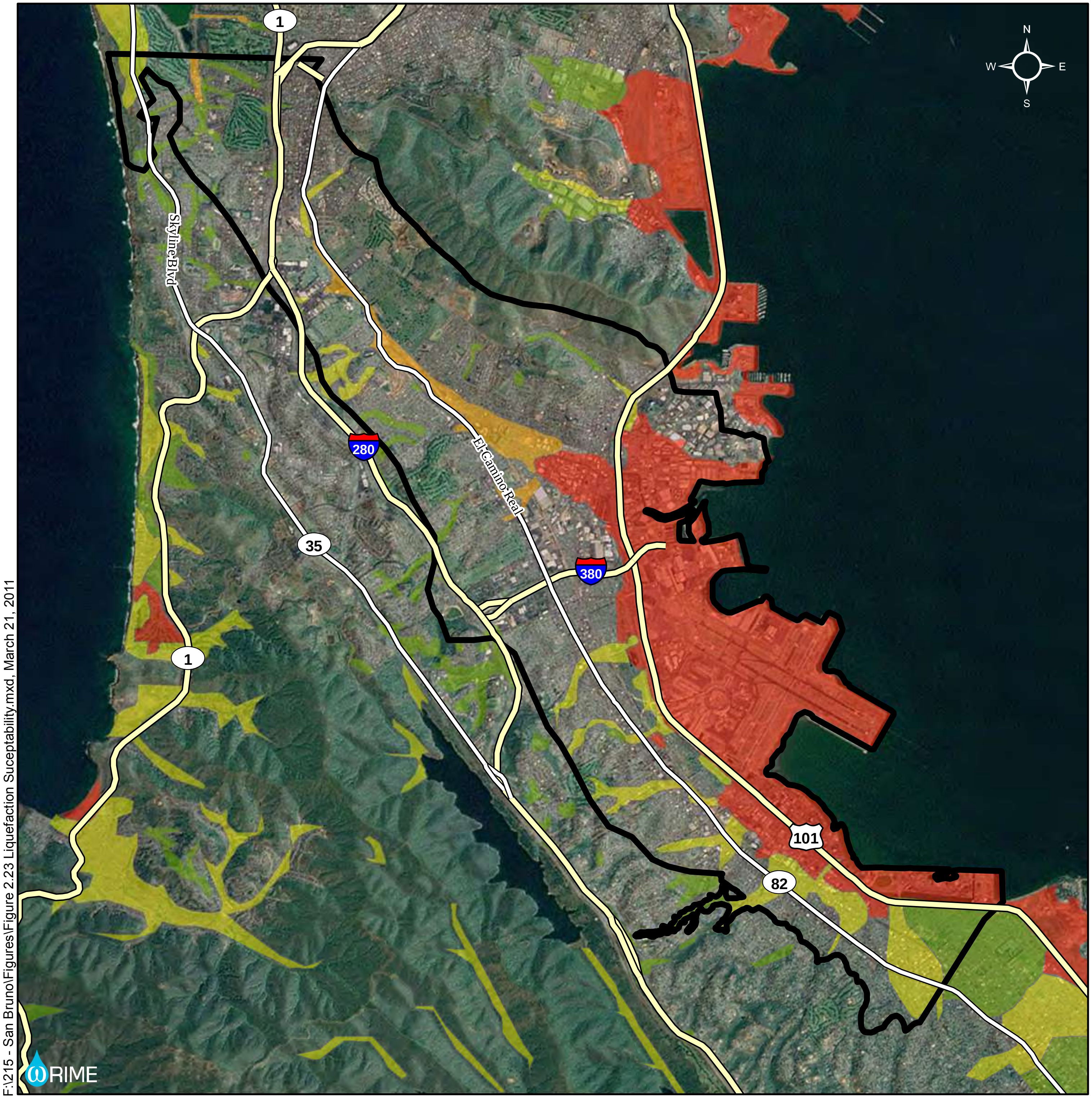
Subsidence and liquefaction are both influenced by changes in groundwater levels. Low groundwater levels can contribute to subsidence while high groundwater levels can contribute to liquefaction.

Land subsidence here refers to the lowering of the ground surface as a result of groundwater level changes, not tectonic changes. Aquifers, particularly the fine-grained materials within or between the aquifers, are compressible. If groundwater levels decrease as a result of pumping or other causes, water may be released from beds of clay or silt around the coarser materials that are the primary source of water in the aquifer. The release of water from the beds of clay and silt reduces the water pressure, resulting in a loss of support for the clay and silt beds. Because these beds are compressible, they compact (become thinner), and the effects are seen as a lowering of the land surface (Leake, 2004). Whether or not subsidence through compression occurs in an area depends on groundwater levels (groundwater levels must decline) and on materials (sufficient compressible clays and silts must be present).

There are no available records of historical subsidence in the South Westside Basin. Significant studies have been performed to the south in the Santa Clara Valley, due to extensive subsidence in that area. Those studies show that the extent of subsidence in the area is focused on Santa Clara, where land subsided 8 ft from 1934 to 1967. To the north, subsidence is more limited, with less than 1 foot of subsidence in the Palo Alto area and approximately an inch of subsidence in the Redwood City area (Poland and Ireland, 1988). Studies have not been performed farther north, likely due to a lack of evidence of active subsidence.

The Plan Area has potential for liquefaction, where earthquake-induced shaking can cause a loss of soil strength, resulting in the inability of soils to support structures. This can occur in saturated soils where the shaking causes an increase in water pressure to the point where the soil particles can move easily within the soil-water matrix. Areas along San Francisco Bay have been rated as having "very high" susceptibility to liquefaction by the USGS (Figure 2.24; Witter et al., 2006). These areas are underlain by artificial fill over Bay Mud. While only covering the bayshore area, artificial fill over Bay Mud accounted for 50 percent of all historical liquefaction occurrences in the nine-county San Francisco Bay area and about 80 percent of those liquefaction occurrences resulted from the Loma Prieta earthquake (Witter et al., 2006). In the South Westside Basin, these units have a perched water table that is not influenced by groundwater production. Areas with high to moderate susceptibility to liquefaction include areas along current or former creeks, particularly Colma Creek. Other areas have low or very low susceptibility to liquefaction.

Figure 2.24
Liquefaction Suceptability



Sources:
• Liquefaction Susceptability - Witten et al, 2006

F:\215 - San Bruno\Figures\Figure 2.23 Liquefaction Suceptability.mxd, March 21, 2011

2.3.12 Groundwater Monitoring

Current South Westside Basin-wide groundwater monitoring is coordinated through the agencies throughout the Plan Area and is presented in annual groundwater monitoring reports prepared by SFPUC since 2005. The reports include details on semi-annual monitoring of groundwater production, level, and quality data as well as data on Lake Merced water levels. Prior to that date, San Mateo County maintained a semiannual groundwater monitoring program that included static water level and water quality monitoring. San Mateo County's reports covered the period from 2000 through 2003. The individual agencies also maintain long-term records of production, water levels, and water quality for their facilities.

2.3.12.1 Groundwater Level Monitoring

Groundwater level monitoring for use in the regional annual groundwater reports includes both dedicated monitoring wells and inactive production wells. Dedicated monitoring wells include wells installed as part of seawater intrusion monitoring, groundwater/surface water interaction monitoring, and as part of the GSR. Measurements are taken manually on a quarterly or semiannual basis in some wells, and daily through the use of electronic pressure transducers in other wells (SFPUC, 2010a). Monitoring wells measured in the South Westside Basin include the following:

- Daly City Area
    - LMMW-6D
    - Thornton Beach MW 225, 360, 670
    - DC-1 (Westlake 1)
    - Park Plaza MW460, 620
    - DC-8
    - CUP 10A MW160, 250, 500, 710
- Colma Area
    - CUP 18 MW230, 425, 490, 660
    - CUP 19 MW180, 475, 600, 690
    - CUP 23 MW230, 440, 515, 600
- South San Francisco Area
    - CUP 22A MW140, 290, 440, 545
    - SS 1-02
    - SS 1-20
    - CUP 36 MW160, 270, 455, 585
    - SSFLP MW120, 220, 440, 520
- San Bruno Area
    - CUP 44-1 MW190, 300, 460, 580
    - SB-12 (Elm Ave)

    - UAL-13C, 13D
    - SFO-S, -D
- Millbrae Area
    - CUP-M-1
- Burlingame Area
    - Burlingame-S, -M, -D

Additionally, groundwater levels are also monitored by the individual agencies, and include measurements of static or dynamic water levels, depending on the operational status of the well.

2.3.12.2 Groundwater Production Monitoring

Groundwater production data are summarized for the water agencies and for metered users of recycled water in SFPUC's annual reports. Other irrigation production is estimated and also presented in the report.

2.3.12.3 Groundwater Quality Monitoring

Groundwater quality is monitored for both regional analysis in SFPUC annual reports and to meet the DPH's requirements specified in Title 22 of the California Code of Regulations.

Individual agencies test the water quality in the active municipal productions wells on a schedule to meet DPH requirements and to ensure safe drinking water for their customers.

Water quality data are collected for use in SFPUC's annual reports, either specifically for the program or as part of the testing for DPH requirements or other programs such as seawater intrusion monitoring or monitoring for use in the proposed GSR.

2.4 IMPORTED WATER

Imported water in the South Westside Basin is supplied by SFPUC, which operates the Hetch Hetchy system. Details of the system are provided in the following two paragraphs, based on SFPUC's *Annual Water Quality Report* (SFPUC, 2010b). The *Annual Water Quality Report* is included in Appendix B and contains more detailed information on chemical constituents in the water supply.

The major sources of imported water are from the SFPUC and include Hetch Hetchy Reservoir and the local watersheds. Hetch Hetchy is located in the well-protected Sierra region and meets all federal and state criteria for watershed protection. Based on SFPUC's disinfection treatment practice, extensive bacteriological quality monitoring, and high operational standards, the state has granted the Hetch Hetchy water source a filtration exemption. In other words, the source is so clean and protected that SFPUC is not required to filter water from Hetch Hetchy Reservoir.

Hetch Hetchy Reservoir water is provided by SFPUC to Daly City, San Bruno, Millbrae, Burlingame, and to the Golden Gate National Cemetery. SFPUC provides water to CalWater from sources in accordance with the Raker Act.

Hetch Hetchy water is supplemented with surface water from two local watersheds. Rainfall and runoff collected from the Alameda Watershed, which spans more than 35,000 acres in Alameda and Santa Clara Counties, are collected in the Calaveras and San Antonio reservoirs. Prior to distribution, the water from these reservoirs is treated at the Sunol Valley Water Treatment Plant. Treatment processes include coagulation, flocculation, sedimentation, filtration, and disinfection. Fluoridation, chloramination, and corrosion control treatment are provided for the combined Hetch Hetchy and Sunol Valley Water Treatment Plant water at the Sunol Chloramination and Fluoridation Facilities. Rainfall and runoff captured in the 23,000-acre Peninsula Watershed in San Mateo County are stored in reservoirs, including Crystal Springs (Lower and Upper), San Andreas, and Pilarcitos. The water from these reservoirs is treated at Harry Tracy Water Treatment Plant, where treatment processes include ozonation, coagulation, flocculation, filtration, disinfection, fluoridation, corrosion control treatment, and chloramination.

Daly City has 10 SFPUC pipeline connections called turnouts. They are connected to the Sunset, San Andreas #2, and Crystal Springs #2 pipelines and can supply approximately 30.89 mgd at a rate of approximately 21,400 gallons per minute (Daly City, 2005).

CalWater - South San Francisco District receives water from 12 connections at 11 SFPUC turnouts and groundwater from eight wells. Portions of CalWater's distribution system rely solely on SFPUC imported surface water, while others use groundwater from CalWater's wellfield for all or a portion of their water supply (MWH, 2007).

San Bruno has four connections to SFPUC's water supply system and one connection to North Coast County Water District (NCCWD). During normal conditions, water from SFPUC is transported through the San Andreas Pipeline from the Harry Tracy Water Treatment Plant near Crystal Springs Reservoir and delivered to three of San Bruno's turnouts. San Bruno also has a connection to SFPUC's 60-inch diameter Sunset Supply Pipeline, which was recently fitted with a pressure reducing valve, and is currently used only for fireflow and other emergency situations. The Sunset Supply Pipeline can deliver water directly from SFPUC's Hetch Hetchy System. San Bruno's connection from the NCCWD extends from SFPUC's Harry Tracy Water Treatment Plant to Crystal Springs Terrace. San Bruno purchases treated water from the NCCWD to serve the Crystal Springs Terrace area. This connection is equipped with a pressure reducing valve at Regulating Station 1 (EKI, 2007; Brown and Caldwell, 2001).

Millbrae receives water from five SFPUC turnouts. The Harry Tracy Water Treatment Plant supplies filtered water in the higher elevations, while the Crystal Springs #2 and #3 pipelines deliver water to the lower elevations (BAWSCA, 2009).

Burlingame receives water from six metered turnouts connected to SFPUC's Sunset Supply Pipeline and Crystal Springs Pipelines #2 and #3 (EKI, 2005).

2.5 RECYCLED WATER

Wastewater collection, treatment, and disposal performed by the local agencies is described in the following sections. Of these agencies, the North San Mateo County Sanitation District also includes treatment and distribution of recycled water as part of its wastewater activities.

2.5.1 Treatment Plants

Wastewater treatment plants in the South Westside Basin include:

- North San Mateo County Sanitation District's (NSMCSD) treatment plant, which includes a recycled water facility permitted to distribute 2.77 mgd of tertiary recycled water.
- San Bruno and South San Francisco's South San Francisco/San Bruno Water Quality Control Plant
- Burlingame's Wastewater Treatment Facility
- City of Millbrae's Water Pollution Control Plant

2.5.1.1 North San Mateo County Sanitation District Treatment Plant

The NSMCSD is a subsidiary of the City of Daly City and owns and operates a treatment plant at the southern end of Westlake Park in Daly City. The plant was expanded in 1989 to a capacity of 10.3 mgd. The NSMCSD provides collection, treatment and disposal for the majority of the residents of Daly City, along with Broadmoor Village, a portion of Colma, the Westborough County Water District in South San Francisco, and the San Francisco County Jail in San Bruno (Daly City, 2009).

In 2003, NSMCSD constructed facilities at its wastewater treatment plant to produce recycled water. The plant has the capacity and permits for production of approximately 2.77 mgd of tertiary-treated recycled water (SFPUC, 2008) and began delivery in 2004 to irrigation users.

2.5.1.2 South San Francisco/San Bruno Water Quality Control Plant

The South San Francisco/San Bruno Water Quality Control Plant was constructed in the early 1970s and is jointly operated by the cities of South San Francisco and San Bruno. The sewage of both cities is treated, as is wastewater from a portion of Colma and the Serramonte portion of Daly City. The Westborough Water District coordinates sewage treatment for the Westborough portion of South San Francisco under contract with Daly City.

The current design capacity of the treatment plant is 13 mgd with an actual capacity of 9 mgd average dry weather flow. A plant expansion, begun in the fall of 1998, increased the dry-weather operational capacity to 13 mgd. The expansion added three new primary clarifiers, additional secondary clarifiers, and removed obsolete equipment (South San Francisco, 2009).

2.5.1.3 City of Millbrae Water Pollution Control Plant

The City of Millbrae provides wastewater service to approximately 5,928 residential and 495 commercial customers. The City's Sanitation System has two components: collection and treatment/disposal. Wastewater is collected via a network of about 57 miles of sewer pipelines and two wastewater pumping stations, and then transported to the City's Water Pollution Control Plant for treatment and disposal (Millbrae, 2009a). In October 2009, Millbrae began a refurbishment of the Water Pollution Control Plant to improve treatment capabilities and minimize sanitary sewer overflows that can occur during stormy weather. This project will add a 1.2 million gallon flow equalization tank to retain the extra water that flows into the treatment plant during storms (Millbrae, 2009b).

2.5.1.4 Burlingame Wastewater Treatment Facility

The wastewater treatment facility at 1103 Airport Boulevard became operational during 1935-36. The facility has a designed capacity to treat 5.5 mgd of wastewater and 16 mgd during wet weather (Burlingame, 2009).

2.5.2 RECYCLED WATER INFRASTRUCTURE AND USERS

Existing recycled water infrastructure and users are in the Daly City / Lake Merced area. Recycled water for non-potable (non-drinkable) uses such as irrigation is encouraged to conserve drinking water supplies. Installation of recycled water pipelines in the NSMCSD began in the mid-1980s when water or sewer projects were constructed. As discussed in Section 2.5.1.1, NSMCSD's treatment plant has the capacity and permits for production of 2.77 mgd of recycled water.

Today, the system is used to irrigate landscaped medians in the Westlake area and golf courses at Olympic Club, Lake Merced Golf Club, and San Francisco Golf Club. These customers use an average of less than 1 mgd of recycled water. Construction is underway to expand the recycled water infrastructure and user base to include irrigation of Harding Park and Fleming golf courses.

Plainly marked purple pipelines, completely separate from drinking water systems, deliver the water to user sites. Water recycling is a safe and proven practice. For many years, recycled water has been safely used for landscape irrigation purposes throughout California and the world saving precious potable water for other uses (Daly City, 2009).

Studies have been performed to investigate recycled water opportunities based on production at the South San Francisco/San Bruno Water Quality Control Plant (Carollo, 2008, 2009). These documents analyzed irrigation demands and infrastructure needs. Demand analysis showed a Phase I average annual recycled water demand of 0.60 mgd and a Phase II average annual recycled water demand of 0.94 mgd. The estimated project costs are $44 million for Phase I and $43.8 million for Phase II. Such projects may be pursued in the future should costs become better aligned with the benefits of the additional reliable supply.

2.5.3 Recycled Water Quantity and Quality

Throughout the year, NSMCSD monitors water quality to maintain compliance with Title 22 for unrestricted use. Monitoring is performed for the following: flow rate, total coliform, contact time, turbidity, dissolved oxygen, dissolved sulfides, and applicable standard observations. NSMCSD additionally monitors pH, electrical conductivity, TDS, boron, chloride, sodium, sodium adsorption ratio, adjusted sodium adsorption ratio, and bicarbonate (ESA, 2009).

3 WATER REQUIREMENTS AND SUPPLIES

3.1 CURRENT AND HISTORICAL WATER REQUIREMENTS AND SUPPLIES

South Westside Basin groundwater, imported water from the SFPUC, and small quantities of recycled water are used to meet water demands in the South Westside Basin as summarized in Table 3.1. All annual values represent calendar years. Details by agency are provided in Section 3.1.2.

Table 3.1 Summary of Current Water Supply Sources (2010)

Entity	Supply (AFY)			
	South Westside Basin Groundwater[1]	Imported Water[2]	Recycled Water[1]	Total
Burlingame	0	4,389	0	***4,389***
CalWater	453	8,075	0	***8,528***
Daly City[3]	1,743 / 3,947	5,524 / 3,320	0	***7,267***
Millbrae	0	2,482	0	***2,482***
San Bruno	2,364	1,637	0	***4,001***
Irrigators[4]	1,800	0	412	***2,212***
Total[5]	***8,564***	***19,903***	***412***	***28,879***

1 – SFPUC, 2011. Since Olympic Club and San Francisco Golf Club overlie both the North Westside Basin and South Westside Basin, the irrigation use assumes the following: Olympic Club – 50 percent of total recycled water use in the North Westside Basin and 50 percent use in the South Westside Basin; and San Francisco Golf Club – 90 percent of total recycled water use in the North Westside Basin and 10 percent use in the South Westside Basin.
2 – BAWSCA, 2011
3 - Daly City banked 2,204 AF of water in a conjunctive use arrangement with SFPUC, resulting in lower than normal groundwater production and higher than normal imported water purchases in 2010. The first value listed is the actual groundwater production and imported water purchase. The second value listed is the adjusted value.
4 –For the irrigators, all groundwater production within the South Westside Basin is listed, including estimated production in Millbrae and Burlingame. For comparison to the basin yield estimate (which does not include the Millbrae and Burlingame area; see Section 3.5.2), a total irrigation production of 1,139 and a total South Westside Basin groundwater production of 5,700 AF (7,904 AF when including banked Daly City production) should be used.

5 – Totals utilize Daly City values adjusted for conjunctive use.

Water demand in the Plan Area is somewhat higher in the summer months than in the winter months, primarily due to outdoor use and irrigation demands. The current water supply facilities are capable of meeting demands throughout the year, including summer days with high water use. The typical average monthly water supply distribution is shown in Figure 3.1, based on monthly data from the South Westside Basin municipal water purveyors.

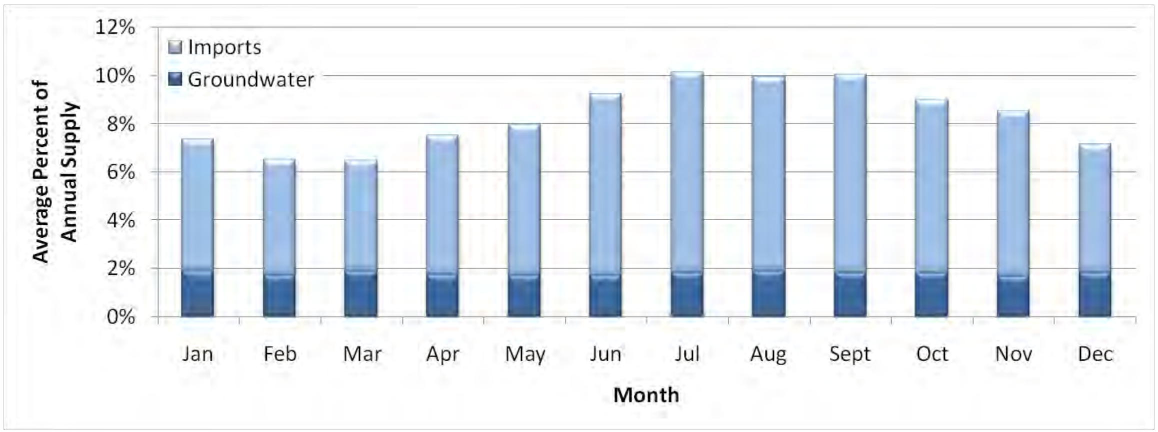


Figure 3.1 Average Monthly Distribution of Annual Municipal Supply, South Westside Basin

3.1.1 WHOLESALE WATER AGENCIES

Imported water is brought into the Plan Area by SFPUC, a wholesaler of imported water in the South Westside Basin and a retailer in the North Westside Basin.

The City and County of San Francisco, through SFPUC, own and operate a regional water system extending from the Sierra Nevada to San Francisco and serves retail and wholesale customers in San Francisco, San Mateo, Santa Clara, Alameda, and Tuolumne counties. The regional water system consists of water conveyance, treatment, and distribution facilities, and delivers water to retail and wholesale customers. The existing regional system includes more than 280 miles of pipelines, more than 60 miles of tunnels, 11 reservoirs, 5 pump stations, and 2 water treatment plants. The SFPUC currently delivers an annual average of approximately 265 mgd of water to its customers. The water supply source is a combination of local supplies from streamflow and runoff in the Alameda Creek Watershed and in the San Mateo and Pilarcitos creeks watersheds (referred to together as the Peninsula Watersheds), augmented with imported supplies from the Tuolumne River Watershed. Local watersheds provide about 15 percent of total supplies and the Tuolumne River provides the remaining 85 percent (ESA, 2009).

The SFPUC serves approximately one-third of its water supplies directly to retail customers, primarily in San Francisco, and about two-thirds of its water supplies to wholesale customers by contractual agreement. One retail customer, the Golden Gate National Cemetery in San Bruno, is located within the South Westside Basin. The wholesale customers are largely represented by BAWSCA, which consists of 27 total customers. Some of these wholesale customers have other sources of water in addition to what they receive from the SFPUC regional system, while others rely completely on SFPUC for supply (ESA, 2009).

3.1.2 RETAIL AGENCY WATER USE

Details on water use by the retail agencies are presented in the following sections. Data are available from metered agency records, agency UWMPs, South Westside Basin annual groundwater reports, and BAWSCA's annual reports. From these data sources the following can be summarized: supply sources, quantification of the current supply mix, and quantification of historical groundwater production.

3.1.2.1 City of Burlingame

The City of Burlingame covers 4.3 square miles and has a population of approximately 28,000 people. Details of the Burlingame water supply system are summarized below based on the city's UWMP (EKI, 2005). Burlingame owns, operates, and maintains the potable water distribution system that serves drinking water to residential, commercial, and industrial establishments. The water supply is imported water purchased from SFPUC.

Burlingame's distribution system consists of six pumping stations, five water storage tanks, and buried pipes of varying compositions, ages, and sizes. The distribution system provides water to eight pressure zones within the city's water service area.

Approximately 80 percent of all service connections are located in the Aqueduct Zone, which contains most of Burlingame's commercial, industrial, and multi-family residence units. Water is transferred between pressure zones through a system of pipes and pumping stations. The pumping stations currently operated by the city are referred to as:

1. Donnelly
2. Easton
3. Skyview
4. Trousdale
5. Hillside
6. Sisters of Mercy (fire flow only)

Five of the pumping stations transfer water from the lower elevations of the city to the higher elevations, while the Sisters of Mercy station provides fire flow to the Sisters of Mercy property. The sizes of the pumps range between 7.5 and 75 horsepower.

The city's five water storage tanks provide aggregate water storage for 2.94 million gallons. The largest water storage facility is the Hillside Tank, which holds 1.5 million gallons. The smallest water storage facilities are the individual tanks at the Alcazar and Donnelly sites. There are two tanks at each site and each tank holds 0.05 million gallons.

The total water supply, all from SFPUC purchases, has averaged 5,100 AF over the past 14 years and has shown a slight declining trend over that time period (Figure 3.2). In 2010, the total water supply for Burlingame was 4,389 AF.

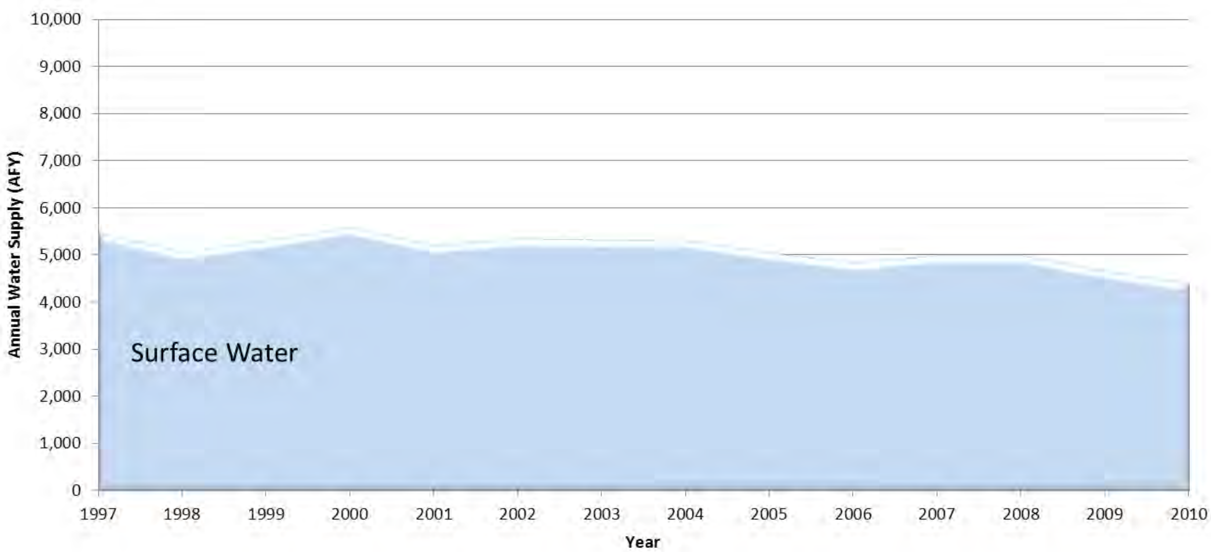


Figure 3.2 Historical Annual Water Supply, Burlingame

3.1.2.2 California Water Service Company –South San Francisco District

CalWater – South San Francisco District provides water to approximately 56,950 people in a service area of approximately 11 square miles. The service area includes South San Francisco, Colma, a small portion of Daly City, and an unincorporated area of San Mateo County known as Broadmoor, which lies between Colma and Daly City. The South San Francisco system includes 144 miles of pipeline, 12 storage tanks, one collecting tank, and 20 booster pumps.

CalWater uses groundwater and imported surface water from SFPUC to meet demands. CalWater's Individual Supply Guarantee with

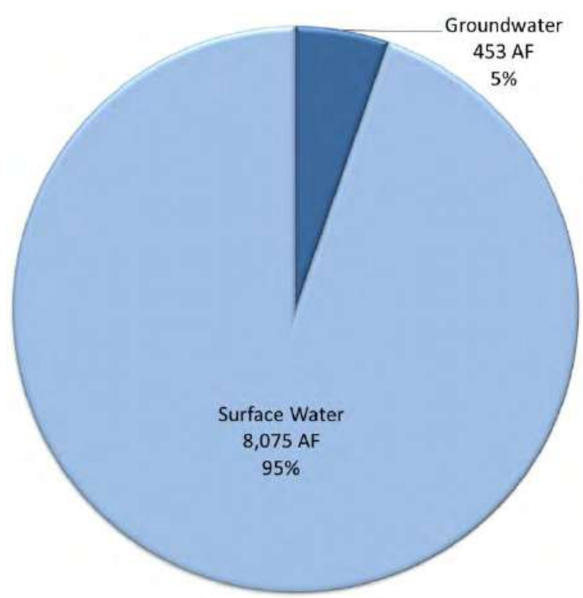


Figure 3.3a
Current (2010) Water Supply Sources, CalWater – South San Francisco District

SFPUC is 35.68 mgd (or approximately 39,967 AFY) and also supplies CalWater's other Bay Area Districts: Bear Gulch and Mid-Peninsula. Imported surface water has been used to a greater extent recently due to reduced groundwater production, as discussed in the following paragraph. In 2010, imported surface water accounted for 95 percent of CalWater's supply, while the remaining 5 percent was supplied by groundwater (Figure 3.3a).

The South San Francisco District has seven wells with a total design capacity of 1,365 gallons per minute (gpm). If operated full-time, these wells could produce 1.97 mgd (2,207 AFY). This production capacity represents approximately 20 to 25 percent of the annual demand in the district. While production in the 1950s and 1960s averaged 2,031 AFY, a maximum of 1,524 AFY has been pumped in calendar years since 1970. From 1998 to 2002, production averaged 1,212 AFY. However, recent years have seen little groundwater production due to participation in the ILPS and unforeseen issues with the wells. There was no groundwater production from 2003-2007; groundwater production steadily increased from when the wells were returned to service in 2008 to where CalWater produced 453 AF of groundwater in 2010. Historical water supplies by year are shown in Figure 3.3b. The district plans to return to earlier levels of production (1,535 AFY) in the future (CalWater, 2011).

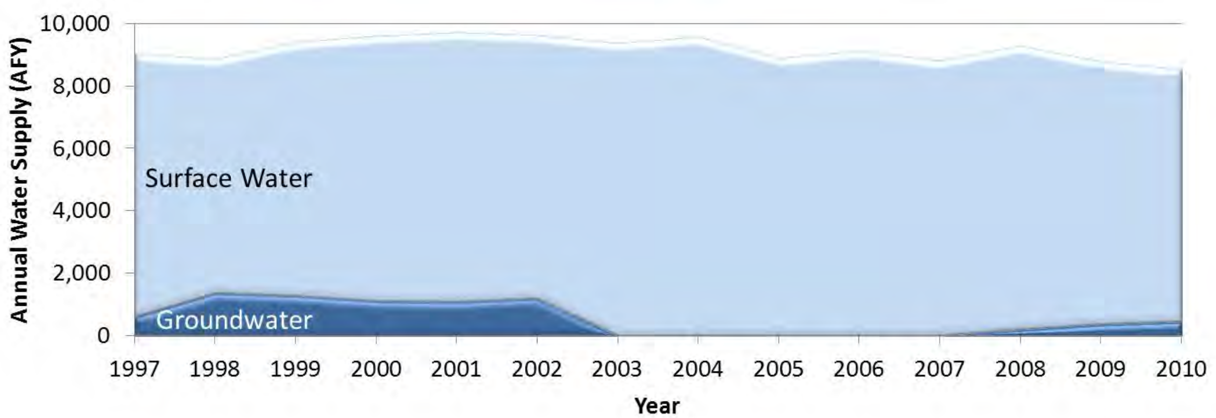


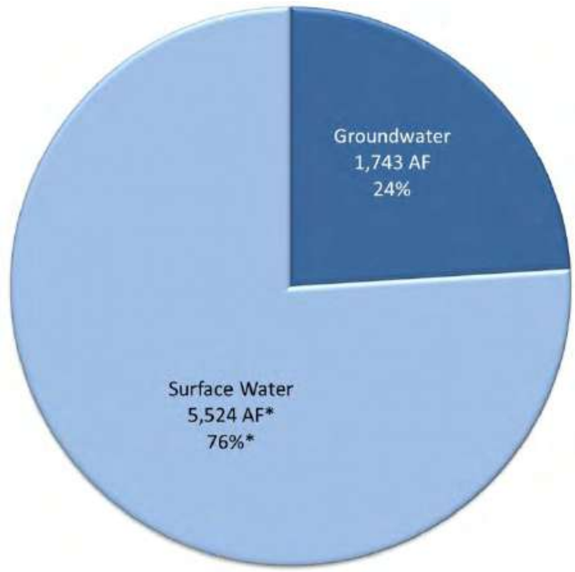
Figure 3.3b Historical Annual Water Supply, CalWater – South San Francisco District

3.1.2.3 City of Daly City

Daly City is in the northern part of San Mateo County, adjacent to the southern boundary of the City and County of San Francisco. Water service is provided by the Daly City Department of Water and Wastewater Resources. The city has an estimated 2009 population of 102,165, including small areas served by CalWater.

Daly City has three water sources: groundwater, water purchased from SFPUC, and recycled water.

Daly City's purchases of water from SFPUC are based on an Individual Supply Guarantee of 4.292 mgd (4,808 AFY) (Daly City, 2005) and are provided through 10 SFPUC turnouts. The turnouts can supply approximately 30.89 mgd at a rate of about 21,400 gpm (Daly City, 2005). During 2010, Daly City's water supply was provided by 76 percent imported surface water from SFPUC and 24 percent from local groundwater (see Figure 3.4a). The 76 percent includes participation in the ILPS. If the in-lieu water were accounted for as groundwater, the percentages would be 46 percent imported surface water and 54 percent groundwater. During normal well operation, SFPUC provides approximately 55 percent of the city's annual water supply. Daly City has been involved in the ILPS for much of the period since 2002 and purchases from SFPUC have contributed up to 92 percent of the city's annual water supply (Figure 3.4b).



* Includes 2204 AF of in-lieu recharge water

Figure 3.4a Current (2010) Water Supply Sources, Daly City

Daly City has six active groundwater wells with a combined capacity of 4.25 mgd (4,760 AFY). During conjunctive use in an emergency or drought scenario, well water can contribute approximately 50 percent of the Daly City water supply (Daly City, 2005).

For the purposes of this document, recycled water produced by Daly City is accounted for under the user of the supply, Private Groundwater Producers in Section 3.1.3.

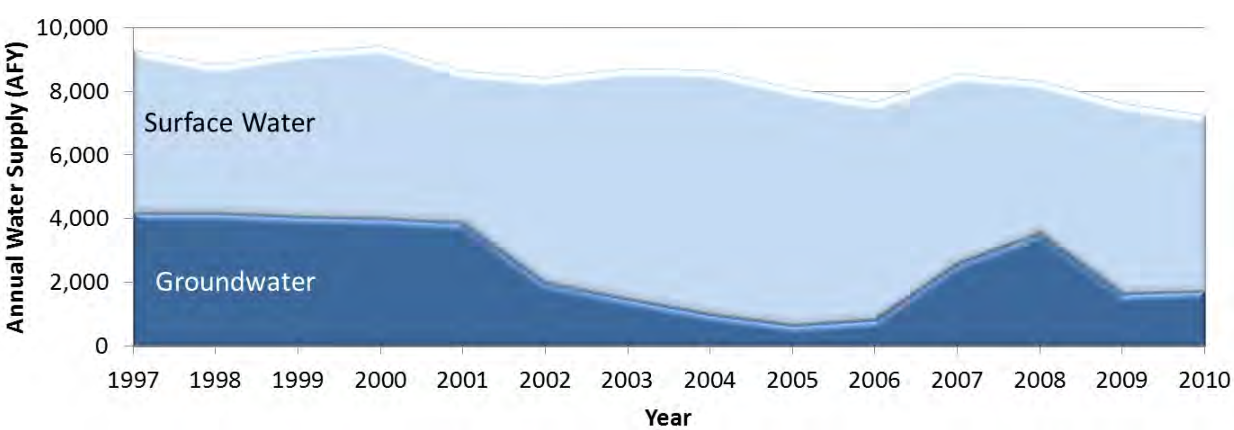


Figure 3.4b Historical Annual Water Supply, Daly City

3.1.2.4 City of Millbrae

Millbrae provides water to approximately 21,800 residents within a service area of 3.2 square miles (Figure 1.3). The City of Millbrae owns and operates approximately 70 miles of domestic water mains, 450 fire hydrants, 1,500 valves, 11 pressure reducing stations, 6 water storage tanks, 2 water pump stations, and approximately 6,500 service connections (Millbrae, 2005). Millbrae purchases its water from SFPUC and has an Individual Supply Guarantee of 3,531 AFY. Total water supplies averaged 2,790 AFY over the 1997-2010 period, and was 2,482 AF in 2010, as shown in Figure 3.5.

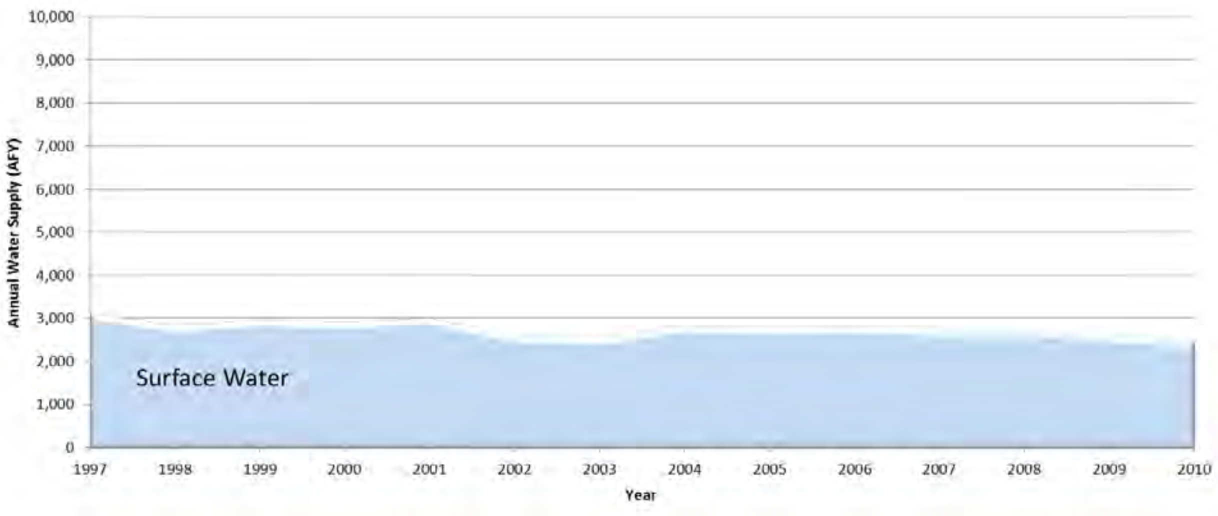


Figure 3.5 Historical Annual Water Supply, Millbrae

3.1.2.5 City of San Bruno

San Bruno owns, operates, and maintains the potable water distribution system that serves drinking water to residential, commercial, institutional, and limited industrial establishments within San Bruno's service area. The City of San Bruno covers 5.5 square miles and has a population of approximately 41,120 people. San Bruno's water system consists of five groundwater supply wells, eleven pressure zones maintained with eight booster pump stations, eight water storage tanks, one filtering plant, 900 fire hydrants, 9,000 valves, more than 100 miles of water mains ranging from 2 inches to 16 inches in

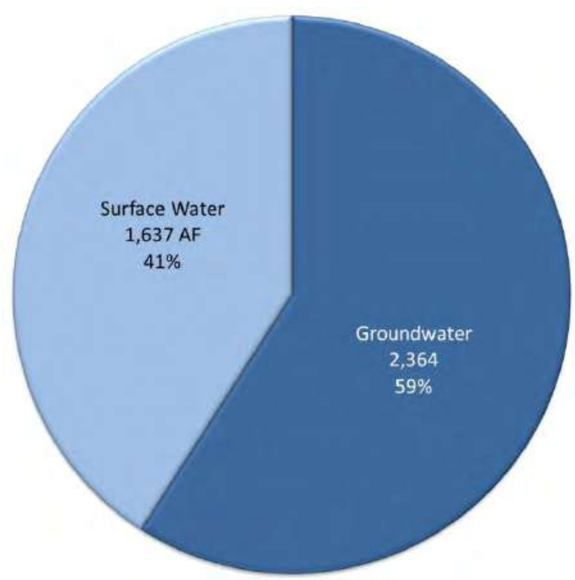


Figure 3.6a Current (2010) Water Supply Sources, San Bruno

diameter, and 12,415 metered service connections. San Bruno has four connections to the SFPUC water supply system and one connection to the NCCWD water supply system. San Bruno's water system can deliver water at a pressure of at least 30 pounds per square inch (psi) during peak-hour demand and 20 psi during maximum-day demand coincident with a fire flow (EKI, 2007).

Water supplied through the city's distribution system is a combination of groundwater pumped at San Bruno's five groundwater supply wells, and water purchased from SFPUC and NCCWD. Purchases from SFPUC are based on an Individual Supply Guarantee of 3.25 mgd (or approximately 3,600 AFY) (EKI, 2007). Note that one of San Bruno's five wells, SB-15, is not currently operational; a replacement well is in the process of sited and designed.

In 2010, groundwater wells provided 2,364 AF of water, or 59 percent of the total supply, while imported water provided the remaining 1,637 AF, as shown in Figure 3.6a. During the 1997 – 2010 period, not including the 2003-2004 In-Lieu Pilot Study, groundwater provided approximately 2,120 AFY, or 46 percent of the total supply, as shown in Figure 3.6b.

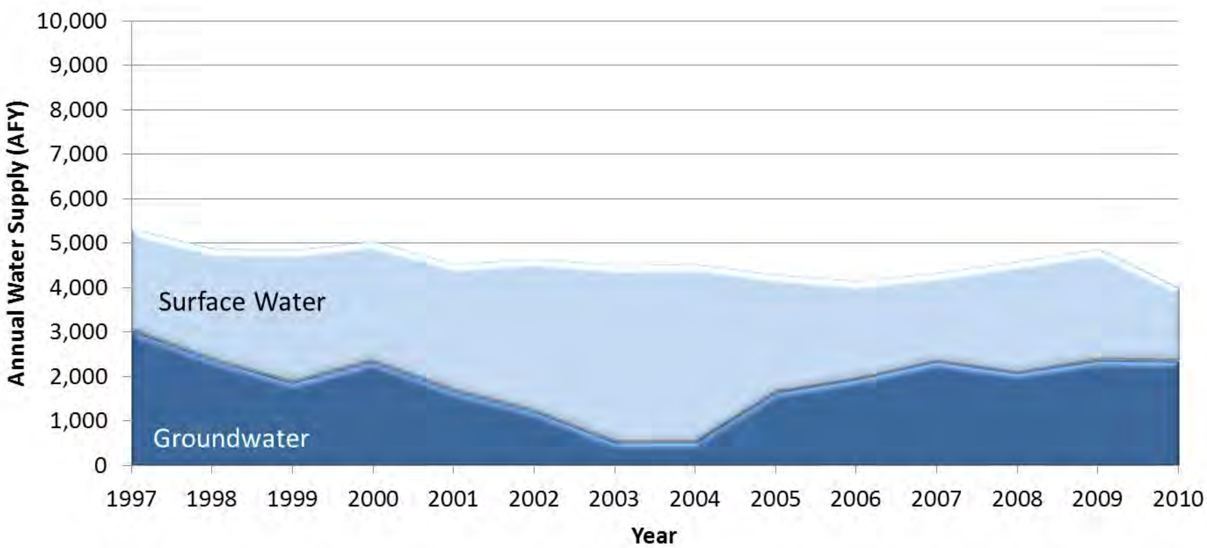


Figure 3.6b Historical Annual Water Supply, San Bruno

3.1.3 Private Groundwater Producers

Private groundwater producers in the Plan Area pump groundwater primarily for irrigation of golf courses, cemeteries, and landscaping. There is some domestic production, particularly in the Hillsborough area. These users typically do not meter the volume of water produced, therefore these volumes must be estimated to present a complete picture of water use. Historical use of South Westside Basin groundwater by private groundwater producers has been estimated by HydroFocus (2011), to support the development of the Westside Basin Groundwater Flow Model (Groundwater Model), using land use, soils, and hydrologic data.

Additional data on private groundwater use is available in annual reports (SFPUC, 2011). Estimates of production are approximately 1,800 AFY based on current (2010) conditions in the basin. The 2010 estimate includes the users summarized in Table 3.2.

Table 3.2 Summary of 2010 Private Groundwater Production

Entity	2010 Production	Source	Notes
Lake Merced Golf Course	33 AF	metered (SFPUC, 2011)	
Olympic Golf Club	10 AF	metered (SFPUC, 2011)	
California Golf Club of San Francisco	237 AF	estimated* (HydroFocus, 2011)	Other estimate (Carollo, 2008) is 206 AF
Cemeteries	859 AF	estimated* (HydroFocus, 2011)	Other estimate (Carollo, 2008) is 787 AF
Subtotal, Daly City to San Bruno	***1,139 AF***		
Hillsborough area domestic wells**	326 AF	estimated* (HydroFocus, 2011)	
Green Hills and Burlingame Country Clubs**	335 AF	estimated* (HydroFocus, 2011)	
Subtotal, Millbrae to Burlingame**	***661 AF***		
Total**	**1,800 AF**		

*Estimates from HydroFocus (2011) are based on the average production using the 2008 No Project Baseline over the full 1959-2009 hydrology.

**These estimates include the Millbrae and Burlingame area production (Burlingame domestic wells, Green Hills Country Club and Burlingame Country Club). Without the Millbrae and Burlingame area, the private production is 1,139 AF. The without- Millbrae and Burlingame value is more appropriate for comparisons with the results of HydroFocus (2011) as that document summarized the private production in the Westside Basin only as far south as San Bruno. Minor differences between the average annual private production estimated by that document (1,122 AFY) and the without-Burlingame values presented here are a result of usage of calendar years in this document versus water years in the HydroFocus document, minor differences in developing the average value, and the incorporation of newly available metered data in this document.

Recycled water produced by NSMCSD is used by private groundwater producers. Much of this use is along the boundary with the North Westside Basin. For accounting purposes, recycled water use in the South Westside Basin includes use in Daly City medians, at Lake Merced Golf Club, and at the Olympic Golf Club, but not at the San Francisco Golf Club, which otherwise would use a groundwater well within the North Westside Basin. Based on this assumption, approximately 410 AF of recycled water was used in the South Westside Basin.

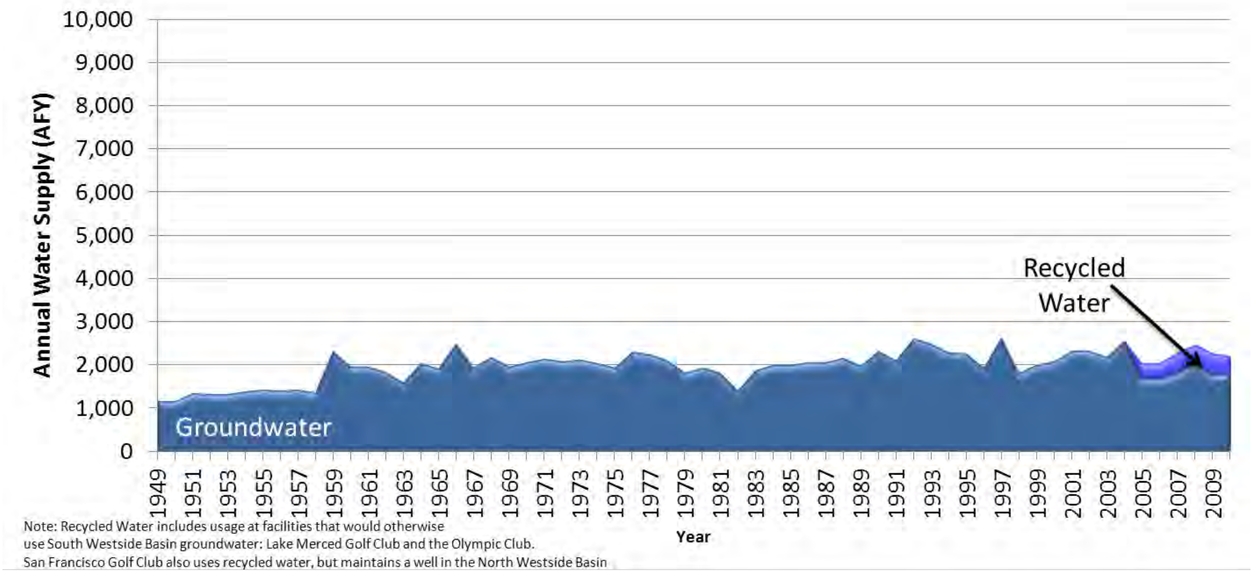


Figure 3.7 Historical Annual South Westside Basin Groundwater Production, Private Groundwater Producers

3.1.4 TOTAL SOUTH WESTSIDE BASIN

Current and historical water demands in the South Westside Basin have been met with purchases of imported surface water from SFPUC, local groundwater, and a smaller quantity of recycled water, as shown in Figure 3.8.

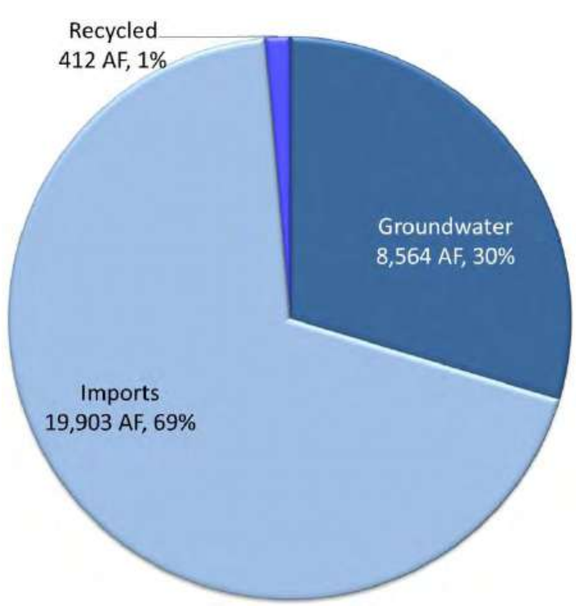


Figure 3.8 Current Water Supply Sources, South Westside Basin

South Westside Basin groundwater is an important component of the supply mix; Table 3.3 shows the percentage of the total water supply provided by groundwater in 2010 for the entities in the basin.

Table 3.3 2010 Groundwater Production by Entity as a Percent of Total Water Supply

Entity	Groundwater as Percent of Total Water Supply
Burlingame	0%
CalWater – South San Francisco District	5%
Daly City	24%*
Millbrae	0%
San Bruno	59%
private groundwater producer	81%

*54% if including in-lieu recharge

Figure 3.9 shows total annual groundwater production by major producer. In 2010, total groundwater production from the South Westside Basin was approximately 8,600 AF, including approximately 2,200 AF of banked groundwater under the ILRP to be potentially extracted at a later date. Figure 3.10 shows the distribution of groundwater production throughout the South Westside Basin, based on 2008 production data.

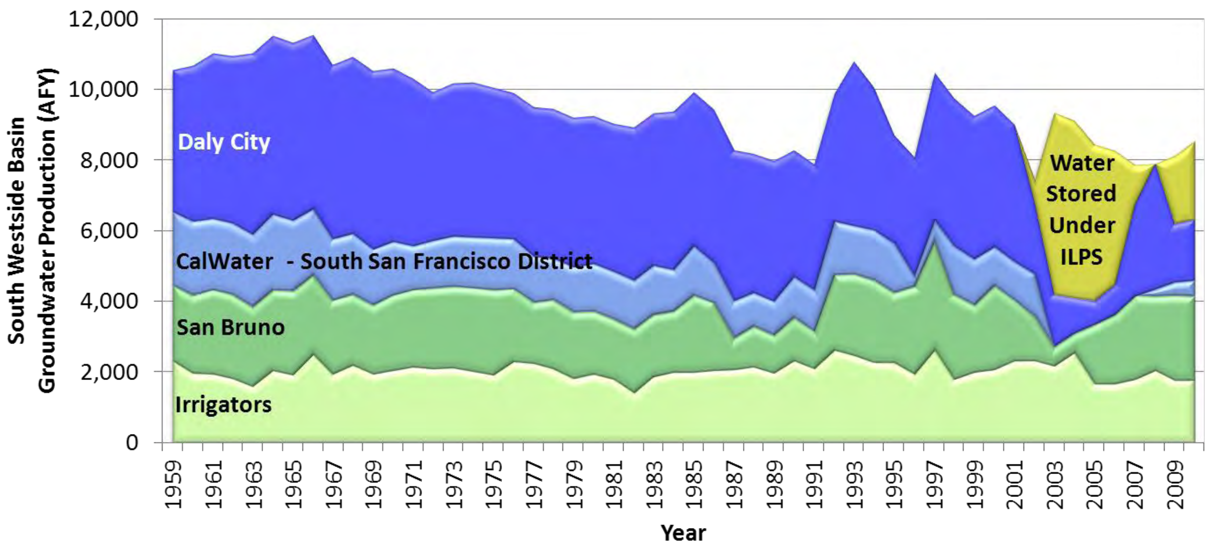
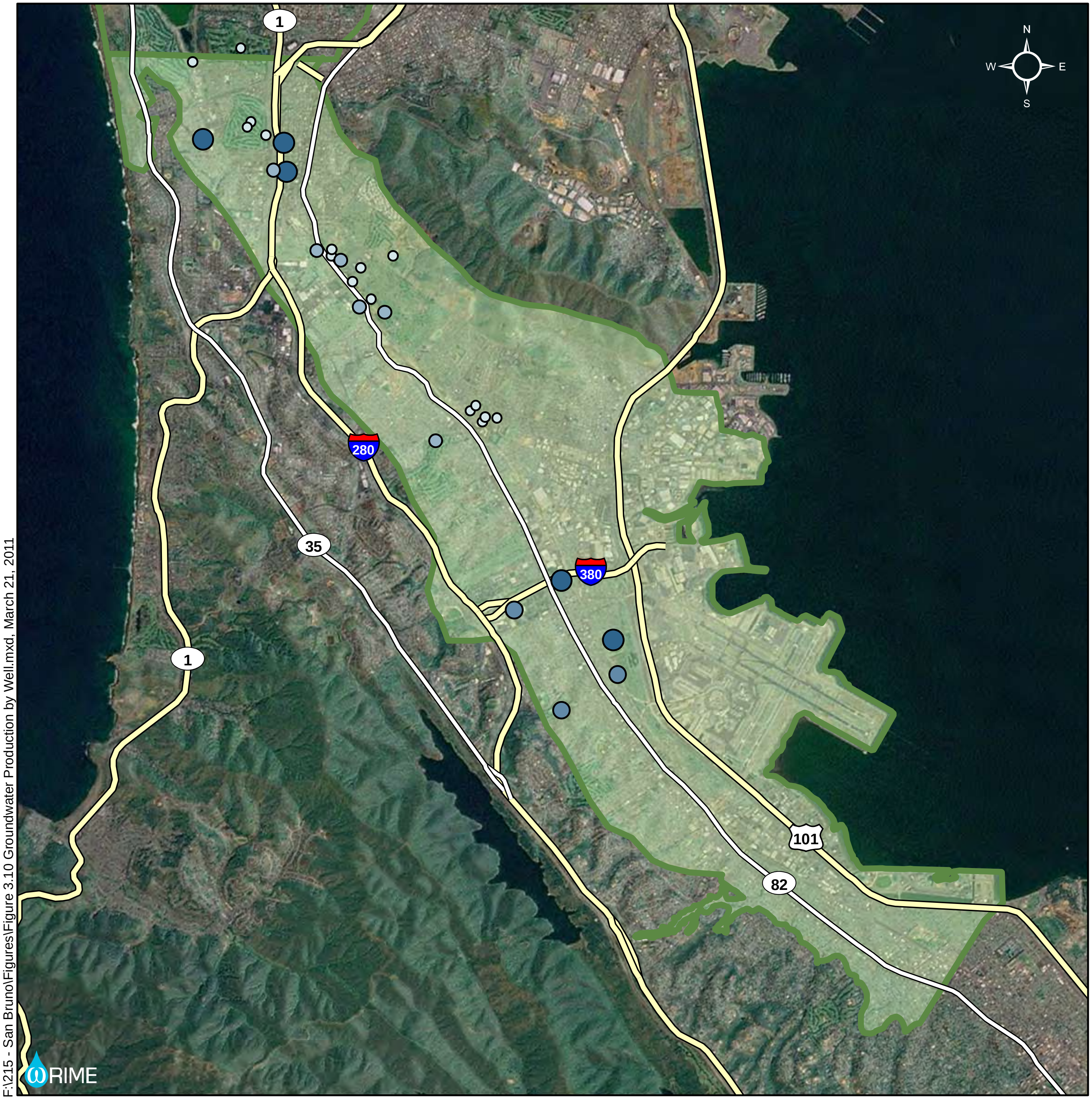


Figure 3.9 Historical Annual South Westside Basin Groundwater Production by Entity

Figure 3.10
Groundwater Production by Well



Legend

Highways

Groundwater Basin

Plan Area

2008 Production (af)

1 - 100

100 - 250

250 - 500

> 500

0 0.5 1 2 Miles

Groundwater Production Sources:
CalWater, personal communication, 2009
City of Daly City, personal communicaiton, 2009
City of San Bruno, pers. comm., 2009
Hydrofocus, 2009
SFPUC, 2009

F:\215 - San Bruno\Figures\Figure 3.10 Groundwater Production by Well.mxd, March 21, 2011

3.2 CURRENT WATER BUDGET

A more thorough understanding of the groundwater conditions can be obtained through analysis of the water budget, which estimates the different inflows and outflows of the aquifer. There are several different components of inflows and outflows. A South Westside Basin water budget was estimated below based on the results of the Groundwater Model, which is described in *Westside Basin Groundwater-Flow Model: Updated Model and 2008 No-Project Simulation Results.* (HydroFocus, 2011).

The simplified version of the water budget equation for a basin is:

Inflow – Outflow = Storage Change **(1)**

Inflow, outflow, and storage consist of the following more detailed subcomponents:.

- Inflow
  - Applied water components
    - Agricultural water use
    - Landscape and outdoor irrigation
  - Recharge from precipitation
  - Boundary flow from Coast Range and San Bruno Mountain
  - Underflow from
    - North Westside Basin
    - Pacific Ocean
    - San Francisco Bay
- Outflow
  - Groundwater production
  - Underflow to
    - Pacific Ocean
    - San Francisco Bay
  - Evapotranspiration
- Groundwater storage change

Water budget estimates were based on HydroFocus's (2011) basin-wide groundwater modeling effort. That document included the development of the 2008 No Project Scenario, which simulates a 47-year continuation of anticipated land and water use conditions as of May 2008. It assumes no new projects are implemented, but includes new supply wells, planned operational changes to the magnitude and spatial distribution of pumpage, and existing recycled water projects in place as of May 2008. The 2008 No Project Baseline simulation results were averaged over the full 1959-2009 hydrology to develop an average annual water budget for the central portion of the South Westside Basin (Daly City southeast to San Bruno). The average annual water budget for the South Westside Basin is presented in Table 3.4.

Table 3.4 Estimated Average Annual* South Westside Basin Water Balance

Water Budget Component	Average Annual Volume (AFY)
Groundwater Production	8,756
Underflow to the Bayshore area	460
Underflow to Millbrae	429
Underflow to North Westside Basin	71
Total Outflow	***9,716***
Recharge, all sources	4,517
Underflow from the Bayshore area	762
Underflow from Millbrae	967
Underflow from North Westside Basin	2,167
Underflow across Serra Fault	1,109
Total Inflow	**9,522**
Change in Storage	***-194***

*Average of 1959-2009 Hydrology

The change in storage is less than zero, showing a reduction in groundwater in storage over time. However, this value is small and within the errors associated with the data and the model. For example, the 194 AFY is just 17% of the simulated unmetered groundwater production in the basin (1,122 AFY). There are significant unknowns in the volume of unmetered groundwater pumped by private groundwater producers as well as in other modeling parameters including future precipitation, recharge, and aquifer parameters. Given the uncertainties, the small change in storage, with outflows exceeding inflows by approximately 2 percent, should be considered as showing the basin essentially in balance.

3.3 PROJECTED WATER REQUIREMENTS AND SUPPLIES

Projected water use is an important component of determining the ability of a basin to meet future demands. Figure 3.11 illustrates the projected water supplies and demands through 2035 by the primary retail water agencies in the South Westside Basin using projections discussed in Section 3.3.1. Private groundwater producers are also included with the assumption of a continuation of current levels of production. The water served by the retail water agencies includes groundwater from the South Westside Basin, imported surface water purchased from SFPUC, and recycled water.

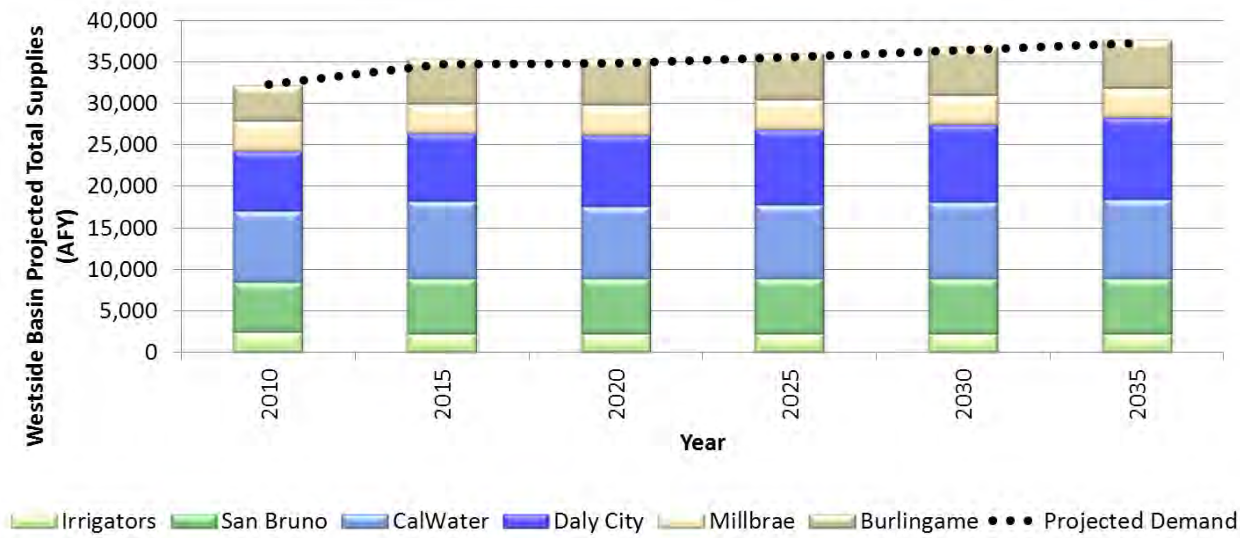


Figure 3.11 Projected Water Supplies in the South Westside Basin, by Agency

Table 3.5a presents current and projected South Westside Basin groundwater production through 2030. Table 3.5b presents the projected increase in South Westside Basin groundwater production compared to 2010 production.

While these projections represent the best available information from the agencies, they are subject to uncertainties related to climatic conditions, availability of water supplies, maintenance issues, and policy changes. Additionally, no projections are available for the private groundwater producers, whose production is assumed to remain at current levels, which themselves are largely estimated. Even with these uncertainties, the existing projections provide a good baseline for anticipated future use and for determining how the basin would respond to future use and management. These projections are not intended to set limits for the production by individual agencies; such limits may be established by the agencies in the future, but would likely be developed based on a wide range of demand and supply information, as discussed in Section 5.3.1, Action F5.

Table 3.5a Current and Projected South Westside Basin Groundwater Production (AFY)

Agency	2010	2015	2020	2025	2030	2035
Burlingame	0	0	0	0	0	0
CalWater – South San Francisco	453	1,535	1,535	1,535	1,535	1,535
Daly City	1,743* 3,947	3,349	3,842	3,842	3,842	3,842
Millbrae	0	0	0	0	0	0
San Bruno	2,364	2,364** 3,026	2,364** 3,026	2,364** 3,026	2,364** 3,026	2,364** 3,026
Private Producers* **	1,800	1,800	1,800	1,800	1,800	1,800
Total**	**8,564**	**9,048**	**9,541**	**9,541**	**9,541**	**9,541**

* Daly City's 2010 production was 1,743 AF, but does not include 2,204 AF of groundwater stored as a result of in-lieu water deliveries under the ILPS. For accounting purposes, this pumping may be included in 2010.

** San Bruno projects future groundwater production at its current rate. However, it is evaluating whether it can increase its production of groundwater to a rate of 3,026 AFY (2.7 mgd), which is consistent with a historical maximum annual production rate. San Bruno will coordinate with other basin users to ensure the groundwater basin is managed sustainably and in a manner consistent with the consensus driven basin yield analysis based on the modeling of HydroFocus, Inc.

*** Values for Private Producers include production outside of the area defined for the basin yield. See Section 3.5.

**** Totals utilize the Daly City values based on effective long-term pumping and San Bruno at its 2010 rate.

Sources: Daly City projected production: Brown and Caldwell, 2011;
San Bruno projected production: EKI, 2011;
CalWater projected production: CalWater, 2011

Table 3.5b Projected Change in South Westside Basin Groundwater Production, from 2010 Production (AFY)

Agency	2015	2020	2025	2030	2035
Burlingame	0	0	0	0	0
CalWater – South San Francisco	1,082	1,082	1,082	1,082	1,082
Daly City	1,606* -598	2,099* -105	2,099* -105	2,099* -105	2,099* -105
Millbrae	0	0	0	0	0
San Bruno	662** 0	662** 0	662** 0	662** 0	662** 0
Private Producers	0	0	0	0	0
Total*	**484**	**977**	**977**	**977**	**977**

* When compared to Daly City's actual 2010 production (1,743 AF), future Daly City groundwater production will increase by 2,099 AFY. However, Daly City's actual 2010 production does not include 2,204 AF of groundwater stored as a result of in-lieu water deliveries under the ILPS. For accounting purposes, this pumping may be included in 2010. Compared to the pumping value that includes the stored water, future Daly City groundwater production will decrease by 105 AFY.

** San Bruno projects future groundwater production at its current rate 2,354 AFY (2.1 mgd), but is evaluating its ability to increase its production of groundwater to a rate to 3,026 AFY (2.7 mgd). There is no change from the current rate, while the increase to the higher rate would be 662 AFY.

*** Totals utilize the Daly City values based on effective long-term pumping and San Bruno at its current rate.

The projected South Westside Basin supplies are shown in Figure 3.12 with the historical production discussed in Section 3.1. Projected demand in the South Westside Basin is within 300 AFY of projected supply.

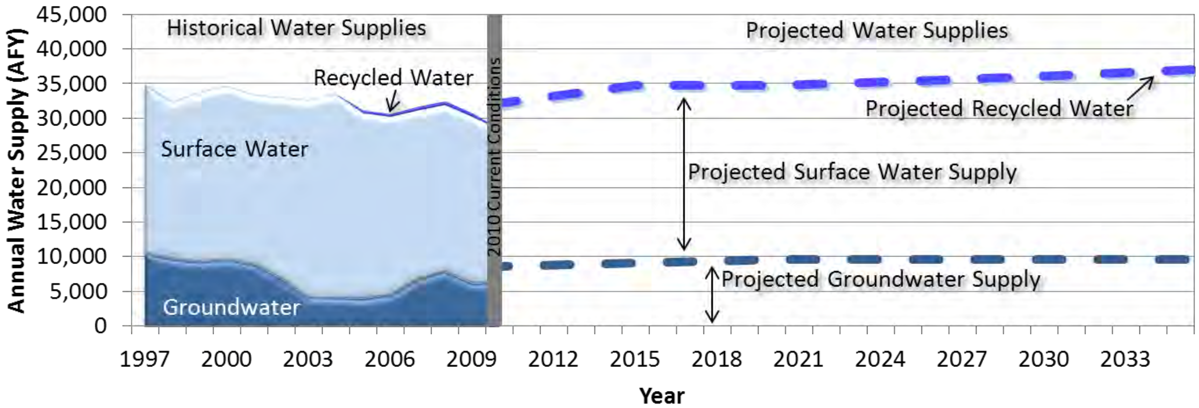


Figure 3.12 Historical and Projected South Westside Basin Groundwater Supply

3.3.1 AGENCY WATER PROJECTIONS

Detailed water supply projections for each retail water agency, as well as private irrigators, are provided in the following sections.

3.3.1.1 City of Burlingame

Water demands for the City of Burlingame are projected to increase from 4,389 AFY in 2010 to 5,852 AFY in 2035 (Burlingame, 2011), as shown in Figure 3.13. The projected supply meets the projected demand. No groundwater use is projected and imported water use is projected to stay within the city's Individual Supply Guarantee of 5,867 AFY.

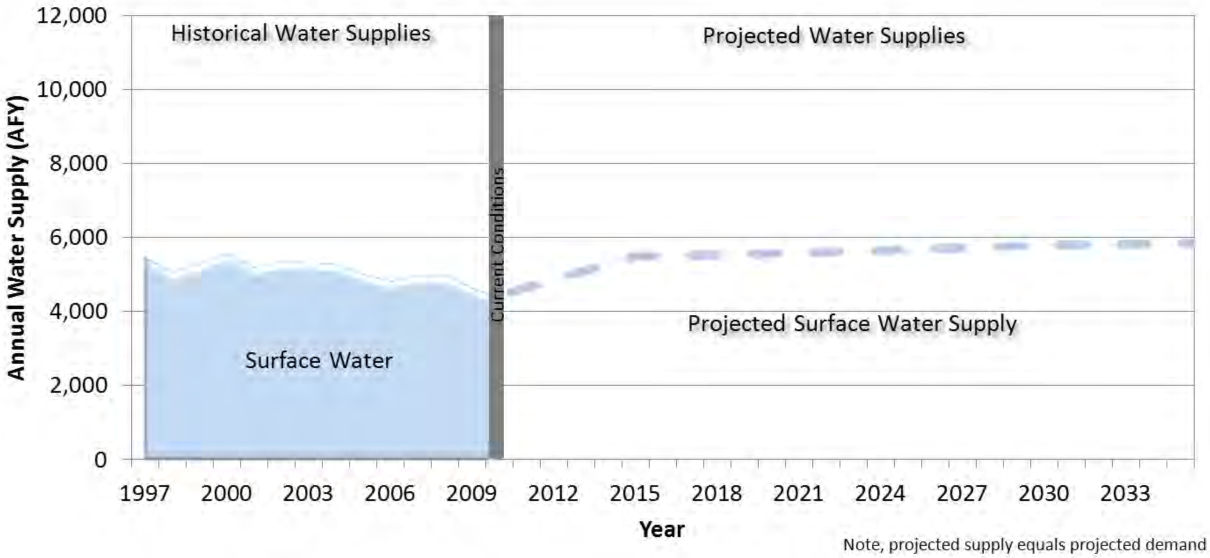


Figure 3.13 Projected Water Supply for Burlingame

3.3.1.2 California Water Service Company – South San Francisco District

Water demands for CalWater's South San Francisco District service area are projected to increase from 8,527 AFY in 2010 to 9,494 AFY in 2035. These demands will be met through:

- Approximately 1,100 AFY of additional South Westside Basin groundwater supplies as CalWater returns its wellfield to producing 1,535 AFY
- Reduction of surface water purchases by approximately 200 AFY (CalWater, 2011)

CalWater's projected supplies are shown in Figure 3.14. The projected supply meets the projected demand.

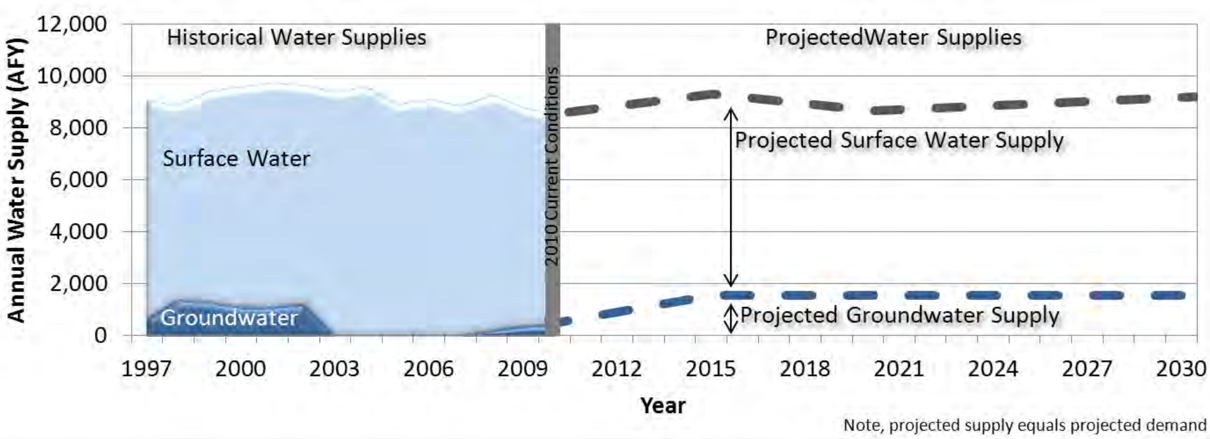


Figure 3.14 Projected Water Supply for CalWater

3.3.1.3 City of Daly City

Water demands for Daly City are projected to increase from 7,267 AFY in 2010 to 10,552 AFY in 2035. These demands will be partially met through:

- A decrease of approximately 100 AFY of South Westside Basin groundwater supplies
- An increase in surface water purchases by approximately 2,700 AFY (Brown and Caldwell, 2011)

These values are compared to 2010 supplies with in-lieu surface water deliveries accounted for as South Westside Basin groundwater. Total projected supplies in 2035 are 9,858 AFY and are less than the projected demand of 10,552 AFY. Daly City's projected supplies are shown in Figure 3.15. Imported water use is projected to exceed Daly City's Individual Supply Guarantee of 4,808 AFY, with a projected surface water supply of 6,016 AFY by 2035 (Daly City, 2011).

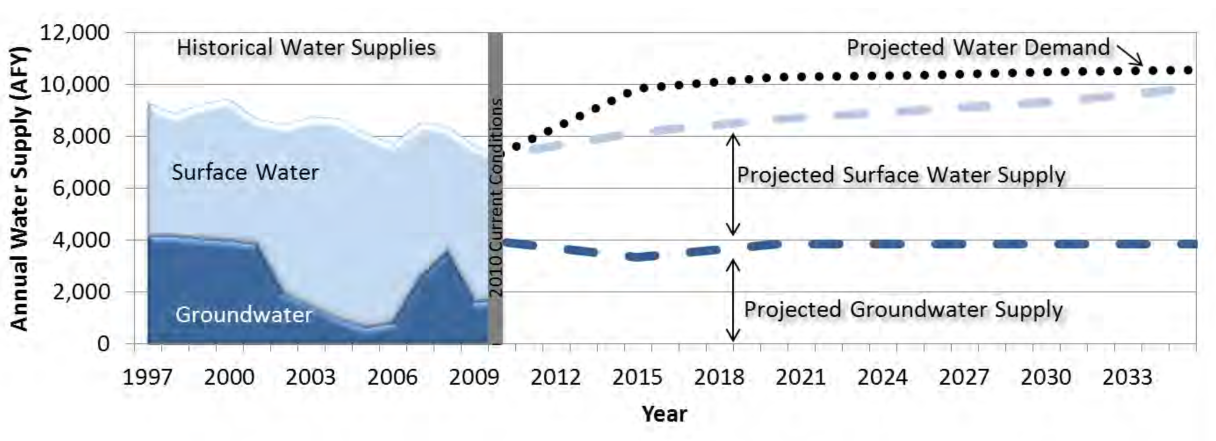


Figure 3.15 Projected Water Supply for Daly City

3.3.1.4 City of Millbrae

Water demands for Millbrae are projected to increase from 2,482 AFY in 2010 to 3,379 AFY in 2035. By 2035, total surface water supplies are projected to total 3,558 AFY (Millbrae, 2011), as shown in Figure 3.16. No groundwater use is projected and imported water use is projected to slightly exceed the city's Individual Supply Guarantee of 3,533 AFY.

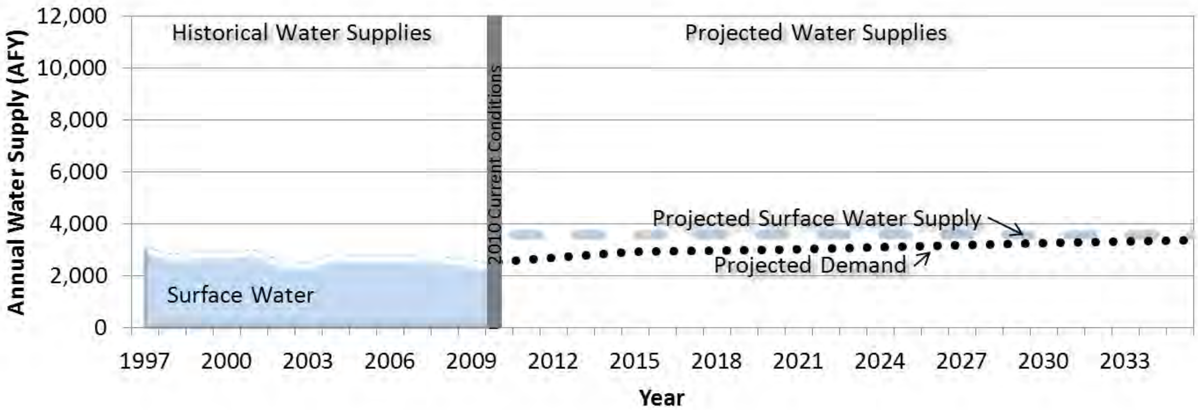


Figure 3.16 Projected Water Supply for Millbrae

3.3.1.5 City of San Bruno

Water demands for San Bruno are projected to increase from 4,001 AFY in 2010 to 5,751 AFY in 2035. These demands will be met through:

- Continued South Westside Basin groundwater production at 2,364 AFY
- Increase in surface water purchases from SFPUC and NCCWD from 1,637 AFY to 3,699 AFY
- Potential additional future groundwater production of 673 AFY. San Bruno will evaluate its ability to increase its groundwater production to 2.7 MGD, which is consistent with its historical maximum production rate. (EKI, 2011)

San Bruno's projected supplies are shown in Figure 3.17. Projected imported water purchases would be within San Bruno's Individual Supply Guarantee of 3,643 AFY.

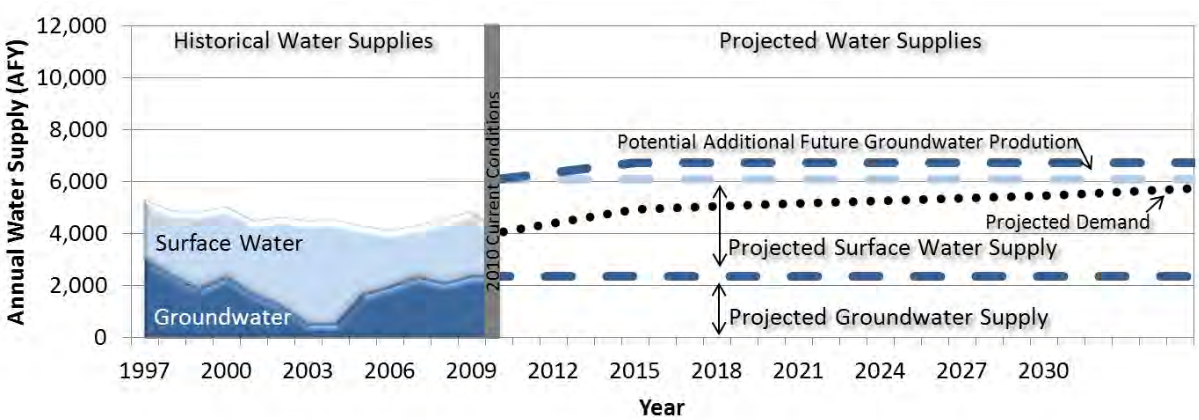


Figure 3.17 Projected Water Supply for San Bruno

3.3.2 PRIVATE GROUNDWATER PRODUCERS

No projections of private groundwater use are available. Modeling results show an average demand of approximately 1,800 AFY (see Section 3.1.3). Future use is assumed to continue at this level. Of the 1,800 AFY, 1,139 AFY is produced from the area used to estimate basin yield, as described in Section 3.5

3.4 PROJECTED WATER BUDGET

The projected changes in South Westside Basin groundwater production indicated in agency projections in Section 3.3, show an increase in groundwater production of 977 AFY (Table 3.5b), from 8,564 AFY in 2010 to a projected 9,541 AFY in 2035.

The historical water budget analysis in Section 3.2 showed a basin only slightly out of balance under modeled conditions (8,756 AFY of groundwater production), with a change in storage of approximately -200 AFY. Groundwater production within the central portion of the South Westside Basin (Daly City southeast to San Bruno (an area consistent with the area analyzed in the historical water budget) is projected to increase from 7,904 AFY in 2010 to 8,881 AFY in 2035. This represents only a small increase in groundwater production of 124 AFY over the conditions analyzed in the historical water budget, leaving the basin nearly in balance.

The goals, objectives, elements, and implementation plan presented in the following sections seek to maintain this balance, accounting for increased competition for imported supplies and measures to improve the quantity of groundwater available to the stakeholders in the South Westside Basin.

3.5 BASIN YIELD

3.5.1 BASIN YIELD DEFINITION

Basin yield is defined in this document as the maximum average annual groundwater production that could be maintained for a long-term time period and that would result in stable groundwater levels. This value does not explicitly take into consideration water quality, surface water resources, or environmental or socio-economic consequences. The basin yield is intended to be used along other data to guide groundwater management. Any use of groundwater has an impact; the aim of the basin yield is to assist in understanding the balances between the use of the groundwater and the impacts caused by that use. The balances in the Westside Basin are based on the following:

- There is a desire to maintain a sustainable groundwater reservoir by not pumping at levels that result in long-term declines in groundwater levels. Avoiding these declines will also avoid increased pumping costs and the need to deepen wells.

- There is a desire to maintain groundwater levels at elevations that prevent or slow the migration of poor quality groundwater. Poor quality groundwater includes the point-source and non-point source contaminants discussed in Section 2.3.8 as well as seawater intrusion discussed in Section 2.3.3.
- As there is little interaction between groundwater and surface water resources in the area, impacts to surface water resources are not directly considered.
- The basin yield estimate will change over time in response to changing hydrology, groundwater production infrastructure, and the built environment. As such, the basin yield definition and estimate is intended to be reviewed and updated at regular intervals.

3.5.2 Basin Yield Estimate

A variety of methods may be used to estimate basin yield. These include:

- Analysis of historical production and groundwater levels, identifying periods with stable water levels (if any) and the associated level of groundwater production.
- Development of a water budget to estimate inflow and outflows from the basin. Yield is then estimated as the sum of the change in storage and the volume of groundwater production.
- Development of a numerical groundwater model and simulations to estimate the yield.

The estimate of basin yield is developed through the use of the Groundwater Model, which incorporates the best available knowledge of the basin and was developed in a cooperative manner with extensive input. Basin yield is estimated as a level to maintain current groundwater levels. To reduce risk of seawater intrusion, groundwater levels need to be raised through increased recharge or decreased production. Higher groundwater levels would also reduce pumping costs and could help control migration of lower quality groundwater. Addressing seawater intrusion through the basin yield estimate may be revisited during implementation of the GWMP.

The basin yield estimate is based on work performed by HydroFocus (2011) to determine sensitivity to pumping and the level of municipal pumping that results in zero change in storage. The estimate does not include the southern portion of the South Westside Basin, including the Millbrae and Burlingame areas, due to limited groundwater use and higher model uncertainty due to limited data. In that groundwater modeling exercise, the near-term anticipated groundwater production was modeled over historical hydrology and recent land use. Recent groundwater elevations were used as initial conditions. Municipal groundwater production was then adjusted based on calculated uniform percentages for each water purveyor to determine a level of production that results in zero long-term change in storage. Production by private producers was left unchanged. The level of groundwater production with no long-term change in storage estimated by this scenario is approximately 10,600 AFY for the entire Westside Basin and approximately 8,600 AFY for the South Westside Basin. This value is consistent with the historical water budget analysis shown in Table 3.4, which showed a decline in storage of 194 AFY with a production of 8,756 AFY. These basin yield estimates are based on the current operating conditions in the basin; changes to the operating conditions in the basin may increase the yield (such as through capturing outflow to the Pacific Ocean through increased production or through increased recharge to the basin) or decrease the yield (such as by increasing outflows to the Pacific Ocean or San Francisco Bay through higher groundwater levels). Simulations indicated that groundwater production could be increased in one portion of the basin if production in adjacent areas is reduced. This is a result of the connectivity of the South Westside Basin aquifer and highlights that the aquifer is a shared resource among all groundwater producers. Due to the connectivity of the aquifer throughout the basin, the basin yield estimate is presented at the scale of the South Westside Basin.

Additional work was performed to estimate the variability of basin yield with respect to hydrology. Historical hydrology during the 1959-2009 time period simulated in the Groundwater Model was analyzed, and it was estimated that wet periods experienced approximately 30 percent more precipitation and dry periods experienced approximately 30 percent less precipitation than the overall average precipitation. Two additional model scenarios were developed, one with precipitation increased 30 percent across the full modeling period and one with precipitation decreased 30 percent across the full modeling period. The same methodology was applied to determine basin yield under these wetter and drier conditions. The estimated wetter period yield is 9,700 AFY and the estimated drier period yield is 7,200 AFY. Given the uncertainty in future hydrology, these values provide a range of yields to be used with the overall estimated basin yield of 8,600 AFY, which is based on historical hydrology.

Figure 3.18 compares the range of basin yield estimates to historical and projected groundwater production, showing that recent production is within the basin yield, although historical production exceeded the basin yield. The production shown in Figure 3.18 includes only production within the area defined for the basin yield estimate (i.e., does not include production in Burlingame and Hillsborough).

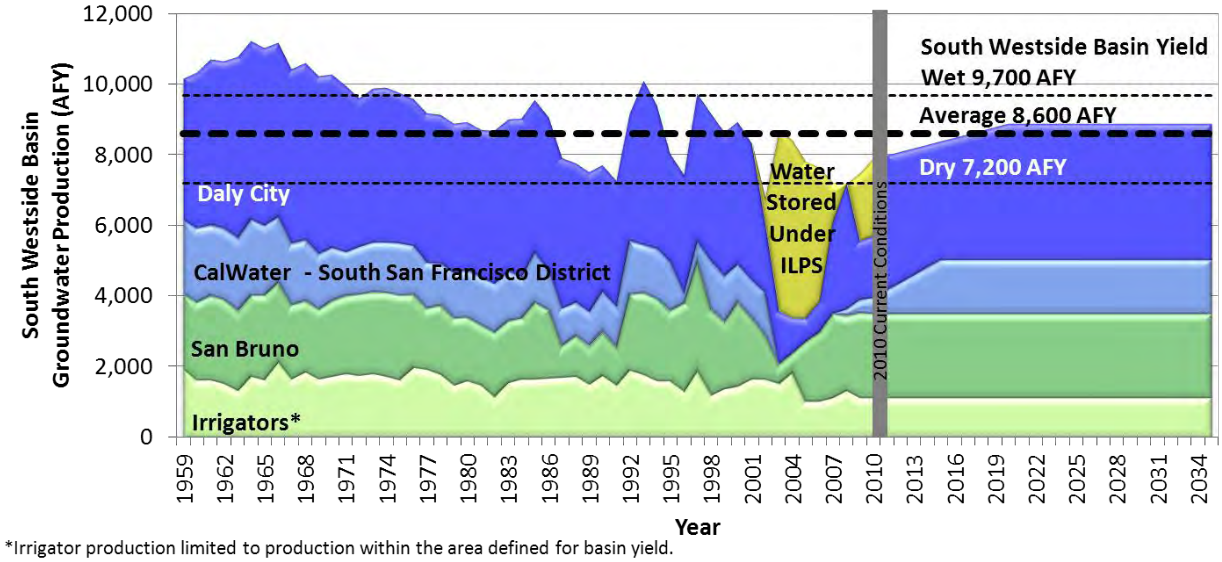


Figure 3.18
Comparison of Basin Yield Estimate and Historical Groundwater Production

Projected future production for 2020-2035 is 8,881 AFY, slightly above the average basin yield of 8,600 AFY, but within the range of yield.

These estimates are subject to uncertainty inherent in any groundwater model. Regular monitoring of static groundwater levels will assist in determining if groundwater levels are responding as anticipated over the long term.

3.5.3 Basin Yield Use

The Basin Management Objectives described later in this document are based upon groundwater levels rather than production volumes. As groundwater production is the most significant component of outflow from the basin, an understanding of the basin yield can assist in policy decisions on production which will directly impact groundwater levels in the basin. However, careful consideration must be given before using the basin yield to drive policy decisions.

- First, basin yield is a long-term average annual value. Dry years or other operational needs may require production above the basin yield; this can be acceptable if previous or subsequent years balance production with reduced pumping.
- Second, options to bring the basin into balance with the basin yield include increasing the volume recharged to the aquifer in addition to reducing groundwater production.
- Third, the basin yield is not a static value. Changes in the understanding of the groundwater basin, climate, land use, and location and quantity of groundwater production can all alter the estimate of basin yield. For example, decreasing production may bring production closer to the basin yield, but it will also reduce the basin yield

through reduced capture of additional recharge (less recharge due to higher groundwater levels) and increased natural discharge (more discharge to surface water due to higher groundwater levels). The availability and cost of alternate water supplies or development of recharge projects can also require revisions of the basin yield as this changes the socioeconomic impact of changes in groundwater production.

- Finally, benefits may be seen by approaching the basin yield value, even if the value itself is not met. Additional benefits can also be accrued by pumping significantly below the basin yield, through increasing groundwater levels resulting in increased groundwater in storage, decreased risk of seawater intrusion, and decreased energy costs for groundwater production.

4 GOAL AND OBJECTIVES FOR THE BASIN

4.1 SOUTH WESTSIDE BASIN GOAL

The goal of the GWMP is to ensure a sustainable, high-quality, reliable water supply at a fair price for beneficial uses achieved through local groundwater management.

Sustainable is defined for this GWMP as being able to continue groundwater production over the next 50 years or more with a similar real cost, quantity, and end-user quality as today. Beneficial uses include water supplies for municipal use, irrigation use, private wells, and environmental purposes.

Basin Management Objectives (BMOs) are required by SB 1938 , which amended Section 10753.7of the Water Code to state that groundwater management plans must include BMOs, including components relating to the monitoring and management of groundwater levels within the groundwater basin, groundwater quality degradation, inelastic land surface subsidence, and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping in the basin.

The following five BMOs are defined to support this goal:

1) Maintain Acceptable Groundwater Levels
2) Maintain or Improve Groundwater Quality
3) Limit the Impact of Point Source Contamination
4) Explore Need for Land Subsidence Monitoring
5) Manage the Interaction of Surface Water and Groundwater for the Benefit of Groundwater and Surface Water Quantity and Quality

In turn, elements needed to meet the BMOs are presented in Section 5 (Elements of the Groundwater Management Plan), and an implementation plan is presented in Section 6 (Implementation) to support the objectives and elements. Together the goal, BMOs, elements, and implementation plan function as the overall groundwater strategy for the South Westside Basin. The BMOs are intended solely for these uses.

4.2 BASIN MANAGEMENT OBJECTIVE COMPONENTS

Basin management objectives, are adaptable, quantifiable objectives with prescribed monitoring and defined reporting and responses. These are the accomplishments that need to occur to meet the overall basin goal stated above. BMOs are defined through:

- Management areas and sub-areas
- Public input
- Monitoring
- Adaptive management
- Enforcement

4.2.1 Management Areas and Sub-areas

The management area is the entire Plan Area, as described in Section 1.2 and shown in Figure 1.1. Sub-areas are not needed and not defined because of the continuous nature of the aquifer system. Changes in aquifer characteristics across the South Westside Basin are gradual and are not conducive to defining sub-areas based on physical properties.

Future efforts should evaluate incorporating the North Westside Basin and its associated Sub-Areas and BMOs into a Groundwater Management Plan for the entire Westside Basin. The North Westside Basin is separated from the South Westside Basin only by a jurisdictional boundary (the county line).

4.2.2 Public Input

Public input is important in establishing BMOs. Local knowledge is needed to develop appropriate objectives and local acceptance is necessary to ensure implementation. Public input for the BMOs was gathered through Advisory Committee meetings and public meetings, as described in Sections 1.6 and 1.7.

4.2.3 Monitoring

Accurate, consistent, and accepted monitoring is necessary to ensure the BMOs are being met. This monitoring will show if objectives, which are quantitative to the extent possible, are being met and will trigger actions if defined thresholds are crossed. The monitoring must allow for quick and easy data sharing among all stakeholders to gain acceptability and to allow for action, if needed, in a timely fashion. Monitoring protocols are described under each BMO, in Section 2.3.12, and in Appendix C.

4.2.4 Adaptive Management

Every year brings new data and new conditions to the groundwater aquifer. As such, the BMOs are intended to be flexible and adaptive, allowing for changes due new physical, hydrologic, or operational conditions or new understanding of the physical system. Adjustments to BMOs are discussed in Section 5.7, Reporting and Updating.

4.2.5 Enforcement

In its current form, the GWMP does not have enforcement mechanisms for the BMOs. The BMOs are guidelines to be monitored and reported on for the benefit of all South Westside Basin users. As the BMOs are defined to meet a common goal, the Advisory Committee believes that enforcement will not be necessary. However, future plan revisions may implement enforcement mechanisms if deemed necessary by the Groundwater Task Force.

4.3 BASIN MANAGEMENT OBJECTIVES

The BMOs include definitions of acceptable groundwater levels, groundwater quality, land subsidence, and surface water/groundwater interaction, along with actions to be taken if defined triggers are met.

4.3.1 Maintain Acceptable Groundwater Levels

The BMO for groundwater levels is designed to maintain operationally acceptable groundwater levels. Operational acceptability is based on avoiding the following infrastructure impacts:

- **Water levels below the top of the existing well screens.** Water levels that are below the top of the screen can negatively impact efficiency of wells through higher incrustation rates, cascading water, and reduced hydraulic efficiency. Several municipal production wells have pumping water levels below the top of the screen under current conditions. Additional lowering of water levels beyond current and historical water levels may adversely impact the ability and cost to pump groundwater, on a case-by-case basis.
- **Water levels below existing pump intakes or bottoms of well screens.** These situations should be avoided whenever possible, as under such conditions groundwater cannot enter the well or cannot be pumped to the surface.

These BMOs are set to maintain conditions for operational purposes; however, they are not currently designed to fully meet the goal of sustainability. Current water levels and water levels meeting the above criteria can remain well below sea level, posing a risk for seawater intrusion. Geologic barriers appear to have thus far prevented seawater from intruding along the Pacific Coast or San Francisco Bay (see Section 2.3.3), but no barrier is perfect and the best way to prevent seawater from migrating into the aquifer is to maintain groundwater levels at or above sea level. Future revisions to this GWMP may seek to raise groundwater level targets to provide a more sustainable water level or may investigate alternate methods of preventing seawater intrusion, such as injection barriers. Such revisions to the GWMP will need to be developed in a manner that can meet the overall goal and will need to function within any then-existing conjunctive use agreements that may require availability of subsurface storage space.

Until then, this BMO will serve as a first step toward managing groundwater levels in the South Westside Basin.

Groundwater level monitoring, triggers, and actions are initially defined below for each well with available data. Note that these items are part of adaptive management of the basin and are thus subject to change as additional data are collected and more information is learned about the basin. This is particularly true for wells with short periods of record, notably the "CUP" wells. The static water level monitoring will monitor progress toward meeting BMOs. Monitoring includes static groundwater level measurements from April (spring) and October (fall) of each year from the designated wells. See details on static water level monitoring protocols are provided in Appendix C

4.3.1.1 Triggers

Groundwater level measurements will be adjusted to reflect conditions without any stored water, determined by modeling results that include conjunctive use projects. Trigger thresholds are developed based on historical water levels as these levels have been considered operationally acceptable by the groundwater producers in the South Westside Basin. The triggers are defined as follows:

- Trigger 1: Groundwater elevations below the historical minimum elevation (more details provided later in this section)
- Trigger 2: Groundwater elevations 10 ft below the historical minimum elevation

Adjustments to water level measurements are needed to account for water stored in the aquifer as part of a conjunctive use study and not part of the native groundwater supply. As this BMO addresses native groundwater, stored GSR Project and ILPS water, which is intended to be recovered, should not be included in BMO monitoring. The adjustment will be made based on differences seen in the Groundwater Model (HydroFocus, 2011) comparing water levels with conjunctive use and without conjunctive use, as shown in the equation below.

$$GWSE_{adjusted} = GWSE_{measured} + GWSE_{modeled,without\ conjunctive\ use} - GWSE_{modeled,with\ conjunctive\ use}$$

where GWSE = groundwater surface elevation

As modeling is required to analyze water levels without the conjunctive use project, reporting will only occur when the Groundwater Model is updated to extend the hydrologic period. It is anticipated that this will occur annually, although biennial updates may be sufficient and may be adopted during implementation. The method of adjustment may be altered if a more accurate and consistent method is identified and accepted by the Groundwater Task Force.

Groundwater level BMO triggers are shown in Table 4.1 based on the hydrographs included in Appendix D. The data presented uses the Groundwater Model to remove the impacts of the In-Lieu Pilot Study (see Section 1.5.3) initiated in 2002 between San Bruno, CalWater, Daly City, and SFPUC. These adjustments are intended solely for the use of BMO development. Trigger 1 for the BMOs is based on the historical low water level without the effects of the ILPS. For wells designated for seawater intrusion monitoring, Trigger 1 is the historical low minus two feet, rounded down. For other wells, Trigger 1 is the historical low minus five feet, rounded down to the nearest five. Trigger 2 is 10 feet below Trigger 1 for all wells. Well locations are shown in Figure 4.1.

4.3.1.2 Actions

If Trigger 1 is met, the Groundwater Task Force will meet to discuss the situation, including confirming the result, an analysis of trends, potential impacts to groundwater producers or the environment, and the most appropriate actions, both immediate and upon Trigger 2 (if met). Actions will be based on plan elements defined in Section 5 (Elements of the Groundwater Management Plan). These actions may include:

- Continued operation
- Conservation measures
- Increased monitoring
- Decreased production, potentially including assignment of pumping thresholds for individual entities
- Accelerated development of artificial or in-lieu recharge projects
- Substitution of alternate supplies
- Reoperation of existing wells or construction of new wells to move production to other parts of the basin

If Trigger 2 is met, the actions defined for Trigger 1, and any additional measures, actions, or mechanisms deemed necessary by the Groundwater Task Force, will be implemented.

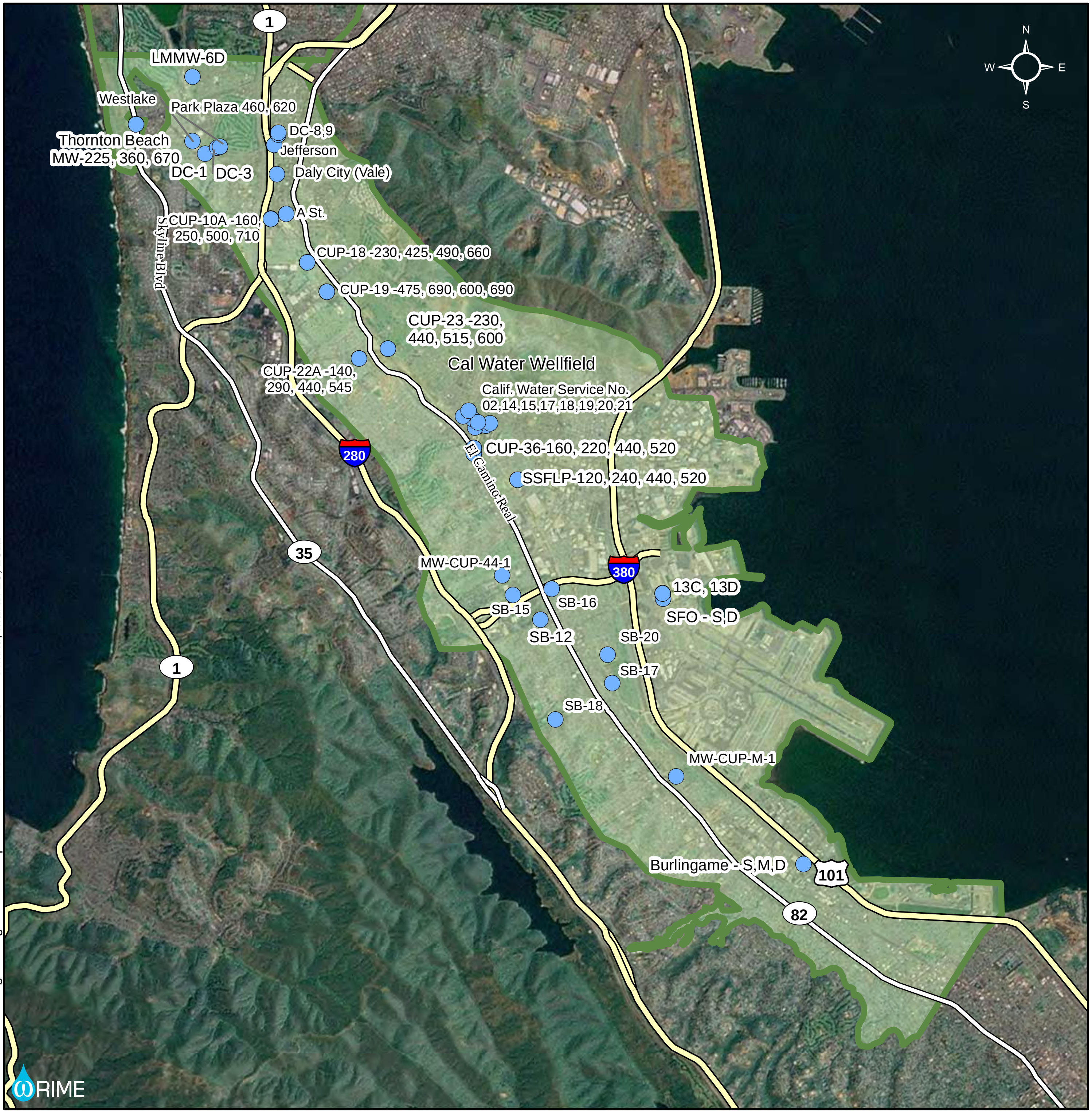
Table 4.1 Groundwater Level BMO Triggers

BMO Wells	Well Owner	Trigger 1 Adjusted Static Water Level (feet NAVD88)	Trigger 2 Adjusted Static Water Level (feet NAVD88)
SSF 1-02	CalWater	-130	-140
SSF 1-14	CalWater	n/a	n/a
SSF 1-15	CalWater	n/a	n/a
SSF 1-17	CalWater	n/a	n/a
SSF 1-18	CalWater	n/a	n/a
SSF 1-19	CalWater	n/a	n/a
SSF 1-20	CalWater	-220	-230
SSF 1-21	CalWater	n/a	n/a
DC-1 (Westlake)	Daly City	-130	-140
DC-3	Daly City	n/a	n/a
DC-8	Daly City	-165	-175
DC-9	Daly City	n/a	n/a
A Street Well	Daly City	n/a	n/a
Jefferson Well	Daly City	n/a	n/a
Vale Well	Daly City	n/a	n/a
Westlake 1	Daly City	n/a	n/a
Westlake 2	Daly City	n/a	n/a
Burlingame-S*	**San Bruno**	**-1**	**-14**
Burlingame-M*	**San Bruno**	**-4**	**-17**
Burlingame-D*	**San Bruno**	**-7**	**-20**
SB-12	San Bruno	-225	-235
SB-15	San Bruno	n/a	n/a
SB-16	San Bruno	n/a	n/a
SB-17	San Bruno	n/a	n/a
SB-18	San Bruno	n/a	n/a
SB-20	San Bruno	n/a	n/a
SFO-S*	**San Bruno**	**-2**	**-15**
SFO-D*	**San Bruno**	**-39**	**-51**
13C*	**UAL**	**-45**	**-57**
13D*	**UAL**	**-4**	**-16**
Fort Funston-S*	**USGS**	**2**	**-11**
Fort Funston-M*	**USGS**	**8**	**-5**
Thornton Beach MW 225*	Daly City	75	60
Thornton Beach MW 360*	**Daly City**	**11**	**-2**
Thornton Beach MW 670*	**Daly City**	**9**	**-4**
LMMW-6D*	SFPUC	-50	-60

BMO Wells	Well Owner	Trigger 1 Adjusted Static Water Level (feet NAVD88)	Trigger 2 Adjusted Static Water Level (feet NAVD88)
Park Plaza MW 460*	SFPUC	-120	-130
Park Plaza MW 620*	SFPUC	-220	-230
MW-CUP-10A-160*	SFPUC	55	45
MW-CUP-10A-250*	SFPUC	40	25
MW-CUP-18-230*	SFPUC	-70	-85
MW-CUP-18-425*	SFPUC	-80	-95
MW-CUP-18-490*	SFPUC	-135	-150
MW-CUP-18-660*	SFPUC	-180	-195
MW-CUP-19-180*	SFPUC	Dry Well	Dry Well
MW-CUP-19-475*	SFPUC	-150	-160
MW-CUP-19-600*	SFPUC	-185	-200
MW-CUP-19-690*	SFPUC	-185	-200
MW-CUP-22A-140*	SFPUC	Dry Well	Dry Well
MW-CUP-22A-290*	SFPUC	-120	-130
MW-CUP-22A-440*	SFPUC	-145	-160
MW-CUP-22A-545*	SFPUC	-190	-200
MW-CUP-23-230*	SFPUC	-115	-130
MW-CUP-23-440*	SFPUC	-150	-165
MW-CUP-23-515*	SFPUC	-195	-210
MW-CUP-23-600*	SFPUC	-190	-205
MW-CUP-36-160*	SFPUC	-545	-60
MW-CUP-36-270*	SFPUC	-95	-105
MW-CUP-36-455*	SFPUC	-195	-210
MW-CUP-36-585*	SFPUC	-210	-220
SSFLP-MW120*	SFPUC	-30	-40
SSFLP-MW220*	SFPUC	-45	-55
SSFLP-MW440*	SFPUC	-205	-220
SSFLP-MW520*	SFPUC	-210	-225
MW-CUP-44-1-190*	SFPUC	-25	-35
MW-CUP-44-1-300*	SFPUC	-40	-55
MW-CUP-44-1-460*	SFPUC	-225	-235
MW-CUP-44-1-580*	SFPUC	-225	-235
MW-CUP-M-1*	SFPUC	n/a	n/a

Notes: Wells with thresholds defined as a seawater intrusion monitoring well are shown in **bold**:
n/a: Not available. Triggers are to be developed at a later date for wells with limited data
* Dedicated Monitoring Well

Figure 4.1
Wells Monitored for Compliance with Groundwater Levels BMO



Legend

- Wells
- Highways
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

4.3.2 Maintain or Improve Groundwater Quality

Maintenance of groundwater quality includes management actions to prevent seawater intrusion as well as impacts of elevated nitrate levels.

4.3.2.1 Seawater Intrusion

While there has been no identified seawater intrusion in the production aquifer to date, the South Westside Basin is at risk for seawater intrusion as groundwater levels throughout the basin are below sea level. Monitoring wells have been installed and are being monitored for seawater intrusion indicators along the Pacific Ocean and along San Francisco Bay. As the monitoring network is not capable of monitoring for all potential seawater intrusion pathways, it is reasonable to expand the seawater intrusion monitoring to include production wells and other monitoring wells. Seawater intrusion indicators include chloride, a conservative constituent in seawater, as well as several ratios of ions that are impacted by ion exchange, dolomitization, adsorption, and other chemical processes as seawater first contacts aquifer materials in equilibrium with fresh water. The indicators include the following:

- Chloride: Chloride concentrations are the most common indicator of seawater intrusion. Chloride concentrations can increase rapidly as high-chloride seawater intrudes into low chloride water in the aquifer and are often the first indicator of seawater intrusion. Chloride can also be of other sources, such as sewage, agricultural return, or water in the soil from the time of formation.
- Chloride/Bromide Ratio: The chloride/bromide ratio can be used to distinguish seawater sources (ratio of approximately 297) from sewage (higher ratio), agriculture (lower ratio), and other sources.
- Sodium/Chloride Ratio: The sodium/chloride ratio can be used as an early indicator of seawater intrusion. Low ratios, lower than seawater (<0.56 weight ratio), can indicate seawater intrusion prior to significant increases in chloride concentrations. This is a result of cation exchange, as sodium replaces calcium on aquifer sediments. If seawater intrusion is in the early stages of progressing, the sodium/chloride ratio should decrease, with a resulting increase in the ratio of both calcium and magnesium to chloride.
- Calcium/Magnesium Ratio and Calcium/(Bicarbonate and Sulfate) Ratio: These ratios can also provide an early indication of seawater intrusion. Ratios greater than 1 can be an early indicator of seawater intrusion. This is a result of dolomitization, which increases calcium concentrations and reduces magnesium concentrations as calcium carbonate (e.g., calcite, limestone) transforms into calcium magnesium carbonate (e.g., dolomite) (Jones et al., 1999).

The approach is based on the level of available data. These ratios are used in other basins to study seawater intrusion, along with other ratios and stable isotope analyses. In the Central and West Coast Basins of Los Angeles County, chloride and TDS concentrations; ratios of chloride to bromide, iodide, and boron; isotopic data; age dating; and borehole data are used to assess saline groundwater (Land, et al., 2004). Seawater intrusion analysis in the Seaside Basin of Monterey County utilizes chloride concentrations, sodium/chloride ratios, other cation/anion ratios, geophysical logs, and analysis of groundwater levels (HydroMetrics, 2011). In the San Leandro and San Lorenzo areas of Alameda County, ratios of chloride to bromide, iodide, barium, and boron are used along with chloride concentrations, noble gasses and isotopic data to study seawater intrusion (Izbicki et al, 2003).

Annual monitoring will include pumping and static water level measurements and sampling for the following analytes:

Alkalinity	Ortho-phosphate	Calcium	Conductivity
Bromide	Sulfate	Magnesium	pH
Chloride	Total Dissolved Solids	Potassium	Total Bicarbonate
Nitrate	Boron	Sodium	Iron and Manganese

4.3.2.1.1 Triggers

With the exception of chloride, thresholds are not set for each indicator as the magnitude and timing of each requires analysis prior to making decisions on the status of the South Westside Basin. Chloride thresholds are necessary as the first signs of seawater intrusion need to be recognized rapidly to protect the overall water quality. Thresholds are set at approximately 10 percent above the historical maximum concentration over the past twenty years of sampling (1991 – 2010, with probable outliers removed). This allows for variability inherent in sampling and analytical testing, but will signal potential issues should concentrations increase. Additional information on seawater intrusion parameters for a selection of these wells is presented in Appendix E. Chloride thresholds for each well are presented in Table 4.2. Note that these thresholds are part of adaptive management of the basin and are thus subject to change as additional data are collected and more information is learned about the basin. This is particularly true for wells with short periods of record, notably the “CUP” wells. The well locations are shown in Figure 4.2. The SMCL for chloride is 250 mg/l (recommended), 500 mg/l (upper) and 600 mg/l (short-term).

Regular analysis of water quality and water level data will allow for identification of data gaps that may require installation of new monitoring wells at new locations and/or new depth intervals, geophysical testing, or more rigorous chemical and isotope analysis.

Table 4.2 Seawater Intrusion BMO Chloride Thresholds (mg/l)

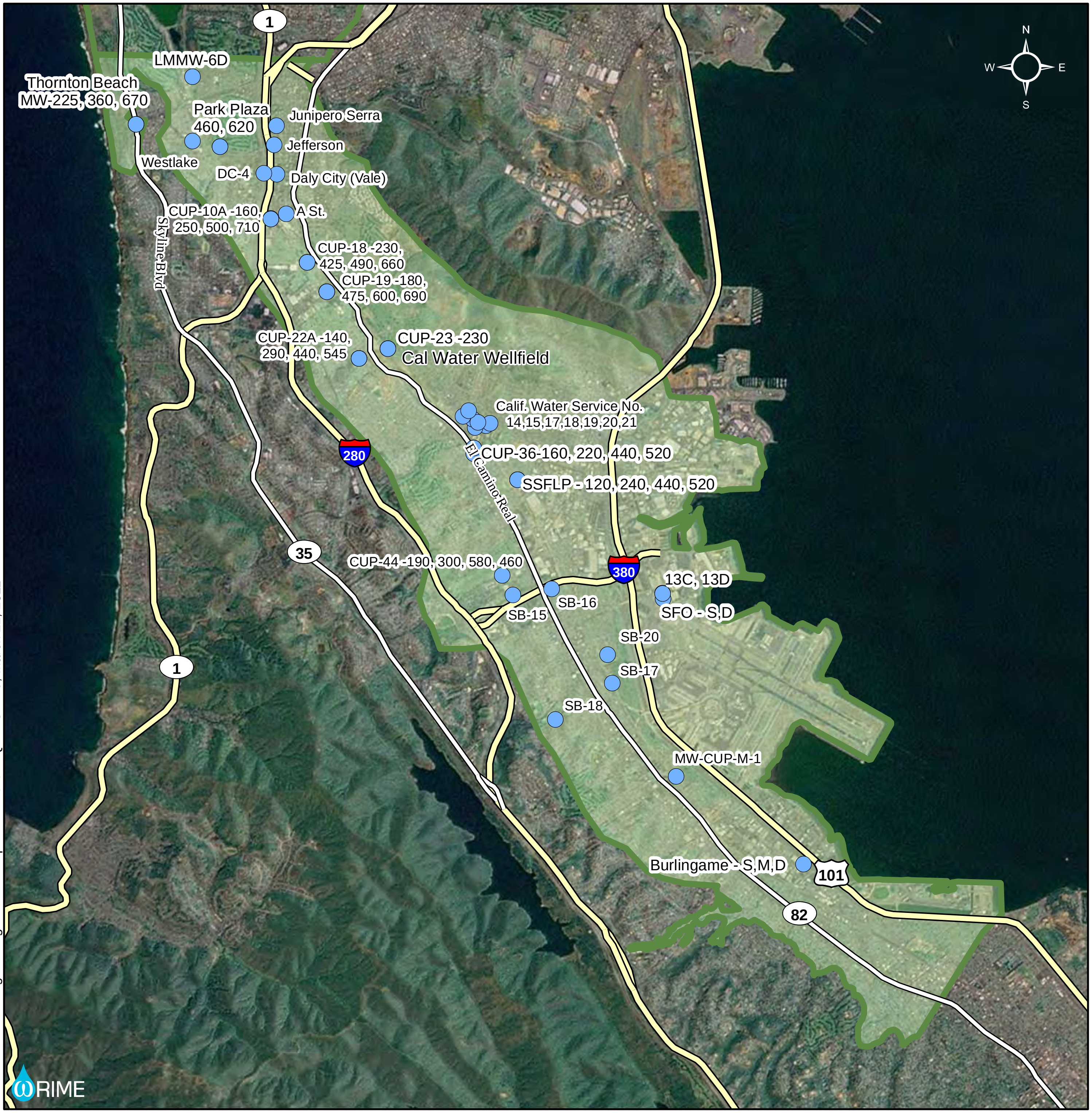
Well	Chloride Threshold	Recent Result	1991-2010 Maximum
Burlingame-S	570	430	518
Burlingame-M	90	63	79
Burlingame-D	55	41	47
SB-15	160	110	145
SB-16	170	110	154
SB-17	65	58	58
SB-18	80	70	72.5
SB-20	100	84	88
SSF 1-14	145	123	129
SSF 1-15	150	110	135
SSF 1-17	115	103	103
SSF 1-18	100	65	91
SSF 1-19	135	120	122
SSF 1-20	185	140	167
SSF 1-21	215	180	196
MW-CUP-M1	60	51	51
MW-CUP-10A-160	145	128	128
MW-CUP-10A-250	145	128	128
MW-CUP-18-230	100	90	90
MW-CUP-18-425	100	91	91
MW-CUP-18-490	100	90	90
MW-CUP-18-660	n/a	n/a	n/a
MW-CUP-19-180	n/a	n/a	n/a

MW-CUP-19-475	110	99	99
MW-CUP-19-600	105	95	95
MW-CUP-19-690	180	160	160
MW-CUP-22A-140	n/a	n/a	n/a
MW-CUP-22A-290	120	106	106
MW-CUP-22A-440	80	71	71
MW-CUP-22A-545	120	106	106
MW-CUP-23-230	n/a	n/a	n/a
MW-CUP-23-440	n/a	n/a	n/a
MW-CUP-23-515	n/a	n/a	n/a
MW-CUP-23-600	n/a	n/a	n/a
MW-CUP-36-160	125	110	110
MW-CUP-36-270	130	118	118
MW-CUP-36-455	90	81	81
MW-CUP-36-585	205	186	186
MW-CUP-44-1-190	80	69	69
MW-CUP-44-1-300	95	84	84
MW-CUP-44-1-460	150	134	134
MW-CUP-44-1-600	95	85	85
SSFLP-MW120	200	173	180
SSFLP-MW220	115	100	104
SSFLP-MW440	75	61	65
SSFLP-MW520*	125	107	110
Park Plaza MW 620*	175	143	155
Park Plaza MW 460	n/a	n/a	n/a
LMMW-6D	n/a	n/a	n/a

Thornton Beach MW 225	n/a	n/a	n/a
Thornton Beach MW 360	n/a	n/a	n/a
Thornton Beach MW 670	n/a	n/a	n/a
A-Street	165	88	150
Jefferson	135	58	120
Junipero Serra	55	50	50
Vale	80	67	71
No. 4 Citrus	85	61	76
Westlake	200	99	180
SFO-S	13,600	10,000	12,400
SFO-D	605	550	550

Note: n/a: Not available; triggers are to be developed at a later date for wells with limited data

Figure 4.2
Wells Monitored for Compliance with Groundwater Quality BMO



F:\5.1 - San Bruno\Figures\Figure 5.1 Compliance Wells WQ BMO.mxd, March 21, 2011

4.3.2.1.2 Actions

If the trigger threshold is met, the Groundwater Task Force will meet to discuss the situation, including confirming the result, an analysis of trends, analysis of other seawater intrusion indicators including analytical results and water level measurements, potential impacts to groundwater users or the environment, and the most appropriate actions.

If confirmed, analysis should be initiated to determine if the elevated value is likely the result of seawater intrusion, upconing of deep saline water, or other sources. Actions will be based on plan elements defined in Section 5, Elements of the Groundwater Management Plan. These actions may include:

- Continued operation
- Increased monitoring
- Studies of sources of chloride (seawater intrusion or upconing from deeper sediments) and additional options to manage water quality
- Reoperation or new wells to move production to other parts of the basin or different depths
- Decreased production to reduce seawater intrusion or upwelling
- Substitution of alternate supplies

4.3.2.2 Nitrate

Elevated nitrate levels in portions of the basin have become an increasing concern over the past several years. Although concentrations have largely remained below MCLs, individual wells have shown sudden increases and trends suggest possible issues in the future. The source of nitrate in the basin has not been studied, but historical and current land use point to either previous agricultural land uses, including extensive cattle operations, or current urban and turf-grass uses. If trends continue, work may be needed to identify the source and to determine how the region could keep nitrate levels within desired levels, potentially through development of a salt and nutrient management plan or through other studies. .

4.3.2.2.1 Triggers

This section defines nitrate monitoring, triggers, and actions on a well-by-well basis. Monitoring is based on existing DPH data collection efforts and local sampling of monitoring wells. Trigger 1 is based on 80 percent of the MCL, 36 mg/l, and Trigger 2 is based on 90 percent of the MCL, 41 mg/l.

It should be noted that data presented in this section is representative of raw water quality. Raw water quality is different from the water served to customers, as water purveyors pump selectively from wells based on quality and provide blended water from both groundwater and surface water sources to maintain a safe water supply in compliance with state and federal regulations.

Future nitrate monitoring should proceed annually, unless trends or levels indicate a need for more frequent measurements.

4.3.2.2.2 Actions

If Trigger 1 is met for one or more wells, the Groundwater Task Force will meet to discuss the situation, including confirming the result, an analysis of trends, potential impacts to groundwater users or the environment, and the most appropriate actions, both immediate and upon Trigger 2 (if met). The Groundwater Task Force will consider the status of all wells, including the wells below the trigger threshold, the quantity and quality of other supply sources for blending, and will also consider water level data and other environmental and operational factors that could contribute to increases in nitrate concentrations. Actions will be based on the plan elements and programs defined in Section 5, Elements of the Groundwater Management Plan.

If Trigger 2 is met, the actions defined for Trigger 1 and any additional measures, actions, or mechanisms deemed necessary by the Groundwater Task Force will be implemented.

Historical estimates of nitrate concentrations and current groundwater quality BMO trigger status are shown in Table 4.3. Note that the triggers are part of adaptive management of the basin and are thus subject to change as additional data are collected and more information is learned about the basin. This is particularly true for wells with short periods of record, notably the "CUP" wells.

Table 4.3 Groundwater Quality BMO Triggers

Well	1991-2010 Maximum Nitrate (as NO3) Concentration (mg/l)	Recent Nitrate (as NO3) Concentration (mg/l)	Trigger Status
Burlingame-S	< 1	ND	
Burlingame-M	ND	ND	
Burlingame-D	1	1	
SB-15	15	5	
SB-16	8	ND	
SB-17	6	5	
SB-18	7	7	
SB-20	7	1	
01-14	82	76	Trigger 2
01-15	32	18	
01-17	222	219	Trigger 2
01-18	85	76	Trigger 2
01-19	60	35	
01-20	104	4	
01-21	3	ND	
MW-CUP-M1	12	12	
MW-CUP-10A-160	35	35	
MW-CUP-10A-250	48	48	Trigger 2
MW-CUP-10A-500	36	36	Trigger 1
MW-CUP-10A-710			
MW-CUP-18-230	7	7	
MW-CUP-18-425	8	8	
MW-CUP-18-490	2	2	
MW-CUP-18-660			
MW-CUP-19-180			

Well	1991-2010 Maximum Nitrate (as NO3) Concentration (mg/l)	Recent Nitrate (as NO3) Concentration (mg/l)	Trigger Status
MW-CUP-19-475	1	1	
MW-CUP-19-600	ND	ND	
MW-CUP-19-690	ND	ND	
MW-CUP-22A-140			
MW-CUP-22A-290	33	33	
MW-CUP-22A-440	1	1	
MW-CUP-22A-545	24	24	
MW-CUP-23-230			
MW-CUP-23-440			
MW-CUP-23-515			
MW-CUP-23-600			
MW-CUP-36-160	26	26	
MW-CUP-36-270	8	8	
MW-CUP-36-455	ND	ND	
MW-CUP-36-585	ND	ND	
MW-CUP-44-1-190	35	35	
MW-CUP-44-1-300	37	37	Trigger 1
MW-CUP-44-1-460	2	2	
MW-CUP-44-1-600	ND	ND	
SSFLP-MW120	ND	ND	
SSFLP-MW220	1	1	
SSFLP-MW440	ND	ND	
SSFLP-MW520*	ND	ND	
Park Plaza MW 620*	1	< 1	
Park Plaza MW 460*			
LMMW-6D			

Well	1991-2010 Maximum Nitrate (as NO3) Concentration (mg/l)	Recent Nitrate (as NO3) Concentration (mg/l)	Trigger Status
A-Street	170	98	Trigger 2
Jefferson	31	10	
Vale	46	35	
No. 4 Citrus	71	63	Trigger 2
Westlake	61	33	
Junipero Serra	47	34	
SFO-S	8	ND	
SFO-D	ND	ND	

Note: Blanks: Triggers are to be developed at a later date for wells with limited data

4.3.3 LIMIT THE IMPACT OF POINT SOURCE CONTAMINATION

Point source contamination can also threaten water supplies in the South Westside Basin. Loss of a portion of the water supply due to point source contamination would require use of alternate supplies, which are limited. The point source contamination BMO seeks to coordinate with regulatory agencies to ensure potential impacts to water supplies and environmental receptors are fully incorporated into remedial actions and monitoring programs at contaminated sites. The BMO recognizes that clay layers only slow the migration of contaminants and that these contaminants, if not properly remediated, may reach the primary production aquifer at some concentration at some point in the future.

No quantitative thresholds are set for this BMO as there are numerous potential contaminants; however, a qualitative objective of limiting the impact of point source contamination is defined through identifying and protecting areas of basin recharge, ensuring rapid response to new detections of contaminants at any well, and fully cleaning up contaminated sites, including perched aquifer systems that eventually recharge the deeper aquifer used for water supplies. Full cleanup may be through remediation programs or natural processes. The following are actions to achieve this BMO:

- Use basin understanding and the existing Groundwater Model to identify important areas of basin recharge. Identify appropriate measures to protect those areas.
- Actively engage with regulatory agencies and potentially responsible parties on existing sites.

- o Notify regulators of contamination issues in wells, even for low-level detections, to ensure discovery of new problems as quickly as possible.
- o Coordinate with land use planners to ensure land uses are suitable for land overlying the aquifer.

4.3.4 EXPLORE NEED FOR LAND SUBSIDENCE MONITORING

The land subsidence BMO focuses on increased understanding of the possible problem through potential additional monitoring activities. There has been no evidence of historical land subsidence, even though water levels have declined significantly from pre-development levels. Land subsidence is most rapid immediately after the initial dewatering of sediments. Thus, land subsidence is not anticipated from sediments that have been historically dewatered. Should water levels decline in the future, it is unlikely that subsidence would occur as these materials are similar to those historically dewatered and would likely exhibit similar limited compressibility.

However, without any previous studies of subsidence, there is a potential that land subsidence may have occurred unnoticed or that deeper materials may behave differently. As such, there is a need to perform a subsidence study to assess the status of the subsidence in the South Westside Basin.

Interferometric synthetic aperture radar (InSAR) studies are included in the implementation of the plan. The results of the InSAR study may confirm that no land subsidence is occurring in the South Westside Basin, or could show the need for more formalized monitoring and development of quantitative BMOs, which may be established under the reporting and updating element contained in Section 5.7, Reporting and Updating.

4.3.5 MANAGE THE INTERACTION OF SURFACE WATER AND GROUNDWATER FOR THE BENEFIT OF GROUNDWATER AND SURFACE WATER QUANTITY AND QUALITY

This BMO seeks to manage changes in surface flow and surface water quality and quantity that directly affect groundwater levels or quality or are caused by groundwater production in the basin. As discussed in Section 2.3.10, there is little interaction between surface water and groundwater in the South Westside Basin. Colma Creek is the largest surface water feature, but it is relatively small and lined for most reaches. Other creeks are very small and drain local watersheds.

No quantitative thresholds are set for this BMO, however, the following qualitative objectives of maintaining or improving the interaction of surface water and groundwater are set:

- o Maintain natural watercourses and investigate potential benefits of removing lining from watercourses where feasible.

- Maintain baseflow in creeks.
- Monitor groundwater levels to assist in water level studies at Lake Merced in San Francisco County in the North Westside Basin.

5 ELEMENTS OF THE GROUNDWATER MANAGEMENT PLAN

California Water Code section 10753.8 states that a GWMP may include components relating to all of the following:

- Control of saline water intrusion
- Identification and management of wellhead protection areas and recharge areas
- Regulation of migration of contaminated groundwater
- Administration of a well abandonment and well destruction program
- Mitigation of overdraft conditions
- Replenishment of groundwater extracted by water producers
- Monitoring of groundwater levels and storage
- Facilitation of conjunctive use operations
- Identification of well construction policies
- Construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects
- Development of relationships with state and federal regulatory agencies
- Review of land use plans and coordination with land use planning agencies to assess activities that create a reasonable risk of groundwater contamination

These items are grouped and related back to the South Westside Basin GWMP goal and objectives in Table 5.1 and discussed in the following sections. Some of the items below call for consideration, evaluation, and the potential implementation of measures to address conditions in the groundwater basin. These items are intended to address goals and objectives of the GWMP, but do not propose specific actions or projects that might be developed on a case-by-case basis, as needed. Such specific actions or projects are not fully known at this time and may be subject to evaluation, including but not limited to environmental review, when and if proposed for implementation, and may require approval by regulatory agencies with jurisdiction over the proposed action following completion of any required environmental review.

Table 5.1
Summary of GWMP Objectives and Elements

Item	BMOs				
	Maintain Acceptable Groundwater Levels	**Maintain or Improve Groundwater Quality**	**Limit the Impact of Point Source Contamination**	**Explore the Need for Land Subsidence Monitoring**	**Manage Interaction of Surface Water And Groundwater**
Stakeholder Involvement	✓	✓	✓	✓	✓
Monitoring and Management					
Monitoring of groundwater levels and storage	✓		✓		✓
Monitoring of groundwater quality		✓	✓		✓
Monitoring of inelastic land subsidence				✓	
Monitoring of surface water/groundwater interaction	✓	✓			✓
Groundwater Storage					
Mitigation of overdraft conditions	✓	✓			✓
Replenishment of groundwater extracted by water producers	✓	✓			✓
Facilitation of conjunctive use operations	✓	✓			✓
Groundwater Quality					
Control of saline water intrusion		✓		✓	✓
Identification and management of wellhead protection areas and recharge areas	✓	✓	✓	✓	✓
Regulation of migration of contaminated groundwater		✓	✓	✓	✓
Administration of a well abandonment and well destruction program		✓	✓	✓	✓
Identification of well construction policies		✓	✓	✓	✓
Construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects	✓	✓	✓	✓	✓
Coordinated Planning					
Development of relationships with state and federal regulatory agencies	✓	✓	✓	✓	✓
Coordination with IRWMP efforts	✓	✓	✓	✓	✓
Review of land use plans and coordination with land use planning agencies to assess activities that create a reasonable risk of groundwater contamination	✓	✓	✓		✓
Reporting and Updating	✓	✓	✓	✓	✓

5.1 STAKEHOLDER INVOLVEMENT

Ongoing stakeholder involvement is critical to successful implementation of the GWMP. Interested parties include agencies within and near the South Westside Basin, environmental interests, and individuals and companies that rely on the groundwater basin for water supply. Coordination with these groups is necessary to ensure that goals and objectives continue to be consistent with the desires of the community; that a full range of alternatives are considered along with potential adverse impacts; and that progress can be made toward meeting the goal and objectives.

Actions

A1. *Distribute the GWMP in an electronic format to all parties that have expressed interest in the plan, including all agencies within and bordering the basin.*

A2. *Hold Groundwater Task Force (see Section 6.1) meetings on a semi-annual basis to discuss ongoing groundwater management issues and activities. These discussions will include other agencies, thus enabling cooperation between public entities whose service areas or boundaries overlie the groundwater basin. Meetings will focus on progress towards meeting BMOs, implementation of projects in this plan, new or updated status on the condition of the groundwater basin, and new or updated plans or strategies.*

A3. *Continue outreach to private groundwater producers, notably cemeteries, to involve these stakeholders in the ongoing groundwater management process.*

A4. *Reorient the GWMP web site from its current plan-development focus to an implementation focus, highlighting implementation activities and soliciting public input.*

A5. *Present actions implemented by the agencies at public meetings of the respective councils.*

A6. *Provide public notice for any revisions to the GWMP.*

5.2 MONITORING AND MANAGEMENT

Elements pertaining to Monitoring and Management of the South Westside Basin relate to groundwater levels and storage; groundwater quality; inelastic land subsidence; and changes in surface flow and surface water quality that directly affect groundwater levels or quality or are caused by groundwater pumping.

5.2.1 GROUNDWATER LEVELS AND STORAGE

The South Westside Basin needs additional groundwater level and quality monitoring to meet the objectives of this plan and the needs of the individual water agencies. Monitoring protocols are included in Appendix C. Coordination among the agencies is necessary to make existing and future monitoring as complete as possible with respects to spatial distribution and timing.

Figure 5.1 shows all wells in the South Westside Basin with static water level measured at least once in 2009. Water level data are taken regularly by the water agencies, but typically static water levels are only taken when pumps are not operating due to maintenance activities. There is no existing basin-wide static groundwater level monitoring program.

To the extent possible, groundwater level monitoring should continue at all wells that are currently or have recently been measured, as shown in Figure 5.1. Water levels should be measured minimally in the spring (April) and fall (October). Datalogging pressure transducers should be installed in selected wells to determine variability between readings, which may refine future timing of groundwater level measurements. Measurements should be taken when the well and, to the extent possible, nearby wells are not pumping, to represent static water levels. In addition to the measurement, the pumping status at the well and nearby wells should be noted and preserved in the database. Additional monitoring details are provided in Appendix C.

Groundwater level monitoring should be coordinated with the California Statewide Groundwater Elevation Monitoring (CASGEM) program, a statewide groundwater elevation monitoring program that is intended to track seasonal and long-term trends in groundwater elevations in California's groundwater basins. Daly City, CalWater, and San Bruno, through the South Westside Basin Voluntary Cooperative Groundwater Monitoring Association, are the monitoring entities for the portion of the South Westside Basin within their service area. Coordination with CASGEM should include consistent monitoring protocols between data provided to the CASGEM program and other data collected in the basin.

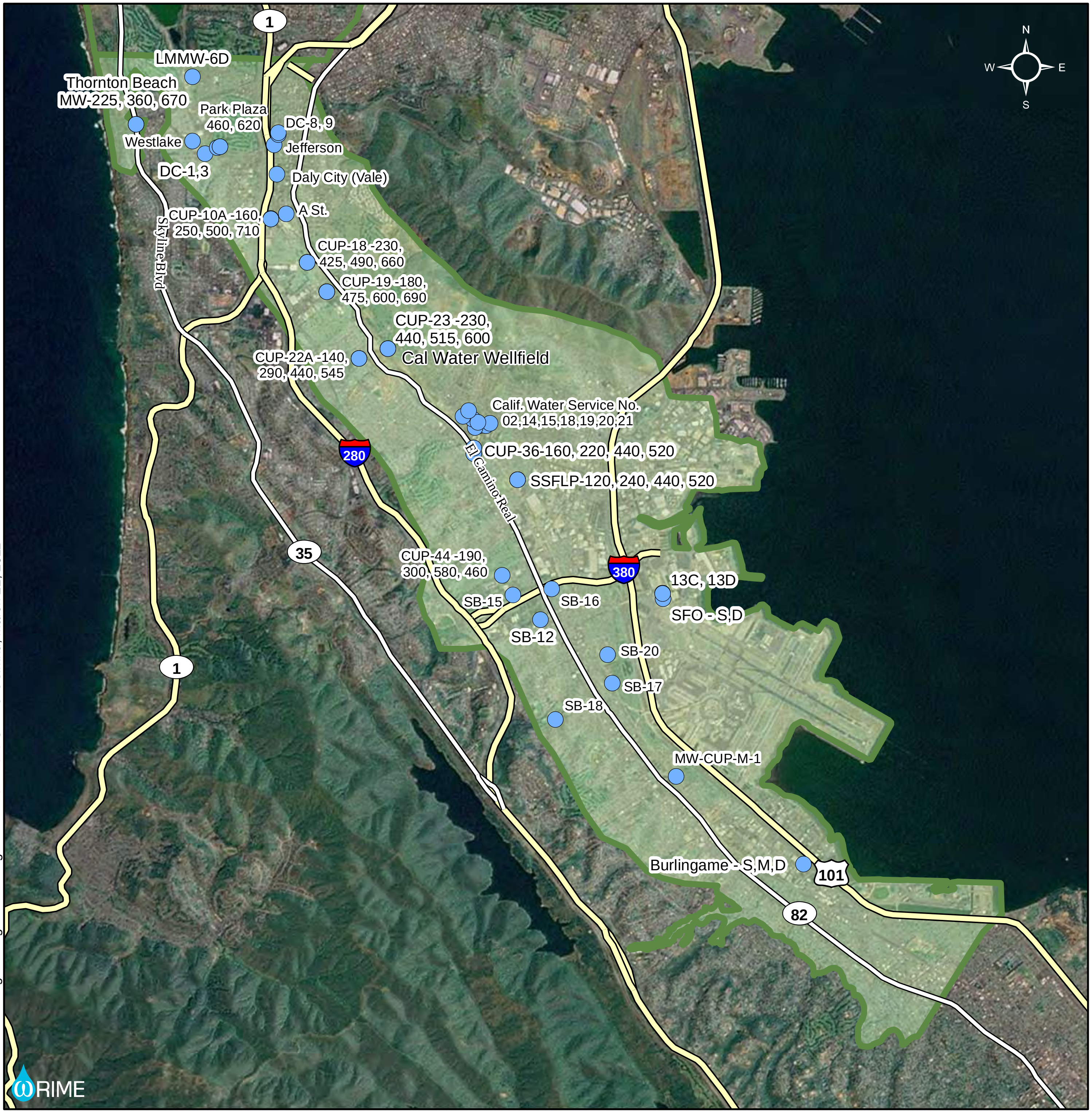
A key element of monitoring and management of groundwater levels and storage is the Groundwater Model. The Groundwater Model is used primarily to improve the understanding of the groundwater system, but also is useful for the following:

- Aggregating, organizing, and analyzing existing data
- Identifying data gaps
- Simulating impacts on groundwater levels and storage of various projects and of continuation of existing operations

The Groundwater Model is available for use by all interested stakeholders from Daly City. Output from the model may be used in GWMP implementation to ensure that projects are designed to meet the stated goal and objectives.

These activities result in a significant amount of data. Usage of a data management system, such as the existing HydroDMS, can assist in storing, accessing, and analyzing data across multiple agencies.

Figure 5.1
Wells Monitored for Groundwater Levels



Legend

- Wells
- Highways
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

F:\6.1 - San Bruno\Figures\Figure 6.1 CFigure 6.1 Mon Wells GW Levels.mxd, March 21, 2011

Actions

B1. *Implement a basin-wide semi-annual static water level measurement program that builds upon existing monitoring. The program should include the wells belonging to the retail water agencies. Other wells may be included if feasible.*

B2. *Use existing database structures with data from these databases imported into a central Data Management System (such as the existing HydroDMS) to facilitate data sharing between agencies.*

B3. *Coordinate among agencies to ensure that wells continue to be monitored to provide long-term records of water levels at specific locations, and to ensure a consistent and, to the extent feasible, complete dataset.*

B4. *Participate in the CASGEM program.*

5.2.2 Groundwater Quality

Water quality monitoring is performed for Title 22 compliance by the water agencies. Figure 5.2 shows the locations of wells monitored for water quality at least once in the most recent 5-year period with available data from DPH (2006 – 2010) or other local monitoring activity. Monitoring protocols are contained in Appendix C. Additional water quality monitoring is needed to ensure sufficient data to define nitrate concentrations for use by the water quality BMOs in this GWMP.

Actions

C1. *Continue groundwater quality monitoring as needed to meet Title 22 requirements.*

C2. *Standardize data collection protocols and timing through coordination among agencies.*

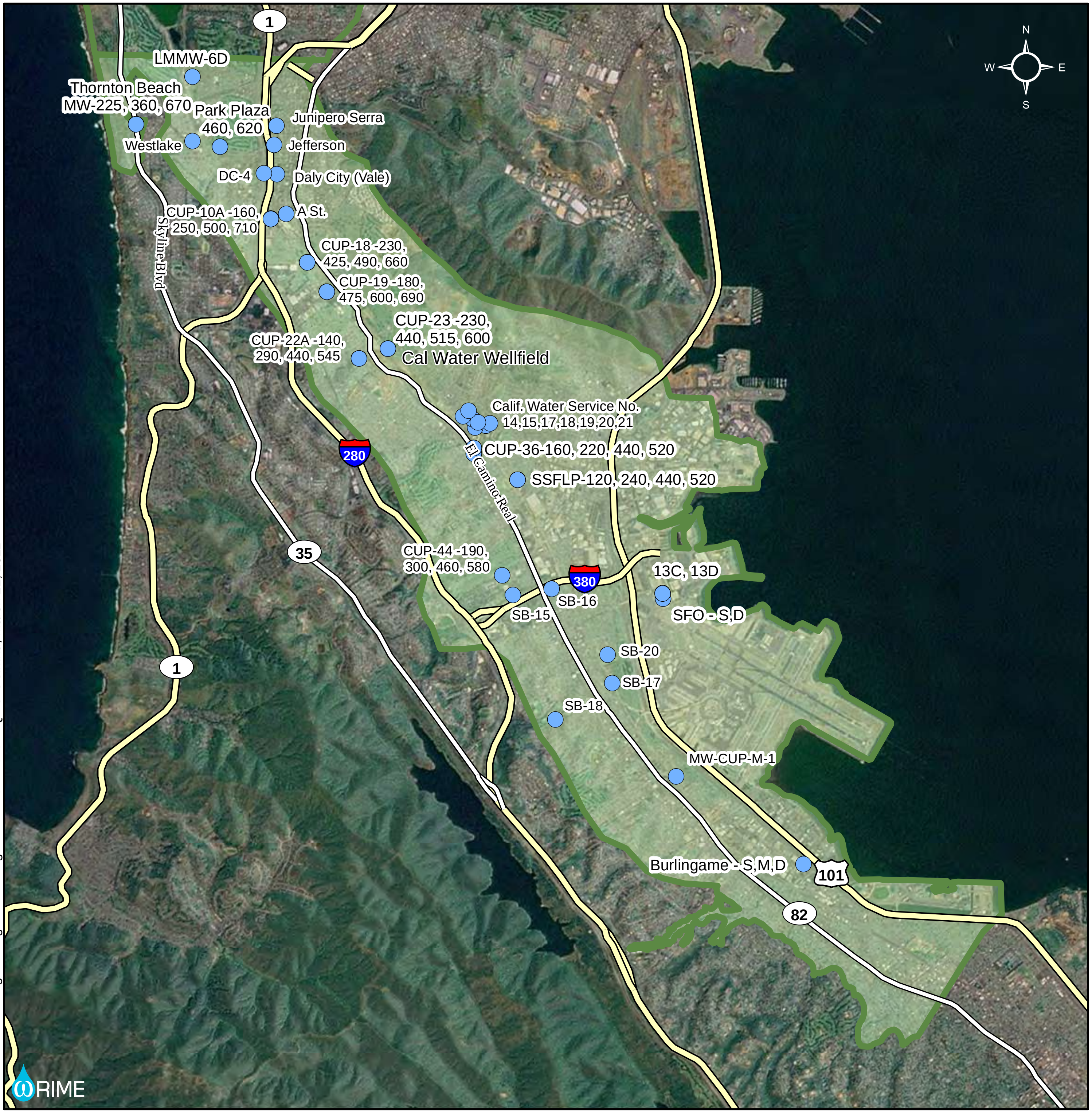
C3. *Continue to use existing database structures, with data from these databases imported into a central Data Management System (such as the existing HydroDMS).*

C4. *Fill gaps in the water quality monitoring network through sampling additional existing or newly constructed monitoring wells.*

C5. *Coordinate with the USGS on its National Ambient Water Quality Assessment (NAWQA) program and GAMA program to potentially integrate its efforts with local monitoring efforts.*

C6. *Consider development of a Salt and Nutrient Management Plan to assist in permitting of future recycled water projects.*

Figure 5.2
Wells Monitored for Groundwater Quality



Legend

- Wells
- Highways
- Groundwater Basin
- Plan Area

0 0.5 1 2 Miles

5.2.3 INELASTIC LAND SUBSIDENCE

Monitoring land subsidence in the South Westside Basin is limited by the cost of traditional surveys and extensometer compared to the limited historical impact of subsidence in the basin. If land subsidence is reported in the area, or if water levels drop below historical lows, additional land subsidence monitoring will be considered. Relatively new technology, InSAR, allows for more cost-effective, regional scale land subsidence monitoring. Over time, these technologies are becoming more powerful and less expensive. Lower costs and opportunities to partner with others such as USGS may allow for land subsidence monitoring in the future.

Actions

D1. *Collect evidence, if any, of active inelastic land subsidence and assess the risk.*

D2. *Develop a land subsidence monitoring program, if needed, using InSAR or traditional surveying and extensometer methods.*

D3. *Partner with the USGS or nearby agencies to implement any needed monitoring.*

5.2.4 CHANGES IN SURFACE FLOW AND SURFACE WATER QUALITY THAT DIRECTLY AFFECT GROUNDWATER LEVELS OR QUALITY OR ARE CAUSED BY GROUNDWATER PUMPING

Surface flow within the South Westside Basin is minimal, primarily Colma Creek and other small creeks, as discussed in Section 2. However, Lake Merced is a significant water body with recreational uses to the north in the North Westside Basin. This GWMP intends to support the actions developed under the North Westside Basin GWMP through coordination with that plan during development and updates. The action listed below are reflective of the actions of the North Westside GWMP.

Action

E1. *Continue groundwater monitoring near Lake Merced to support ongoing studies.*

5.3 GROUNDWATER STORAGE

5.3.1 MITIGATION OF OVERDRAFT CONDITIONS

The South Westside Basin is currently considered not to be in a state of overdraft. Current pumping is estimated to be approximately at the basin yield, as estimated by the Westside Basin Groundwater-Flow Model (Hydrofocus, 2011). However, historical groundwater production has at times exceeded the basin yield, which has resulted in groundwater levels well below sea level. The groundwater level BMO is intended to serve as a prevention, coordination, and warning device.

Currently, the decisions and plans on groundwater production are made independently by each agency based on each agency's individual needs in coordination with the respective surface water supplies from the SFPUC. Under current basin management, there is little or no coordination among the agencies on the individual agency or total production from the basin. To manage the basin in a more robust and sustainable manner, there is a need to coordinate groundwater production among the agencies, along with appropriate level of monitoring and reporting of groundwater production, levels, and quality. This information can be used in several aspects of basin management, including:

- Keeping the Westside Basin Groundwater-Flow Model updated and using the model to evaluate the impact of collective production in comparison to the basin yield. In addition to investigating basin-wide conditions, the model can also provide details on the impact of the geographic distribution of production throughout the basin, so as to assist in managing the basin in a more sustainable manner. While more detailed analyses typically have higher uncertainties than regional analyses, they can provide information on estimated changes in the basin operations that can assist in groundwater management strategies.
- Updating the basin yield estimates over time as better data becomes available, and as operation of the basin evolves into a more coordinated manner. As a result, and in order to address any potential basin yield issues, there may be a need in the future to evaluate additional recharge opportunities or apportion production to each agency through voluntary agreements to assist in meeting groundwater level BMOs. Appropriate monitoring and robust modeling tools will assist in evaluating basin management options and safe yield should that become necessary in the future.

Actions

F1. *Should groundwater levels decline, analyze conditions to determine if the South Westside Basin is in overdraft or if conditions are due to short-term climatic variability or other factors. Analysis will include the use of the most up-to-date groundwater model.*

F2. *Should overdraft conditions occur, actions may include demand reduction through alternate supplies or conservation programs and increased recharge activities through in-lieu or direct recharge.*

F3. *Implement a voluntary groundwater pumping metering program for private wells, such as at golf courses or cemeteries, to improve overall basin understanding.*

F4. *Utilize the groundwater model to simulate the collective impacts of current, near-term, and long-term projected groundwater production*

F5. *If current or future production is considered beyond the basin yield and is anticipated to result in not meeting the Groundwater Level BMO, voluntarily apportionment of pumping to each agency may be performed to provide certainty on future levels of production. The apportionment will be determined by the water agencies at that time, but should consider historical production, access to* *alternate sources, status of existing infrastructure, water quality considerations, and projected needs.*

5.3.2 REPLENISHMENT OF GROUNDWATER EXTRACTED BY WATER PRODUCERS

Groundwater replenishment may take place to cost effectively increase stored water in the aquifer for normal and drought periods or to support regional water supply goals. As long as the South Westside Basin remains in a hydrologically balanced condition, replenishment will occur on a voluntary basis, as economically feasible projects and water sources become available.

Actions

Study the feasibility of and potential for implementing the following replenishment activities:

G1. *Direct recharge of storm water and other surface water, selecting replenishment water to best manage the quality of recharge waters and receiving waters*

G2. *Substitution of other water supplies such as recycled water or imported water for groundwater*

G3. *Conservation efforts*

G4. *Study the suitability of near surface conditions for improved recharge from low impact development techniques such as permeable pavement, swales, and others. Study should include subsurface materials and perched groundwater conditions.*

G5. *Should the basin become overdrafted for extended periods of time, appropriate actions for replenishment should be taken with proper governance structures.*

5.3.3 FACILITATION OF CONJUNCTIVE USE OPERATIONS

Conjunctive use operations can assist groundwater basin management as the agencies have access to both groundwater and surface water supplies. Conjunctive use in the South Westside Basin in the form of large-scale direct recharge through spreading basins may not be cost-effective due to high land costs and clay layers in the upper aquifer system, but potential options should be studied if identified. Conjunctive use could more likely take the form of in-lieu recharge, in which other supply sources, such as imports or recycled water, may replace groundwater, thus offsetting future groundwater pumping during times of reduced imported water supplies. Injection of water into the aquifer may also be considered. Consideration should be given to water quality changes that may occur due to recharge activities and the increase in groundwater levels, particularly with the potential mobilization of nitrate in the subsurface.

Actions

H1. *Consider the development, implementation, and maintenance of programs and projects to recharge aquifers. Programs may be local or regional in scope. These may use imported water, recycled* *water, and other waters to offset existing and future groundwater pumping, except in the following situations:*

- *Groundwater quality would be reduced, unless lower water quality provides maximum benefit*
- *Available groundwater aquifers are full*
- *Rising water tables threaten the stability of existing structures*

H2. *Support regional groundwater banking operations that are beneficial to the South Westside Basin and the region and support the goals of this GWMP.*

5.4 GROUNDWATER QUALITY

5.4.1 CONTROL OF SEAWATER INTRUSION

The threat of seawater intrusion in the South Westside Basin includes the potential migration of seawater from the Pacific Ocean and San Francisco Bay. Control of this migration includes monitoring groundwater levels, groundwater quality, and groundwater production. Should monitoring indicate increased risk of seawater intrusion, actions should be evaluated that would raise groundwater levels through increased recharge or decreased extraction.

Actions

I1. *Continue monitoring for seawater intrusion at the margins of the basin. Study the need for additional monitoring locations or inclusion of additional indicators or triggers.*

I2. *Combine seawater intrusion monitoring results with monitoring of basin-wide groundwater levels, groundwater quality, and production to fully determine risk of seawater intrusion.*

I3. *Evaluate the reduction of the gradient between sea level and groundwater levels through increased recharge or decreased production in the affected area.*

5.4.2 IDENTIFICATION AND MANAGEMENT OF WELLHEAD PROTECTION AREAS AND RECHARGE AREAS

The entire South Westside Basin is a source of recharge and requires protection to ensure high quality recharge and to maintain or enhance existing recharge quantities. Pervious areas such as open spaces and the numerous parks, cemeteries, and golf courses allow water to percolate into the soil and recharge the aquifer. No significant land use changes are anticipated in the built-out South Westside Basin, and these pervious areas are unlikely to be paved or otherwise developed. However, if such actions are considered in the future, the impact to the groundwater basin should be studied. Additionally, opportunities to increase pervious areas should be explored.

Drinking water source assessments produced by the groundwater agencies have identified uses that threaten groundwater quality in the South Westside Basin along with delineation of capture zones around wells. Uses that threaten some wells in the basin include:

- Automobile repair shops
- Automobile gas stations
- Dry cleaners
- Military installations
- Sewer collection systems
- Underground storage tanks - confirmed leaking tanks
- Utility stations - maintenance areas

Actions

J1. Preserve and protect, to the extent possible, aquifer recharge areas.

J2. Implement public outreach efforts.

J3. Design recharge facilities to minimize pollutant discharge into storm drainage systems, natural drainage, and aquifers.

J4. Decrease storm water runoff, where feasible, by reducing paving in development areas, and by using design practices such as permeable parking bays and porous parking lots with beamed storage areas for rainwater detention. Exercise caution to avoid contamination from oil, gas, and other surface chemicals.

J5. Manage streams with natural approaches, to the maximum extent possible, where groundwater recharge is likely to occur.

J6. Identify prime recharge areas and consider offering incentives to landowners in exchange for limiting their ability to develop their property due to its retention as a natural groundwater recharge area. These incentives will encourage the preservation of natural water courses without creating undue hardship on the property owners, and might include density transfer functions.

J7. Submit the map of recharge areas (Figure 2.10) to local planning agencies and notify DWR and other interested persons when the map is submitted to those local planning agencies, as required by AB359 (Huffman)

5.4.3 Regulation of the Migration of Contaminated Groundwater

It is important to regulate contaminated groundwater migration both for protecting existing sources of groundwater and for developing new sources of groundwater. Coordination with regulatory agencies and potentially responsible parties will give water managers input into the cleanup and containment of contaminated sites and will improve long-term planning efforts based on the predicted impact of those hazards. Additionally, new, improved, and more cost-effective treatment technologies can potentially result in additional potable or non-potable supplies from groundwater that was previously considered unavailable for use.

Action

K1. *Coordinate with local regulatory agencies to share information about contaminated sites and about the South Westside Basin groundwater system and wells. Treatment systems will be investigated as new non-potable supply sources.*

K2. *Coordinate with the SWRCB to verify the classification of contaminated media at sites within the basin in their GeoTracker website.*

5.4.4 ADMINISTRATION OF A WELL ABANDONMENT AND WELL DESTRUCTION PROGRAM

Abandoned or poorly constructed wells should be properly destroyed to prevent migration of contaminants down well bores from the surface to the aquifer or across clay layers within the aquifer. Well destruction in the basin is administered by San Mateo County's Groundwater Protection Program (GPP). Destruction of wells is performed in accordance with the procedures set forth in DWR's *California Well Standards*, Bulletin 74-90 (1990).

Actions

L1. *Survey abandoned wells in the South Westside Basin both physically and from county records.*

L2. *Coordinate with San Mateo CountVURQGDWHUURWHFWLRQURJUDP on destruction standards and procedures, as well as on logging of status of abandoned and destroyed wells.*

L3. *Encourage and, if feasible, provide funding for the destruction of abandoned wells.*

5.4.5 IDENTIFICATION OF WELL CONSTRUCTION POLICIES

Well construction in the South Westside Basin also is administered by San Mateo County's Groundwater Protection Program.

San Mateo County's Groundwater Protection Program issues permits for the construction or abandonment of all water wells including, but not limited to driven wells, monitoring wells, cathodic wells, extraction wells, agricultural wells, and community water supply wells. The wells are inspected during different stages of construction to verify standards are met. All drinking water wells are evaluated once installation is complete to ensure compliance with California Well Standards set forth in DWR's *California Well Standards*, Bulletin 74-90 (1990) and minimum drinking water standards.

Actions

M1. *CoordinatHLW6DQ0DWHRRQWVURQGDWHUURWHFWLRQURJUDP staff to ensure all parties are aware of local and regional contamination plumes. Increased caution or restrictions may be necessary near these plumes.*

5.5 CONSTRUCTION AND OPERATION BY THE LOCAL AGENCY OF GROUNDWATER CONTAMINATION CLEANUP, RECHARGE, STORAGE, CONSERVATION, WATER RECYCLING, AND EXTRACTION PROJECTS

Properly designed, constructed, and operated projects can cost-effectively move the South Westside Basin towards meeting water quantity, water quality, and subsidence objectives.

These projects could include:

- Groundwater contamination cleanup

Actions

N1. *Remediate basin groundwater from point-source (e.g., TCE, fuels) and non-point-source (e.g., nitrate) contamination, in a cost-effective manner. Point-source cleanup activities will include interfacing with regulatory agencies, potentially responsible parties, and other nearby agencies and municipalities. These actions will seek to return the contaminated area, to the extent possible, to a water supply source. Cleanup activities will be performed by the potentially responsible parties, and the regulatory agencies. Payment for impacts to the water system, if any, will be sought from the potentially responsible parties.*

- Recharge

Actions

N2. *Evaluate and consider the construction and operation of projects to recharge good-quality surplus water to the groundwater basin. Recharge water may include storm water, surface water, recycled water, or imported water and will be captured through existing pumping facilities. Recharge water would be selected to mutually benefit groundwater quantity and quality. It is not anticipated that additional facilities will be needed to extract stored water. Facilities are anticipated to be small in scale, rather than large spreading basins that are not cost-effective in the urbanized South Westside Basin.*

- Storage – Additional surface storage, while beneficial, is not anticipated in the area beyond small scale water harvesting and detention basins.
- Conservation – Conservation is a key part of water demand management in the South Westside Basin, exhibited by already low per-capita water use. CalWater and Millbrae are signatories to the MOU of the California Urban Water Conservation Council and participate in demand-side management measures. These agencies have committed to implementing best management practices to reduce water demand.

Actions

N3. *Agencies should work to build upon already successful conservation efforts by considering signing the MOU and participating in the California Urban Water Conservation Council, or implementing equivalent local efforts.*

N4. *Encourage installation of water-conserving systems such as dry wells and gray water systems where feasible, especially in new construction. Also encourage installation of rain gardens, cisterns, or infiltrators to capture rainwater from roofs for irrigation in the dry season and flood control during heavy storms.*

N5. *Support outreach programs to promote water conservation and widespread use of water saving technologies.*

N6. *Encourage continued outdoor irrigation water conservation.*

- Water recycling – Recycled water is available from Daly City's tertiary treatment plant. Other treatment plants could potentially provide recycled water in the future.

Actions

N7. *Evaluate and consider the expansion of existing recycled water programs, including efforts to utilize effluent from other treatment plants in the basin. Significant opportunities are available for usage of tertiary recycled water at the cemeteries, if appropriate funding mechanisms can be developed.*

- Extraction – Continued groundwater extraction will likely be necessary to meet future demand.

Actions

N8. *Perform groundwater modeling during the planning stages to ensure there are no significant impacts from new wells.*

5.6 COORDINATED PLANNING

5.6.1 DEVELOPMENT OF RELATIONSHIPS WITH STATE AND FEDERAL REGULATORY AGENCIES

Federal and state regulatory agencies to develop of relationships with include the following:

- Federal
  - EPA – contaminated sites
  - USGS – aquifer and watershed conditions, groundwater and surface water monitoring
- State
  - DPH – drinking water quality and vulnerability
  - DTSC – contaminated sites
  - DWR – aquifer conditions

- RWQCB – surface water quality and groundwater quality, permitting
- Water Board – groundwater monitoring (GAMA)

Actions

O1. *Coordinate with these federal and state agencies on issues related to monitoring and contaminated sites as well as on opportunities for grant funding.*

5.6.2 COORDINATION WITH IRWMP EFFORTS

As noted in Section 1, Introduction and Background, the Plan Area is part of the Bay Area IRWMP. Coordination during implementation of the GWMP with these IRWMP efforts is important to ensure that local efforts help meet regional goals and vice-versa.

Action

P1. *Ensure that at least one member of the Groundwater Task Force is actively involved in the coordination of both the IRWMP and the GWMP. This member will provide dialogue between the two efforts.*

5.6.3 REVIEW OF LAND USE PLANS AND COORDINATION WITH LAND USE PLANNING AGENCIES TO ASSESS ACTIVITIES THAT CREATE A REASONABLE RISK OF GROUNDWATER CONTAMINATION

As discussed in Section 5.4.2, Identification and Management of Wellhead Protection Areas and Recharge Areas, certain land uses and activities can potentially impact groundwater quality. Avoiding these uses in recharge areas and near wells is a better strategy than mitigation once the land uses are already in place.

Actions

Q1. *Coordinate between stakeholders and land use planning agencies to encourage protection of the groundwater resource by limiting activities that create an unreasonable risk to groundwater. Maps of well locations with soil properties will be provided to assist land use planning agencies in their decision process.*

Q2. *Monitor environmental impact reports and comment on such reports to ensure the water resources are protected.*

Q3. *Involve water agencies through water supply assessments as required under SB 610. The water supply assessment documents water supply sufficiency by identifying sources of water supply, quantifying water demands, evaluating drought impacts, and providing a comparison of water supply and demand.*

5.7 REPORTING AND UPDATING

Reporting on the status of the GWMP implementation is important for the fulfillment of the actions and projects listed in the plan. Updating the plan is important to reflect changing conditions and understanding of the basin.

Actions

R1. *Report on WH:0V implementation progress every 2 years; include details on monitoring activities, trigger status of BMOs, project implementation, and new or unresolved issues. Post reports and status tables or maps for BMOs on the Internet.*

R2. *Update the GWMP every 5 years, unless changes in conditions in the basin warrant updates on a different frequency. Updates will be limited to those sections that require updating. Notify the public of the update and develop the update with input from the public and the Groundwater Task Force.*

6 IMPLEMENTATION

6.1 GOVERNANCE

The current governance of the South Westside Basin is based on the individual interest model. Under the individual interest model, stakeholders govern and develop water resource projects individually. The individual interest model will be retained with representatives from each stakeholder eligible for participation in the Groundwater Task Force. Individual development of projects will be designed and implemented following the common goal, objectives, and elements described in this GWMP, and will be presented to the Task Force for informational and coordination purposes. Additionally, coordination between stakeholders will allow for easier implementation of projects spanning multiple jurisdictions or benefitting multiple jurisdictions. As a potential next step, the governance structure may be defined in a MOU, which may be developed and signed after the adoption of this GWMP. The primary feature of the governance of the South Westside Basin would be the South Westside Basin Groundwater Task Force (Groundwater Task Force), which would lead the implementation of this GWMP.

6.1.1 ROLES AND RESPONSIBILITIES

The Groundwater Task Force will

- Guide the implementation of the GWMP
    - Discuss and advance regional and local groundwater projects such as
        - Conjunctive use
        - Stormwater capture
        - Alternate supplies, such as recycled water
    - Coordinate on monitoring and CASGEM compliance
    - Coordinate on groundwater modeling and data management
    - Coordinate with larger regional efforts such as the Bay Area IRWMP
    - Coordinate on grant and loan opportunities
    - Develop reporting for GWMP implementation
- Share hydrogeological and operational information with others, such as
    - Groundwater levels
    - Groundwater quality
    - Well performance
- Provide a forum for public interaction on groundwater issues
- Provide a basis for future governance, if needed

6.1.2 MEMBERSHIP AND PARTICIPATION

Membership in the Groundwater Task Force is anticipated to include representatives from San Bruno, Daly City, California Water Service Company, and SFPUC as well as other major stakeholders, as follows in alphabetical order:

- Agricultural representative
- BAWSCA
- California Water Service Company
- Cemetery representative
- Town of Colma
- City of Daly City
- Environmental representative
- Golf Course representative
- Public representative
- Representative for cities not using groundwater (Millbrae and Burlingame)
- City of San Bruno
- San Francisco Public Utilities Commission
- San Mateo County

Changes to the composition of the Groundwater Task Force may be made with unanimous consent of the signatories to the potential MOU and a majority of all members attending the meeting.

Other entities are also encouraged to attend the meetings, including City of South San Francisco, RWQCB, United Airlines, and other interested groups or individuals. Participation by these groups in the meetings should be encouraged to allow for transfer of knowledge and a unified implementation of groundwater management.

6.1.3 ADMINISTRATION

A Groundwater Task Force administrator is needed to provide leadership to maintain progress and meet the implementation goals of the GWMP. The potential MOU may establish the initial administrator and a procedure to change the administrator from time-to-time. The administrator must have adopted this GWMP. Responsibilities of the administrator include:

- Scheduling regular meetings
- Providing agendas and minutes
- Monitoring or directing the monitoring of progress towards meeting implementation goals
- Developing or directing the development of annual reports
- Updating the GWMP as necessary

6.1.4 MEETINGS

Groundwater Task Force meetings would provide a forum for representatives from stakeholder groups to discuss and resolve regional groundwater issues. The meetings would be at least twice a year and open to the public.

The meetings would be intended to allow for the sharing of information as well as for the development of programs or projects needed to implement the GWMP. Information sharing may include changes to water supply infrastructure, new monitoring data, or new problems or opportunities. New programs and projects may be developed and implemented by individual stakeholders, by groups of stakeholders, or by all stakeholders. The ultimate project-making authority remains within the entity sponsoring the project.

6.1.5 VOTING

The representatives on the Groundwater Task Force would coordinate on matters relevant to groundwater management in the South Westside Basin, using the goal, objectives, and elements of this GWMP to guide their decisions. Some occasions may require a formal vote by the Groundwater Task Force, specifically for the following:

- Changing of the composition of the Groundwater Task Force
- Changes to the MOU

Decisions to change the composition of the group would require unanimous support among the signatories to the potential MOU and would require majority support among all members attending the meeting to move forward. Decisions of the group to change the MOU must be unanimous among the MOU signatories to move forward. Projects may move forward with the support of a subset of the group, but would do so outside of the auspices of the Groundwater Task Force.

6.1.6 POTENTIAL FUTURE GOVERNANCE

If deemed necessary by the Groundwater Task Force, a MOU may be signed to create a more formalized governance structure. It is not anticipated at this time that future needs would require a more structured management system through a JPA.

Advantages to the individual interest approach in this Plan and through the potential MOU include the following:

- Agencies can focus their resources on projects specific to their needs
- No loss of management control by local groundwater resources
- Ease of implementation because it is a continuation of the current approach to groundwater management in the region.

Moving to a mutual interest model based on a JPA could provide the following:

- Ease pursuing regional projects that would benefit the entire South Westside Basin
- Define who coordinates projects and what role each agency plays during regional project planning, construction, operation, and maintenance
- Generate economies of scale for large projects
- Increase likelihood of state funding for projects benefiting multiple entities
- Prevent individual stakeholders from undertaking actions not complementary to the BMOs.
- Improved framework for resolution of conflicts.

Any potential future need to develop a MOU or JPA would be discussed through the Groundwater Task Force.

6.2 DISPUTE RESOLUTION

Disputes relating to implementation of the GWMP will be resolved by the Groundwater Task Force. In the event that the Groundwater Task Force cannot resolve the dispute, an outside neutral third party will assist the parties in working towards a satisfactory resolution, with completion of all procedures within 60 to 90 days, unless the parties to the dispute agree to a longer timeframe. Costs incurred, if any, in this process will be equally shared by the involved parties.

6.3 FINANCING AND BUDGET

Financing of projects will be on a project-by-project basis and will be the responsibility of the sponsoring agency or group, unless other agreements are made. Financing for the reporting and updating of the GWMP will be shared among the GWMP participants, with details to be mutually agreed upon.

It is anticipated that SFPUC will, at their discretion, continue providing for the development of annual reports for the entire South Westside Basin, with support from the GWMP participants for data and review. Additional items not currently included in SFPUC's annual reports but required by this GWMP may require a funding agreement from the water agencies adopting and agreeing to this GWMP.

6.4 SCHEDULE

The following schedule highlights the key milestones for implementation of the Groundwater Management Plan.

Item	*Reference Section*	*Initial Completion*	*Recurrence*
Meet with stakeholders to define and consider adoption of a governance structure	***6.1***	***2 years***	***n/a***
Implement basinwide semiannual static groundwater level monitoring	***4.3.1, 5.2.1, App. C***	***1 year***	***n/a***
Add additional pressure transducers to existing groundwater level monitoring network	***5.2.1 App. C***	***2 year***	***n/a***
Implement a voluntary groundwater level monitoring program for private groundwater producers	***App. C***	***2 years***	***n/a***
Develop program to survey and destroy abandoned wells	***5.4.4***	***3 years***	***n/a***
Implement a voluntary groundwater production monitoring program for private groundwater producers	***App. C***	***3 years***	***n/a***
Identify recharge strategies to increase yield	***2.3.5, 5.3.1 5.3.2 5.3.3 5.4.1 5.4.2 5.5 5.6.3***	***2 years***	***As needed***
Update Groundwater Model	***4.3.1***	***1 years***	***1 year***
Complete subsidence analysis using InSAR	***4.3.4***	***5 years***	***As needed***
Continue public outreach and education	***5.1***	***2 years***	***Ongoing***
Report on GWMP	***5.7***	***2 years***	***1 year***
Update GWMP	***5.7***	***5 year***	***5 years***

7 REFERENCES

Alley, W. M., T. E. Reilly, and. O. E. Franke, 1999. *Sustainability of Groundwater Resources*. USGS Circular 1186, http://pubs.usgs.gov/circ/circ1186.

Bartell, M.J. 1914. *Field Examinations*. Prepared for M.M. O'Shaughnessy, City Engineer, City of San Francisco, Department of Public Works.

Bay Area Water Supply & Conservation Agency (BAWSCA). 2009. *BAWSCA Annual Survey FY 2007-08*. January.

Bay Area Water Supply & Conservation Agency (BAWSCA). 2011. Spreadsheets of Monthly/Seasonal SFPUC Purchases Among BAWSCA Members. January.

Bonilla, M.G.. 1998. *Preliminary geologic map of the San Francisco South 7.5' quadrangle and part of the Hunters Point 7.5' quadrangle, San Francisco Bay area, California: A digital database*. USGS Open-File Report 98-354

Brown and Caldwell. 2001. *Water System Master Plan Update*. July.

Brown and Caldwell. 2011. *City of Daly City 2010 Urban Water Management Plan*. June.

Burlingame, City of. 2009. *Waste Water Treatment Plant.* http://www.burlingame.org/Index.aspx?page=82. Accessed on July 13.

Burns & McDonnell and ERM-West. 2006. *Building 84 Feasibility Study/Remedial Action Plan, United Airlines San Francisco Maintenance Center, San Francisco International Airport*. May 15.

California Department of Public Health (DPH). 2010. *California Drinking Water Data. December 1.*

California Department of Public Health (DPH). 2009. *California Regulations Related to Drinking Water.* http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Lawbook/dwregulations-08-13-2009.pdf. Accessed on August 25.

California Department of Water Resources (DWR). 1975. *California's Ground Water.* Bulletin 118.

California Department of Water Resources (DWR). 1980. *Ground Water Basins in California.* Bulletin 118-80.

California Department of Water Resource (DWR). 1990. *California Well Standards*. Bulletin 74-90.

California Department of Water Resources (DWR). 2003. &DOLIRUQLDV*URXQGZDWHU Bulletin 118-03.

California Department of Water Resources (DWR). 2010. IWRIS: Integrated Water Resources Information System. http://app1.iwris.water.ca.gov/IWRIS. Accessed on February 4.

California Irrigation Management Information System (CIMIS). 2009. Climatic data http://www.cimis.water.ca.gov/cimis/monthlyEToReport.do. Accessed on March 23.

California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB). 1996. *San Francisco and Northern San Mateo County Beneficial Use Evaluation*. April.

California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB). 2007. *San Francisco Bay Region (Region 2) Water Quality Control Plan*. January.

California Water Service Company. 2011. *2010 Urban Water Management Plan South San Francisco District.* June.

Carollo. 2008. *Recycled Water Feasibility Study, Cities of South San Francisco, San Bruno, Brisbane in coordination with Cal Water and SFPUC.*

Carollo. 2009. *Recycled Water Facility Plan.*

Clifton, H.E., and Hunter, R.E., 1987, The Merced Formation and related beds; a mile-thick succession of late Cenozoic coastal and shelf deposits in the seacliffs of San Francisco, CA, in Hill, M.L., ed., Centennial field guide: Boulder, Colo., Geological Society of America, Cordilleran Section, v. 1, p. 257–262.

Clifton, H.E., and Hunter, R.E., 1991, Depositional and other features of the Merced Formation in sea cliff exposures south of San Francisco, CA, in Sloan, Doris, and Wagner, D.L., eds., 1991, Geologic excursions in northern California; San Francisco to the Sierra Nevada: California Division of Mines and Geology Special Publication 109, p. 35–44.

Daly City, City of. 2005. *2005 Urban Water Management Plan*. December.

Daly City, City of. 2009. *Recycling/Reusing Treatment Plant By-product*. http://www.dalycity.org/city_services/depts/wwr/waste_treatment.htm#5. Accessed on July 28.

EKI. 2005. *City of Burlingame Urban Water Management Plan*. November.

EKI. 2007. *City of San Bruno Urban Water Management Plan*. January.

EKI. 2011. *City of San Bruno Urban Water Management Plan*. June.

ERM. 2005. *Fourth Quarter 2004 Ground Water Monitoring Report United Airlines Building 84 FS/RAP San Francisco Maintenance Center.*

ESA. 2009. *Harding Park Recycled Water Project Draft EIR.*

Fio, J.L., and Leighton, D.A., 1995, *Geohydrologic framework, Historical Development of the ground-water system, and general hydrologic and water-quality conditions in 1990, south San Francisco Bay and Peninsula area, California*: U.S. Geologic Survey Open-File Report 94-357, 46 p.

Gillespie, K. and B. Gillespie. 2009. *An Overview of Daly City History*. http://www.dalycityhistory.org/overview.htm. Accessed on September 1.

Harden, D.R., 1998. *California Geology*.

Hensolt, W. H. and Brabb, E.E.. 1990. Maps showing elevation of bedrock and implications for design of engineered structures to withstand earthquake shaking in San Mateo County, California. Open-File Report 90-496. U. S. Geological Survey, Menlo Park, CA.

HydroFocus. 2003. Westside Basin Unified Groundwater Model. May 14.

HydroFocus. 2011. Westside Basin Groundwater-Flow Model: Updated Model and 2008 No-Project Simulation Results. May.

HydroMetrics. 2011. *Water Year 2011, Seawater Intrusion Analysis Report, Seaside Basin, Monterey County, California*. Prepared for Seaside Basin Watermaster. November.

Izbicki, J.A., Borchers, J.W., Leighton, D.A., Kulongoski, J, Fields, L., Galloway, D.L., and Michel, R.L. 2003. *Hydrogeology and Geochemistry of Aquifers Underlying the San Lorenzo and San Leandro Areas of the East Bay Plain, Alameda County, California:* U.S. Geological Survey Water-Resources Investigations Report 02–4259, 71 p.

Jones, B.F., A. Vengosh, E. Rosenthal, and Y. Yechieli. 1999. "Geochemical Investigations." *Seawater Intrusion in Coastal Aquifers: Concepts, Methods, and Practices*. Jacob Bear, Saul Sorek, Driss Ouazar, Eds.

Kennedy/Jenks. 2009. *Monitoring Well Installation Technical Memorandum South Westside Basin Conjunctive Use Project (CS 879C)*. April 9.

Kennedy/Jenks. 2010. *Phase 2 Monitoring Well Installation Technical Memorandum*.

Kirker, Chapman & Associates. 1972. *Daly City ground water investigation*. San Francisco, CA, 159 pp., 1972.

Land, M., Reichard, E.G., Crawford, S.M., Everett, R.R., Newhouse, M.W., and Williams, C.F. 2004. *Ground-Water Quality of Coastal Aquifer Systems in the West Coast Basin, Los*

Angeles County, California, 1999–2002: U.S. Geological Survey Scientific Investigations Report 2004–5067, 80 p.

Leake, S.A. 2004. *Land Subsidence from Ground-Water Pumping*. U.S. Geological Survey.

Lee, C.H. and M. Praszker. 1969. “Bay Mud Developments and Related Structural Foundations.” *Geologic and Engineering Aspects of San Francisco Bay Fill*. California Division of Mines and Geology Special Report 97.

Luhdorff & Scalmanini Consulting Engineers (LSCE). 2004. *Update on the Conceptualization of the Lake-Aquifer System Westside Ground-Water Basin San Francisco and San Mateo Counties.* April.

Luhdorff & Scalmanini Consulting Engineers (LSCE). 2005. *Results of In-Lieu Recharge Demonstration, Fall 2002 through Spring 2005, Westside Basin Conjunctive Use Pilot Project*. October 13.

Luhdorff & Scalmanini Consulting Engineers (LSCE). 2010. Final Task 8B. *Technical Memorandum No. 1, Hydrologic Setting of the Westside Basin.* May 5.

MWH. 2007. *Alternatives Analysis Report for San Francisco Public Utilities Commission Water System Improvement Project, Groundwater Conjunctive Use Project.* October.

Millbrae, City of. 2005. *City of Millbrae 2005 Urban Water Management Plan*. December.

Millbrae, City of. 2009a. *Water Pollution Control Plant*. http://www.ci.millbrae.ca.us/index.aspx?page=98. Accessed on September 1.

Millbrae, City of. 2009b. *Ground Breaking Ceremony for the Water Pollution Control Plant Renovation Project*. http://www.ci.millbrae.ca.us/index.aspx?page=24&recordid=116&returnURL=%2findex.aspx%3fpage%3d93. Accessed on October 9.

National Oceanic and Atmospheric Administration. 2011. NCDC Weather Station - San Francisco International Airport. Accessed online at http://hurricane.ncdc.noaa.gov/dly/DLY?randomnum=64485550W115507. Accessed on February 1.

Oakland Museum of California. 2011. Guide to San Francisco Bay Area Creeks. Accessed online at http://museumca.org/creeks/1590-RescColma.html# on February 9, 2011.

Phillips, S. P., Hamlin, S. N. and Yates, E.B.. 1993. *Geohydrology, water quality, and estimation of ground-water recharge in San Francisco, California*, 1987-92. Water- Resources Investigations Report 93-4019. U. S. Geological Survey, Sacramento, CA.

Poland, J. F., And Ireland, R. L., 1988, Land Subsidence in the Santa Clara Valley, California as of 1982, U. S. Geological Survey Professional Paper 497-F, 61 p.

RMC and Jones & Stokes. 2006. *Bay Area Integrated Regional Water Management Plan (IRWMP)*. November.

RMC. 2006. *Vista Grand Watershed Study*. Prepared for the City of Daly City and SFPUC.

California Regional Water Quality Control Board, San Francisco Bay Region [RWQCB]. 2010. *San Francisco Bay Basin Water Quality Control Plan*. December.

Rogge, Erdmann. 2003. *Dimensions of the Westside Groundwater Basin, San Francisco and San Mateo Counties, California*. MS Thesis, San Francisco State University. May.

San Francisco Public Utilities Commission (SFPUC). 2005. *Final Draft North Westside Basin Groundwater Basin Management Plan.* April.

San Francisco Public Utilities Commission (SFPUC). 2008. *Proposed Harding Park Recycled Water Project*. Spring.

San Francisco Public Utilities Commission (SFPUC). 2010a. *2009 Annual Groundwater Monitoring Report, Westside Basin, San Francisco and San Mateo Counties, California. May.*

San Francisco Public Utilities Commission (SFPUC). 2010b. *Annual Water Quality Report…*

San Francisco Public Utilities Commission (SFPUC). 2011. *2011 Annual Groundwater Monitoring Report, Westside Basin, San Francisco and San Mateo Counties, California.*

Sloan, D. 2006. *Geology of the San Francisco Bay Region*, California Natural History Guide Series No. 79, Berkeley, University of California Press, 318p.

South San Francisco. 2009. *General Plan*.

U.S. Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS). 1991. *Soil Survey of San Mateo County, Eastern Part, and San Francisco County, California*.

U.S. Environmental Protection Agency (EPA). 2009. *Drinking Water Contaminants*. http://www.epa.gov/safewater/contaminants/index.html Accessed on August 25.

Waltham, T. 2002. *Foundations of Engineering Geology*, 2nd Edition.

Western Regional Climate Center. 2011. Climatic data. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7769 Accessed on March 1.

Witter, R.C., Knudsen, K.L, Sowers, J.M., Wentworth, C.M., Koehler, R.D., Randolph, C.E., Brooks, S.K., and Gans, K.D. 2006. *Maps of Quaternary deposits and liquefaction susceptibility in the central San Francisco Bay region, California*: U.S. Geological Survey Open-File Report 2006-1037. (http://pubs.usgs.gov/of/2006/1037/).

WRIME. 2007. San Bruno Groundwater Monitoring Wells: Installation and Monitoring, An AB303 Project Report. April.

APPENDIX A – PUBLIC PROCESS

APPENDIX B – CONSUMER CONFIDENCE REPORTS

APPENDIX C – MONITORING PROTOCOLS

APPENDIX D – BASIN MANAGEMENT OBJECTIVE HYDROGRAPHS

APPENDIX E – SEAWATER INTRUSION INDICATORS

Policy 7.05

EFFECTIVE 27 NOV 12

SUPERSEDES 14 SEP 10

SUSTAINABILITY

IT IS THE POLICY OF THE EAST BAY MUNICIPAL UTILITY DISTRICT TO:

Provide reliable, high-quality drinking water and wastewater service through sustainable operations, maintenance, planning, design, and construction activities that avoid, minimize or mitigate adverse effects to the economy, environment, employees, and the public.

Objective

The District will strive to balance environmental, social, and economic objectives into its decision-making, policies, programs, and work practices.
In doing so, the District will:

- promote an environmental stewardship ethic in its staff and among other drinking water and wastewater treatment agencies;
- adhere to principles of sustainability and environmental justice;
- comply with environmental laws and regulations;
- look for opportunities for continuous improvement of environmental performance including pollution prevention and resource conservation;
- promote the purchase and use of recycled and recyclable products;
- move towards zero waste and seek ways to recycle materials that cannot be used in its operations and activities;
- establish a framework for setting and reviewing environmental objectives; and
- foster communication with employees, contractors, other water and wastewater agencies, regulators, cities and counties, and the public about the environmental significance of the District's current and future operations and activities.

Sustainability

Sustainability means using resources (economic, environmental, and human) in a responsible manner to meet the needs of today without compromising the ability of future generations to meet the needs of tomorrow. This approach applies a holistic view and strives to minimize waste; conserve water, energy, and natural resources; promote long-term economic viability; support safety and well-being for employees, communities, and customers; and be beneficial to society.

Responsibilities

To promote environmental stewardship and facilitate compliance with laws and regulations, the District will conduct compliance audits, administer staff training, and assist in the development and implementation of management and operational practices that support environmental, social, and economic considerations and ensure compliance. The District will maintain strong working relationships with local regulatory agencies, industry and public interest organizations, including exchanging information on District plans and procedures that support the development of sustainable environmental guidelines for the water and wastewater industry at large.

To advance environmental leadership and awareness, the District will participate in water and wastewater organizations and associations, and work cooperatively with and solicit input from employees, the environmental community, and the public on District operations and activities.

To promote the use of recycled and recyclable products, the District has a preference for purchasing materials that include recycled and/or recyclable content without compromising the product's fitness, quality, price, and availability.

The District will establish a framework for setting, reviewing, and reporting on long-term sustainability performance objectives and outcomes. Staff will periodically report to the Board of Directors, management, and staff on the status of the District's sustainability efforts which include regulatory compliance, environmental impacts, resource use, stewardship activities, waste reduction, etc.

Environmental Justice

The District will accord the highest respect and value to every individual and community, by developing and conducting business in a manner that promotes equity and affords fair treatment, accessibility, and protection for all people, regardless of race, age, culture, income, or geographic location.

Authority

Resolution No. 32881-94, September 13, 1994
Amended by Board Resolution No. 33120-98, September 22, 1998
Amended by Board Resolution No. 33684-08, September 10, 2008
Amended by Board Resolution No. 33780-10, September 14, 2010
Amended by Board Resolution No. 33904-12, November 27, 2012

Reference

Policy 3.02 - California Environmental Quality Act Implementation
Policy 4.12 – Purchasing and Materials Management
Policy 7.07 – Renewable Energy
Policy 7.09 – Workplace Safety and Health
Policy 9.05 – Non-Potable Water
Policy 8.02 – Biosolids Management
Policy 9.04 – Watershed Management and Use
Policy 9.06 – Bay/Delta Protection
Procedure 900 – Water Supply Accounting and Reporting

MARIN MUNICIPAL WATER DISTRICT

BOARD POLICY

NO.: 49

DATE: **MAY 3, 2012**

SUBJECT: **Multi-Benefits/Integrated Water Management Projects Policy**

POLICY STATEMENT

It is the policy of the Marin Municipal Water District to achieve multiple benefits in the planning and implementation of its water management projects, where appropriate, and to coordinate these projects with other agencies, to realize the maximum number of benefits from a project. It is the intent of this policy to encourage collaboration within and among MMWD and other agencies to conduct integrated water management planning and achieve multiple benefits on water management projects that provide appropriate opportunities. These may be water supply, stormwater management, flood control, public access, recreation, watershed resource management, and/or waste water management projects, where more than one benefit may be achieved.

BACKGROUND

The Marin Municipal Water District is a member agency of the North Bay Watershed Association (NBWA). The NBWA is a collaboration of City, County and public utility agencies and non-governmental organizations in Marin, Sonoma, and Napa Counties. All of the NBWA member agencies develop and implement projects to fulfill their respective duties.

Population growth, environmental constraints, climate change, integrated land use planning, funding mechanisms, and other forces are driving a fundamental change in water management. State and Federal agencies are tying substantial water management funding to the development of Integrated Regional Water Management Plans (IRWMPs), such as State bond propositions 50 & 84 and other sources. These programs emphasize and give priority to integrated, multi-benefit projects and strategies. The NBWA member agencies encourage informal collaboration for future integrated, multi-benefit projects.

DESCRIPTION OF MULTI-BENEFIT/INTEGRATED PROJECTS

An integrated or multi-benefit project is one that is planned, designed, implemented, and maintained with the intended purpose of providing two or more benefits or of meeting two or more objectives. There is no limit on the number of combined benefits that a project can have, but it must have at least two intended benefits to be considered an integrated or multi-benefit project. The benefits from the project must also be intended and purposely planned into the project goals and objectives; they should not simply be mitigations for impacts from a single-purpose project. However, at the same time, incorporating project elements that add benefits can effectively minimize the potential impacts from other project elements.

GOALS AND OBJECTIVES OF THE POLICY

One of the goals of this policy is for water management projects within the MMWD sphere of influence and NBWA region to be eligible and competitive for State and Federal grant programs that fund integrated, multi-benefit projects. These programs prioritize integrated multiple benefit projects that:

- protect communities from drought; improve water supply reliability and security;
- support water conservation and water use efficiency;
- protect and improve water quality;
- improve storm water capture, storage, and treatment;
- remove invasive plant species;
- create and enhance wetland habitats;
- acquire and protect open space and watershed lands;
- improve recreation and access to public lands;
- reduce and control non-point source pollution;
- implement groundwater recharge, desalinization, reclamation, and other supply, treatment, and conveyance technologies;
- encourage water banking and water exchange;
- provide multipurpose flood control that protects property and protects or improves wildlife habitat;
- restore and protect fisheries and ecosystem functions;
- include watershed management planning and implementation; and
- develop new drinking water treatment and distribution methods.

The legislation and guidelines for these State and Federal grant programs stipulate that projects must be planned and implemented through an integrated approach in order to be eligible for funding. By coordinating projects with other agencies, multiple partnerships can be built around a project and conflicts with other projects and benefits can be avoided. This can reduce costs for the agency and may help minimize environmental impacts. Multi-benefit projects can achieve long-term goals in a single project, rather than over a series of projects. They can effectively resolve significant water-related conflicts within a region. It is most often in the public interest to develop integrated, multi-benefit projects.

IMPLEMENTING THE POLICY

The approach to implementing multi-benefit/integrated projects will be incorporated into all phases of a project, beginning with project conception and carried through the planning, permitting, design, construction, and monitoring phases.

It is recognized that some projects, particularly maintenance of existing facilities, may not readily lend themselves to being able to have multiple benefits. However, this is not to exclude those projects from being considered to be multi-benefit projects. Multiple benefits should be considered and pursued in all appropriate instances, where more than one benefit might feasibly be achieved.

It is also recognized that providing multiple objectives can add complexity and, in some instances, significantly increase the cost of a project. However, the cost-benefit analysis may still be acceptable when considering benefits of a project over a long time period. Therefore, cost-benefit analysis for a multi-benefit project will take a broad view of benefits over time and will consider the time period appropriate to all benefits that could be achieved. Also, the cost-benefit analysis will consider the costs that would be incurred by comparing the multi-benefit project with sum of the costs of several single-benefit projects that might be achieved individually. All possible benefits will be quantified in any cost-benefit analysis of a project.

Coordination and communication about multiple benefits, amongst staff and between agencies, is necessary through all phases of the project. When a project is first developed, agencies will investigate where partnerships can help achieve a multi-benefit project. In some cases, informal collaboration may be sufficient for an integrated, multi-benefit project to be developed. In other cases, a more formal agreement between agencies may be necessary.

Project planning will begin with a project team meeting to brainstorm and discuss potential multi-benefits of the project and to determine the feasible benefits to be included in the plan. The project team will consist of engineers, planners, and biologists/natural resource managers, or some comparable multidisciplinary group of personnel within the agency. The team meeting will include a discussion of the scope and timeline of a project and the time period in which benefits from a project can be realized to help evaluate costs and benefits.

Staff training will be encouraged to foster communication and build expertise in the multi-benefit project approach. The training can focus on the approaches for determining, describing, prioritizing, and implementing projects that include multiple benefits. The training will help to solidify an institutional process for developing and implementing multi-benefit projects.

NORTH MARIN WATER DISTRICT

POLICY: Integrated / Multi-Benefit Water Resource Projects

POLICY NUMBER: 44 Effective Date: 11/4/2008

Background:

The North Bay Watershed Association (NBWA) is a group of 15 regional and local public agencies (including North Marin Water District) located throughout Marin, Sonoma and Napa counties.

The NBWA was created to help regulated local and regional public agencies work cooperatively on water resources issues that impact areas beyond traditional boundaries in order to promote stewardship of the North Bay watershed. Agencies participate in the NBWA in order to discuss issues of common interest, explore ways to work collaboratively on water resources projects of regional concern and share information about projects, regulations and technical issues. NBWA has endorsed and encouraged member agencies to adopt a policy on Integrated / Multi-Benefit Water Resource Projects.

Policy:

It is the intent of North Marin Water District to plan and implement water resource projects to have multiple benefits where reasonably feasible and to coordinate said projects with other agencies (including NBWA members) to achieve greater benefit in the affected watersheds when possible.

Guidance Document for Salt and Nutrient Management Plans

San Francisco Bay Region

Prepared by: Sonoma Valley County Sanitation District

August 2013

Table of Contents

This Guidance Document was developed as a result of the Sonoma Valley Salt and Nutrient Management Plan (SNMP) preparation effort. Sonoma Valley County Sanitation District, along with the Zone 7 Water Agency and Santa Clara Valley Water District are developing SNMPs in three priority groundwater basins (as identified by the Regional Water Board) for the San Francisco Bay Region. The Sonoma Valley SNMP received funding through the Proposition 84 Planning Grant for SNMP preparation and development of a guidance document to assist other Bay Area agencies wanting to undergo a similar process in developing their SNMPs.

The California state-wide Recycled Water Policy, adopted by the State Water Resources Control Board in 2009, indicates that Salt and Nutrient Management Plans (SNMPs) are to be developed for groundwater basins in California, to address the potential for increased salt and nutrient loading from increased recycled water use and other sources. It is anticipated that SNMPs will contain the following components to be responsive to both the Recycled Water Policy requirements and the Basin Planning Amendment process undertaken by the Regional Water Board:

- General groundwater basin information and characteristics
- Beneficial use designation
- Goals for water recycling and stormwater recharge/use (as applicable);
- Salt and nutrient source identification;
- Water quality objectives (both narrative and numeric)
- Salt and nutrient source loading and assimilative capacity estimates;
- Implementation measures and management strategies;
- Antidegradation analysis, as needed;
- Development of a basin-wide monitoring plan; and
- A provision for monitoring Constituents of Emerging Concern (CECs) in recycled water used for groundwater recharge reuse.
- A statement regarding Plan limitations

The purpose of this document is to describe the common steps that may be undertaken by Bay Area groups in preparing an SNMP. The San Francisco Bay Regional Water Quality Control Board (Regional Water Board) is expected to consider the size, complexity, level of activity, and site-specific factors within a basin in reviewing the level of detail and the specific tasks required for each SNMP. It may be appropriate to meet with Regional Water Board staff early in the process of developing an SNMP, to ensure common expectations before resources are expended.

Step 1 Initial Basin Characterization

Task 1.1 Identify the Basin and Delineate the Study Area

- Delineate the study area for salt and nutrient management planning.

- Identify the areal extent of the groundwater basin, including if known, the watershed area tributary to the aquifer, known source loads or impacts within the watershed, the location of existing or proposed recycled water use areas, and/or jurisdictional boundaries.
    - In developing SNMPs, it is recognized that the SNMP may wish to address study areas using a sub-basin approach.
    - SNMPs interested in focusing on groundwater supply development may define the study area to encompass anticipated project sites other than recycled water, or source control needs such as control of pollutants from a dairy operation.

Task 1.2 Identify Stakeholders

- Develop a preliminary list of stakeholders (including potential interest, contact person, and contact information). Key stakeholders include local agencies involved in groundwater management, owners and operators of recharge facilities, water purveyors, water districts, wastewater agencies, known salt and nutrient contributing dischargers, and the general public.
- Perform outreach and obtain stakeholder feedback for planning process (now or near future).

Task 1.3 Establish Communication with the Regional Water Board

- Identify a point of contact at the Regional Water Board with whom to coordinate the preparation of your SNMP.

Task 1.4 Identify Beneficial Uses and Water Quality Objectives

- Identify designated beneficial uses of the groundwater basin (see 2011 Basin Plan, Table 2-2).
- Identify water quality objectives for groundwater basin (see 2011 Basin Plan, starting on page 2-8).

Task 1.5 Identify, Collect, and Review Existing Groundwater Studies and Data

- Collect and review readily available and applicable regional groundwater and salt/nutrient management studies and data. Studies with data on groundwater quality, use, supply development, and salt and nutrient loading may be useful. The types of studies and data that may be useful include the following:
    - Planning documents, including Urban Water Management Plans (UWMPs) and Groundwater Management Plans
    - Groundwater supply, storage, or conjunctive use studies;
    - Groundwater aquifer hydrogeologic investigations;
    - Groundwater quality studies or groundwater protection studies;
    - Groundwater models
    - Recycled water compliance, assimilative capacity, and Basin Plan studies;

- Pollutant modeling and transport studies;
- Watershed studies; and
- Source assessment evaluations.

- Collect and review readily available and applicable well data and information, as follows:
  - Existing and planned municipal supply wells or projects within the basin.
  - Private groundwater wells or private well areas within the basin.
- Contact organizations engaged in ongoing groundwater monitoring to determine if the collected data can be made available for use in the SNMP.

Task 1.6 Perform Initial Groundwater Quality Characterization

- Review prior reference studies and data (collected as part of Task 1.5) and assess the reliability and specificity of the groundwater quality data, depth-to-water data, and estimates for hydrogeologic parameters, as applicable.

Potential Off-Ramp #1

Evaluate the potential feasibility of water uses for beneficial use consistent with land use within the region. If groundwater is not considered suitable for use as a municipal or domestic water supply by meeting an exception listed in State Board Resolution No. 88-63 - *The Sources of Drinking Water Policy*, then at a minimum, Best Management Practices can be documented along with the basin characterization and comprise the SNMP in lieu of the standard required elements listed in the Recycled Water Policy. Depending on stakeholder input, other elements, such as a simplified groundwater monitoring plan could also be included. If groundwater is used as a public water supply in the basin, proceed to next bullet.

- Identify the parameters of interest for the plan which should include salts and nutrients but could include other parameters of interest that adversely affect groundwater quality. These parameters should be based on collected groundwater quality information and stakeholder input.
- Identify whether readily available data and information is sufficient to complete a baseline analysis to determine if the groundwater basin is currently meeting water quality objectives. If not, develop a plan for collecting data, collect the data, and then return to next step.
- If data are sufficient, review data to determine whether (1) water quality objectives are being exceeded, and (2) any trends that show an increase in salt or nutrient management concentrations.
- Select and justify preliminary planning horizon to look into the future (such as 20 years – similar to a UWMP planning horizon), depending on expected changes in the future such

as growth, land use changes, water supply changes and increases in recycled water application.

- Evaluate historical trends and anticipated projects that would contribute salt or nutrients to the groundwater, and estimate whether an exceedance of water quality objectives is anticipated within the planning horizon (document the evaluation and results).

Potential Off-Ramp #2

If there is a sound basis that water quality objectives will not be exceeded, this basin is a No Threat basin. Document the basin characterization, evaluation and results, including Best Management Practices. This documentation will comprise the SNMP unless stakeholders determine collaboratively that other elements suggested by the Recycled Water Policy (i.e. a groundwater monitoring plan) should be included. If it is estimated that water quality objectives would be exceeded, or if there is uncertainty regarding whether water quality objectives would be exceeded, proceed to next section (Step 2).

Step 2 Recycled Water and Recharge Water

Task 2.1 Identify Recycled Water and Recharge Water/Use Quantities

- Collect available data and information about current and predicted recycled water and recharge water (including stormwater or imported water)/use. Urban Water Management Plans (UWMPs) can be used as an initial data source. Recycled water producers will also have information about recycled water and potential plans for future expanded use.

Task 2.2 Identify Recycled Water and Recharge Water Goals

- Identify the goals of the recycled water studies, and stormwater and other recharge water studies related to the basin. Goals should be consistent with the goals within the Recycled Water Policy to increase recycled water use and stormwater recharge. Gather data about the future quantitative goals for these projects.

Step 3 Comprehensive Review of Salt and Nutrient Sources

Task 3.1 Evaluate Sources within the Basin

- Identify general land uses within the basin.
- Identify known sources of salt/nutrient loads within the basin, to supplement work from Task 1.4. Sources may include:
    - Applied Water (groundwater)

- Applied Water (surface water)
- Recycled Water Application
- Artificial Recharge of Stormwater Runoff
- Artificial Recharge with Imported Water Supplies
- Atmospheric Deposition
- Biosolids Application
- Commercial, Industrial, and Institutional Facilities
- Creek Recharge
- Agriculture, including applied fertilizer and soil amendments
- Dairy Operations
- Mines
- Natural Geologic Sources
- Natural Soil Conditions
- Point Source Wastewater Discharges
- Rainfall
- Seawater Intrusion
- Septic Tank Discharges
- Storage Ponds
- Streamflow Infiltration
- Subsurface Inflow (including upstream inflow and seawater intrusion)
- Urban Runoff

- Identify the locations where source loads are impacting the basin.

Task 3.2 Quantify Basin Assimilative Capacity

- Using water quality data gathered under Task 1, establish the baseline water quality. Calculation of constituent concentrations can be performed with a spatial averaging approach.
- Compare these values to the Basin Plan water quality objectives, taking dilution into account if appropriate, to determine the assimilative capacity of the basin. The assimilative capacity is the difference between the water quality objectives and the existing water quality, taking into account dilution if appropriate. If the basin has either an existing or potential beneficial use of municipal and domestic supply (see 2011 Basin Plan, Table 2-2), compliance with the water quality objectives for municipal supply should be assessed (see Basin Plan, Table 3-5).

Task 3.3 Develop Source Load Assessment Tools

- Develop tools for assessing salt and nutrient loading, as well as fate and transport, of salts and nutrients. Examples of tools include geographical information system (GIS) relational models, groundwater flow/transport models (complex basins) or spreadsheet-based mass balance computations.

Task 3.4 Gather Fate and Transport Information

- Gather information about the fate and transport of salts and nutrients in the basin. Reviewing California's Groundwater Bulletin 118 can be a starting point for this process.
- Additional tasks that may be useful are as follows:

- On the basis of available hydrogeological, water quality, or geologic studies, determine fault lines, bedrock constrictions, or vertical stratification that may affect transport and groundwater quality.
- Identify known hydrogeologic parameters for the basin (e.g. hydraulic conductivity, storage coefficient, etc.) and the bases on which these parameters were estimated.
- Assess the geographic completeness of existing groundwater quality data, depth-to-water data, and hydrogeologic parameters and determine if any data gaps exist that prevent geographic, seasonal, or depth-dependent characterization of groundwater quality, occurrence or transport.
- Assess the geographic distribution of water quality concentrations for the salt/nutrient parameters of interest, and assess the depth-dependent distribution of water quality.

Step 4 Salt/Nutrient Loading and Implementation Measures

Task 4.1 Determine Planning Horizon

- Determine an appropriate planning horizon (the number of years to look into the future), and justify the selection. A longer timeframe may be useful, such as the one established in the region's UWMPs (e.g., 25 years), especially if the region expects limited growth. If the region expects significant land use changes or projects with expected impacts to salt and nutrient loadings (such as recharge projects with stormwater or recycled water), a shorter time frame (e.g., 10 years) is recommended.

Task 4.2 Estimate Future Salt/Nutrient Source Loads

- Prepare estimates for future recharge flow to the basin from surface and subsurface sources, discharge/withdrawal (flow) from the basin, and salt and nutrient loading from the sources identified in Task 3.1. Land use data may provide valuable information for estimating source loads.
- Building on the baseline calculations performed in Task 3.2, use the tool developed in Task 3.3 to compute predicted concentration estimates that are representative of the basin for the identified constituents of interest.

Task 4.3 Determine Future Water Quality

- Develop a mixing model on an annual time step for the selected planning horizon to mix the load concentrations developed within the basin. A spreadsheet model is typically adequate for the mixing analysis. Available data from other basin models (e.g. existing USGS or other models) such as hydrogeology characteristics (depth of mixing), water balance and water quality concentration information may be extracted and used within the mixing model. Comment on limitations and sensitivities within the mixing model (i.e. mixing depth, timing of future land use or land management changes, etc).
- Determine the degree to which the basin will be exceeding applicable water quality objectives for the identified salt and nutrient parameters within the planning horizon.

- Determine the impact of recycled water on the assimilative capacity of the basin.
- Assess the general level of effort for managing salts and nutrients in the basin. Consider the basin's characteristics and uses in this assessment.

Task 4.4 Identify Appropriate Implementation Measures and Management Strategies

- Identify the basin's existing implementation measures and strategies to manage salt and nutrient loading in the basin. If future water quality trends are flat, BPOs are not being exceeded or projected to be exceeded, and recycled water project utilize less than 10% assimilative capacity (or 20% for multiple projects); existing management measures may be sufficient for managing salts and nutrients within the basin.
- If salt and/or nutrient concentrations are increasing, additional implementation measures may be necessary. In a collaborative manner with Plan participants, develop (as applicable) a list of additional, appropriate implementation measures and management strategies (additional measures) to manage salt and nutrient loading in the basin on a sustainable basis. Examples of best management practices (BMPs) include:
    - Irrigation at agronomic rates
    - Configuration of irrigation and drainage facilities in land application fields to reasonably minimize runoff of applied animal waste
    - Fertilizer use workshops
    - Industrial discharge controls (local pretreatment limits, high strength surcharge for nutrients and/or salts)
    - Irrigation workshops
    - Land use policy modification
    - Recharge program adoption or modification (stormwater, recycled water, imported water)
    - Recycled water application limitations or quality guidelines
    - Septic system BMPs
    - Source load diversion/control

Task 4.5 Assess Load Reduction & Water Quality Improvement Associated with Additional Measures

- If additional measures are being considered, it may be of interest to evaluate the ability of the additional measures to achieve load reduction or groundwater quality improvement. Use the tool developed in Task 3.3 to assess the ranges of potential load reduction and water quality improvement effects associated with additional measures, if appropriate.
- Evaluate and compare the additional implementation measures and select the preferred measure(s) for implementation. It may be appropriate to consult among stakeholders to inform the process of making decisions about implementation measures.

Step 5 Antidegradation Analysis

- Conduct an antidegradation analysis to demonstrate that implementation measures, including identified projects, included within the SNMP will collectively comply with the requirements of Resolution No. 68-16.

Step 6 Basin/Sub-basin Wide Monitoring Plan

- Identify existing monitoring wells and select appropriately located wells to determine water quality throughout the most critical areas of the basin. Focus on water quality near water supply wells, but also consider wells near large water recycling projects and groundwater recharge projects. Consider a range of well depths to monitor shallow or deep zones, as appropriate.
- Propose additional (new) monitoring wells if appropriate.
- Determine appropriate salt and nutrient parameters and monitoring frequencies that are reasonable and cost-effective that may help determine whether the Basin Plan water quality objectives for salts and nutrients are being, or are threatening to be, exceeded. Monitoring data should be evaluated to understand the effectiveness of the BMPs developed as part of Task 4.4. Refer to the amended Recycled Water Policy (April 2013) for guidance on CEC monitoring requirements.
- Identify stakeholders responsible for maintaining, assessing, and storing the monitoring data.

Step 7 Plan Documents and Regional Water Board Coordination

- Compile analyses in a Plan document.
- Coordinate with the Regional Water Board on next steps regarding Plan submittal and support of their Basin Plan Amendment and California Environmental Quality Act compliance process.

Appendix A - Existing and Future Groundwater Quality Technical Memorandum

Todd Engineers

Technical Memorandum

Sonoma Valley Salt and Nutrient Management Plan

Subject:	**Existing and Future Groundwater Quality**
Prepared For:	Marcus Trotta, SVCSD
Prepared by:	Sally McCraven and Edwin Lin, Todd Engineers
Reviewed by:	Christy Kennedy, RMC
Date:	8/22/13
Reference:	0047-008

Executive Summary

The Sonoma Valley Groundwater Subbasin is located in southern Sonoma County, California abutting San Pablo Bay. Due to an area of historical brackish groundwater located adjacent to San Pablo Bay, the Sonoma Valley Subbasin is divided into a Baylands Area (containing the historical brackish groundwater) and an Inland Area for assessment of groundwater quality. Sonoma Creek is the main surface water feature draining the valley. The Sonoma Valley relies on groundwater, imported surface water, and recycled water to meet domestic, agricultural and urban demands. Recycled water is used for agricultural irrigation in the southern part of the subbasin to offset groundwater pumping and mitigate the potential for saline water intrusion from the bay related to groundwater pumping depressions within the Inland Area. Increased use of recycled water is planned in the future.

The State Water Resources Control Board Recycled Water Policy encourages increased reliance on local water supplies such as recycled water and stormwater. Due to water quality concerns associated with recycled water, the Recycled Water Policy requires completion of a Salt and Nutrient Management Plan that assesses the water quality impacts of recycled water (and all other salt and nutrient sources) in terms of the use of the groundwater basin available assimilative capacity by recycled water projects. Total dissolved solids (TDS) and nitrate are the indicator salts and nutrients assessed for this study. Assimilative capacity is the difference between average TDS and nitrate concentrations in the subbasin and the respective basin plan objectives.

Generally, relatively low TDS and nitrate concentrations are observed throughout most of the Inland Area of the subbasin and water quality concentration trends over time are flat or stable. Average TDS and nitrate concentrations in the Inland Area are below basin plan objectives, and there is available assimilative capacity.

The use of the available assimilative capacity by recycled water projects in the subbasin for the future planning period through 2035 was estimated for this study. The Recycled Water Policy established an impacts evaluation criteria, such that a single recycled water project may use less than 10% of the available assimilative capacity (and multiple recycled water projects may use less than 20% of the available assimilative capacity) until such time as a Salt and Nutrient Management Plan is adopted. If these criteria are satisfied, the associated anti-degradation analysis would only need to document the projected future assimilative capacity use.

The analysis presented in this Technical Memorandum demonstrates that the recycled water irrigation projects planned for the Sonoma Valley Subbasin through 2035 use less than 10% of the available TDS and nitrate assimilative capacity.

1 Introduction

This Technical Memorandum (TM) was prepared by Todd Engineers on behalf of the stakeholders of Sonoma Valley, including the Sonoma Valley County Sanitation District (SVCSD), for the Sonoma Valley Salt and Nutrient Management Plan (SNMP). The key components of this TM include:

- Description of hydrogeologic conceptual model
- Characterization of the existing average salt and nutrient (S/N) groundwater quality
- Calculation of the existing available assimilative capacity for S/Ns
- Description of the baseline period (1997 to 2006) basin water and S/N balances and loading calibration
- Estimation of the water and S/N balances for the future planning period (2014 to 2035)
- Prediction of future S/N groundwater quality
- Calculation of the use of the available assimilative capacity by recycled water projects

2 Hydrogeologic Conceptual Model

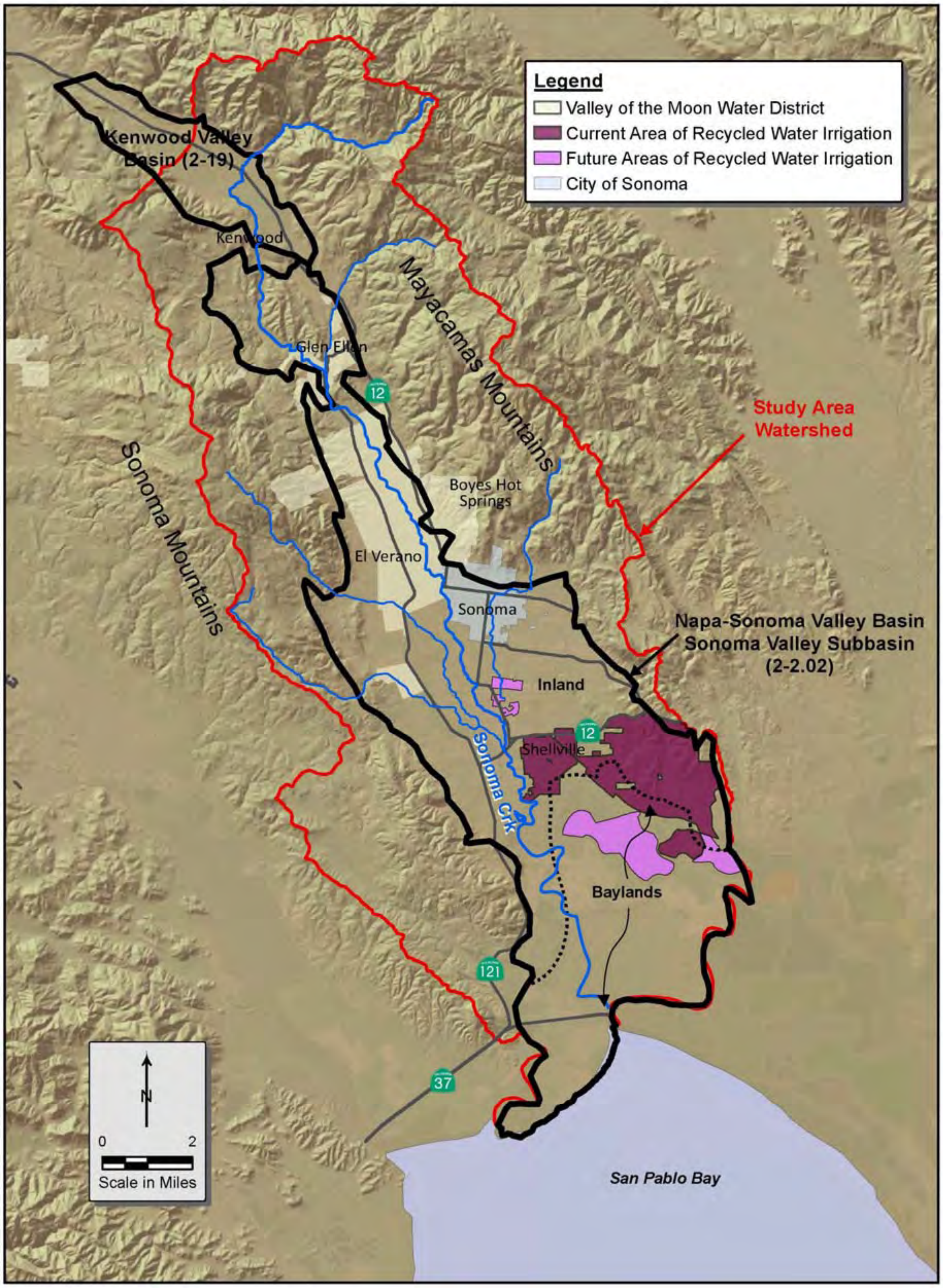
Much of the hydrogeologic conceptual model discussion below is based on data and analysis presented in the "Geohydrological Characterization, Water-Chemistry, and Ground-Water Flow Simulation Model of the Sonoma Valley Area, Sonoma County, California" prepared by the United States Geological Survey (USGS, 2006).

2.1 Study Area

Figure 2-1 shows the Sonoma Valley Subbasin (No. 2-2.02), or Study Area, as defined by the California Department of Water Resources (DWR), Bulletin 118-4 (DWR, 2003). The Sonoma Creek Watershed, which includes part of the Kenwood Valley Groundwater Basin located northwest of the Sonoma Valley Subbasin, is also shown on Figure 2-1 and encompasses an area of 166 square miles (106,680 acres). Due to an area of historical brackish groundwater located adjacent to and northwest of San Pablo Bay, the Sonoma Valley Subbasin is divided into a Baylands Area and an Inland Area as shown in Figure 2-1. The Baylands Area is defined for this study as the area beneath the tidal sloughs adjacent to San Pablo Bay generally containing groundwater with greater than 750 milligrams per liter (mg/L) total dissolved solids (TDS). The Sonoma Valley Subbasin, also referred to as Sonoma Valley, is located in southeastern Sonoma County. The Sonoma Valley is a northwest trending, elongated depression. Geologic units dipping toward the center of the valley are bounded on the southwest by the Sonoma Mountains and on the northeast by the Mayacamas Mountains (Figure 2-1). The uppermost part of the valley is relatively flat and stretches from Kenwood to near Glen Ellen. The middle part of the valley is narrower than the upper part and has a hilly topography. This portion is sometimes referred to as the Valley of the Moon and extends southward to near Boyes Hot Springs and includes the Glen Ellen area. The remainder of the valley slopes gently southward to San Pablo Bay, has flat topography, and extends to a maximum width of about 5 miles.

Sonoma Creek is the main surface water feature draining the valley. The creek originates in the Mayacamas Mountains in the northeastern area of the watershed. The creek flows into the Kenwood Valley Basin before flowing south into the Sonoma Valley Subbasin and ultimately discharging into San Pablo Bay. Other smaller tributary creeks flow into Sonoma Creek from the east and west.

Figure 2-1: Study Area



The watershed area comprises large tracks of native vegetation, as well as lands used for agriculture, primarily vineyards. Urban, residential, commercial, and industrial development constitutes a relatively small percentage of the watershed area and is primarily located in the valley areas. Sonoma is the largest city in the Study Area. Other cities and unincorporated areas in the valley include Kenwood, Glen Ellen, Boyes Hot Springs, El Verano, and Schellville (Figure 2-1).

2.2 Water Use

The Sonoma Valley relies on groundwater, imported surface water, and recycled water to meet domestic, agricultural and urban demands. Based on the USGS study (2006), more than half of the water demand in 2000 was met with groundwater (57%). The remaining demand was met with imported water (36%), recycled water (7%), and local surface water (<1%). The largest use of groundwater in the Sonoma Valley in 2000 was irrigation (72%), followed by rural domestic use (19%), and urban demand (9%). In 2000, total water use in the Sonoma Valley (including groundwater and imported surface water) was estimated at 14,018 acre-feet (AF), of which 48% was used for irrigation, 41% for urban use, and the remaining 11% for rural domestic use.

Groundwater serves approximately 25% of the Sonoma Valley population and is the primary source of drinking water supply for rural domestic and other unincorporated areas not being served by urban suppliers. Rural domestic demand is predominantly met by groundwater through privately owned and operated water wells. There are also mutual water companies in the Sonoma Valley that supply multiple households predominantly with groundwater although some companies also provide imported water. Agricultural water demands are largely met by groundwater supplies. It was estimated that as of 2000 the Sonoma Creek Watershed contained approximately 2,000 domestic, agricultural, and public supply wells (USGS, 2006).

Imported surface water represents the primary source of drinking water to meet urban demands, which serves approximately 75% of the Sonoma Valley population. These imported water supplies are sourced from the Russian River and are provided via aqueduct by the Sonoma County Water Agency (SCWA) to the Valley of the Moon Water District (VOMWD) and the City of Sonoma (City) who, in turn, provide water directly to their urban customers. The imported water is supplemented with local groundwater from the City and VOMWD public supply wells. The City and VOMWD boundaries are shown in Figure 2-1.

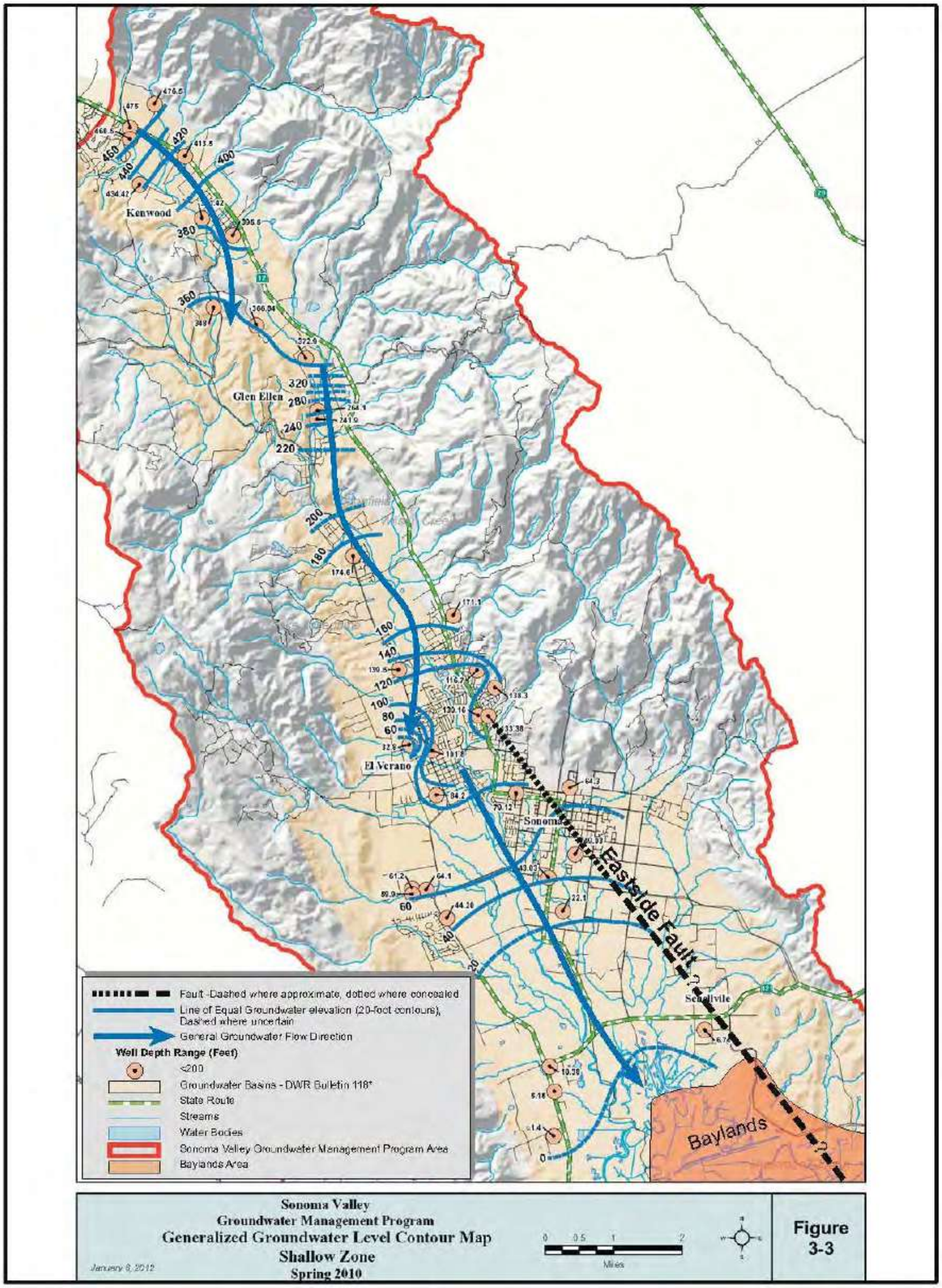
The SCWA manages and operates the wastewater treatment facility owned by the SVCSD. During dry weather months from May through October, the SVCSD provides 1,000 to 1,200 acre-feet per year (AFY) of recycled water for vineyards, dairies, and pasturelands in the southern part of Sonoma Valley. As of 2007, recycled water accounted for approximately 7% of the total estimated water use in Sonoma Valley (SCWA, December 2007). The current and future areas of recycled water use for irrigation are shown in Figure 2-1. Recycled water irrigation areas are located in southern Inland Area and northern Baylands Area.

2.3 Groundwater Levels and Flow

Groundwater levels in the Sonoma Valley are monitored and reported as part of the Sonoma Valley Groundwater Management Program (GMP) (SCWA, 2011). The majority of wells monitored in the program are voluntary private wells, with a smaller but significant number of publicly-owned water supply wells. As of 2010, there were a total of 141 wells in the water level monitoring program with monitoring conducted generally twice per year in the spring (April) and fall (October/November).

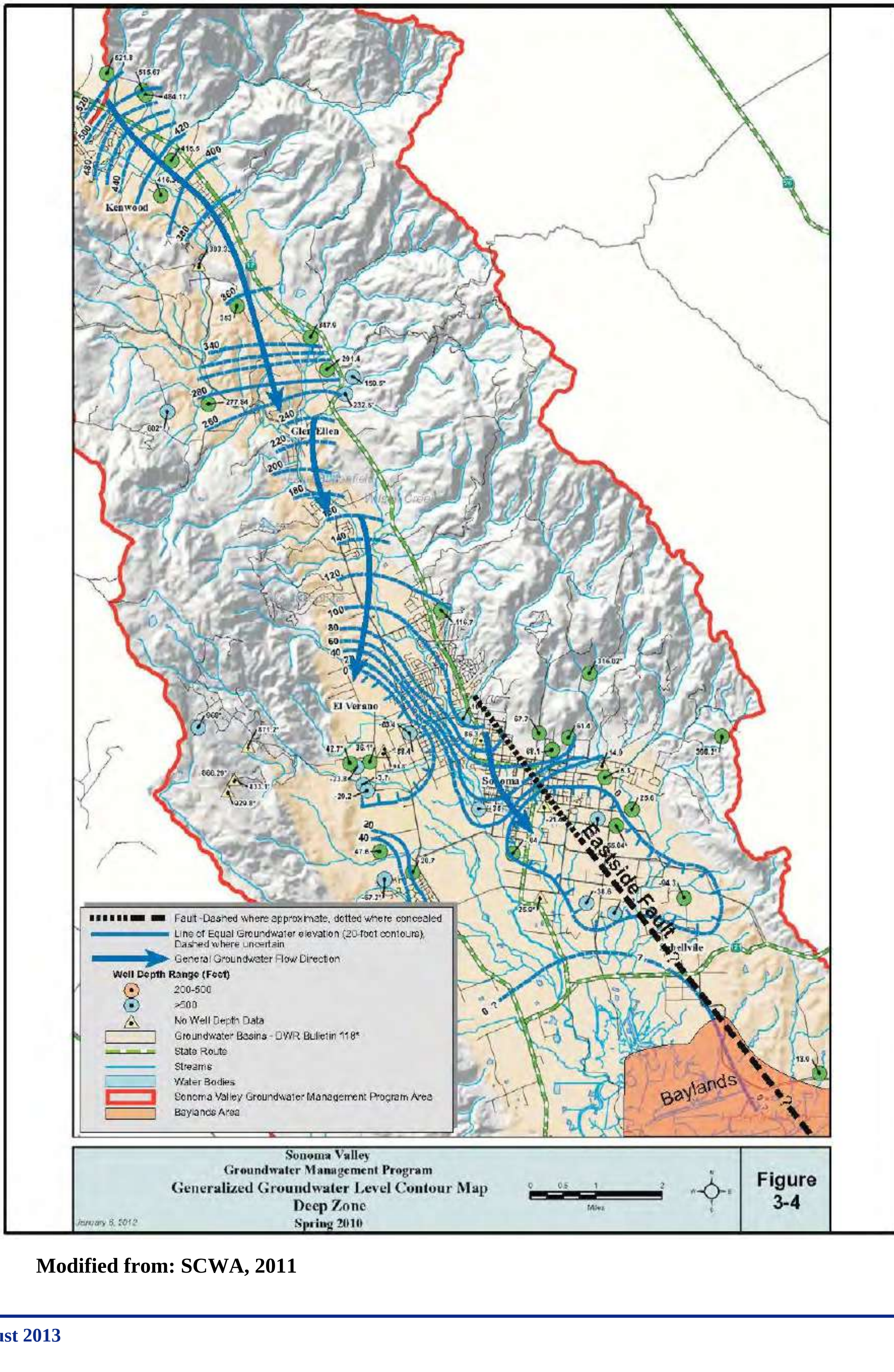
Groundwater elevation contour maps are prepared by the Agency for the shallow zone (less than 200-feet deep) and the deep zone (greater than 200-feet deep). Groundwater elevation contour maps for spring 2010 in the shallow and deep zones are shown in **Figures 2-2** and **2-3**, respectively. There is a

Figure 2-2: Generalized Groundwater Elevation Contour Map, Shallow Zone, Spring 2010



Modified from: SCWA, 2011

Figure 2-3: Generalized Groundwater Elevation Contour Map, Deep Zone, Spring 2010



Modified from: SCWA, 2011

groundwater divide within the Kenwood Valley Basin, with groundwater in the northern half of the Kenwood Basin flowing in a northwestward direction toward Santa Rosa and groundwater in the southern half of the Kenwood Basin flowing in a southeasterly direction toward the Sonoma Valley Subbasin in both the shallow and deep zones. In general, groundwater in the mountains surrounding the Sonoma Valley flows towards lower elevations and follows the dips of the geologic units toward the center of the valley.

Comparison of the shallow and deeper groundwater elevation contour maps indicates that groundwater elevations in the deep zone 1) are similar to groundwater elevations in the shallow zone in northern Sonoma Valley, and 2) are up to 100 feet lower than groundwater elevations in the shallow zone in southern Sonoma Valley, indicating a downward vertical gradient in southern Sonoma Valley.

Two groundwater pumping depressions are apparent in the deep zone groundwater elevation contour map (Figure 2-3) southeast of the City of Sonoma and in the El Verano area. Measured groundwater levels are as low as 94 feet below mean sea level (-94 feet msl) southeast of the City and 63 feet below sea level (-63 feet msl) in deep zone wells southwest of El Verano. There is only one groundwater elevation monitoring well between the pumping depression southeast of the City and the area of saline groundwater. Groundwater elevations in this area are uncertain as shown with the dashed and queried zero elevation contour line. As a result, the potential for the pumping depression to draw brackish groundwater further north into the subbasin is not well characterized. This potential brackish water intrusion is being addressed through replacement of pumped groundwater with recycled water for irrigation in and north of the Baylands Area. Continued monitoring and assessment of groundwater levels and groundwater quality will be conducted to assess inland movement of the brackish water. This monitoring and assessment will be included in the triennial SNMP report.

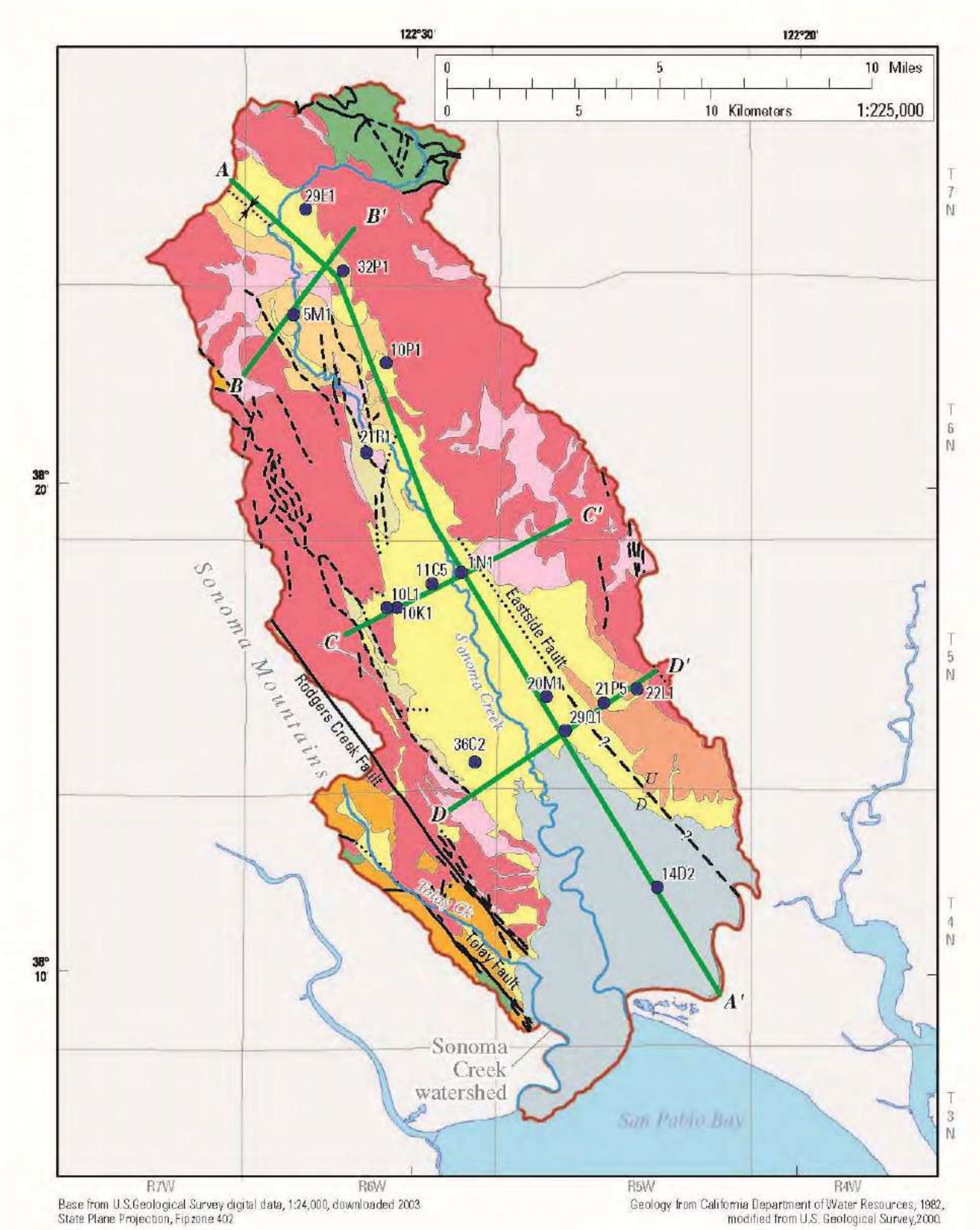
Faults can act barriers to groundwater flow. It has been proposed that the Eastside Fault shown on Figures 2-2 and 2-3 may restrict groundwater movement in the deep zone (USGS, 2006); however, no effects on groundwater levels are apparent in Figure 2-3.

2.3.1 Aquifer Parameters

The most important sources of groundwater in the Study Area are the Quaternary alluvial deposits, the Glen Ellen Formation, the Huichica Formation, and the Sonoma Volcanics. These geologic units are widely distributed and contain zones of high porosity and permeability. Where the units contain a large fraction of silt and clay sized materials, permeability is greatly reduced. The alluvial units, where sufficiently thick and saturated, are the highest yielding materials in the valley. Most wells, except those near the valley axis, that were drilled in the past few decades are screened in both the alluvial units and deeper formations and volcanics (USGS, 2006). Bay Mud deposits crop out over a large area between Schellville and San Pablo Bay and are underlain by the Huichica and Glen Ellen formations. The Bay Mud exhibits low permeability and contains brackish groundwater.

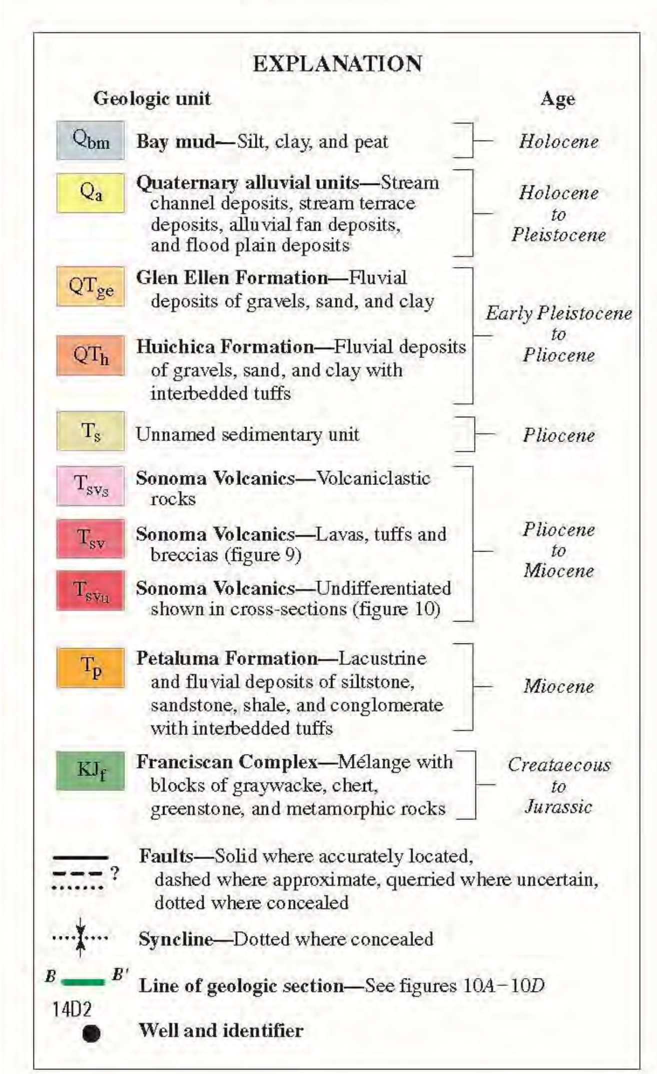
Figure 2-4 shows the surficial geology of the Sonoma Creek Watershed. **Figure 2-5** is a cross section along the axis of the valley, and **Figure 2-6** is a cross section perpendicular to the valley axis near the southern end of the subbasin (USGS, 2006). The cross sections show that alluvial deposits are at the surface in the northern two-thirds of the valley with Bay Muds at the surface in the southern portion of the valley near San Pablo Bay. In the northern two-thirds of the valley, alluvial deposits are underlain by the Glen Ellen Formation, which overlies the Huichica Formation, which overlies Sonoma Volcanics. In the southern portion of the valley, the Bay Muds are underlain by the Huichica Formation, which overlies the Sonoma Volcanics.

Figure 2-4a: Geology of Sonoma Creek Watershed



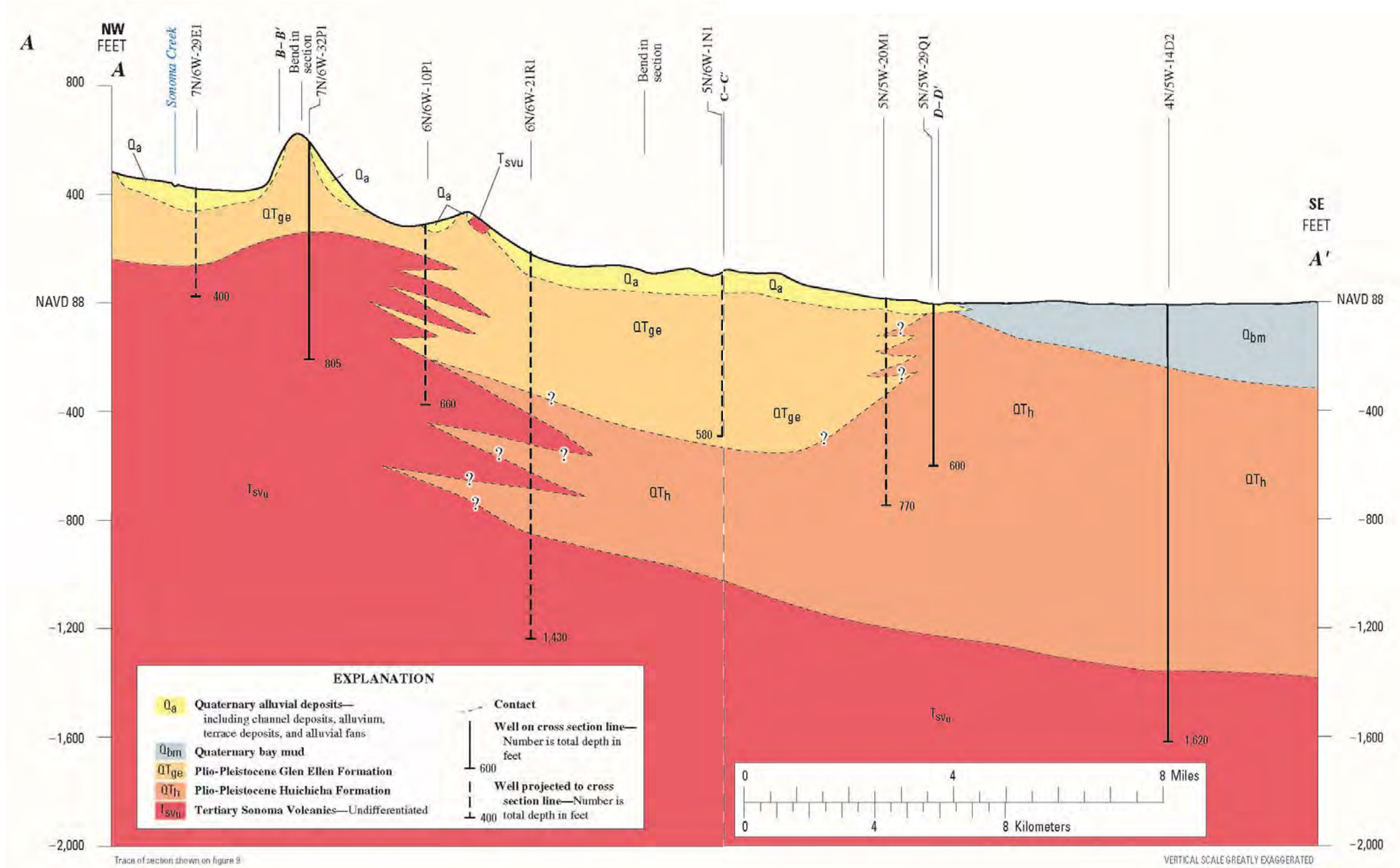
From: USGS, 2006

Figure 2-4b: Explanation for Geology of Sonoma Creek Watershed



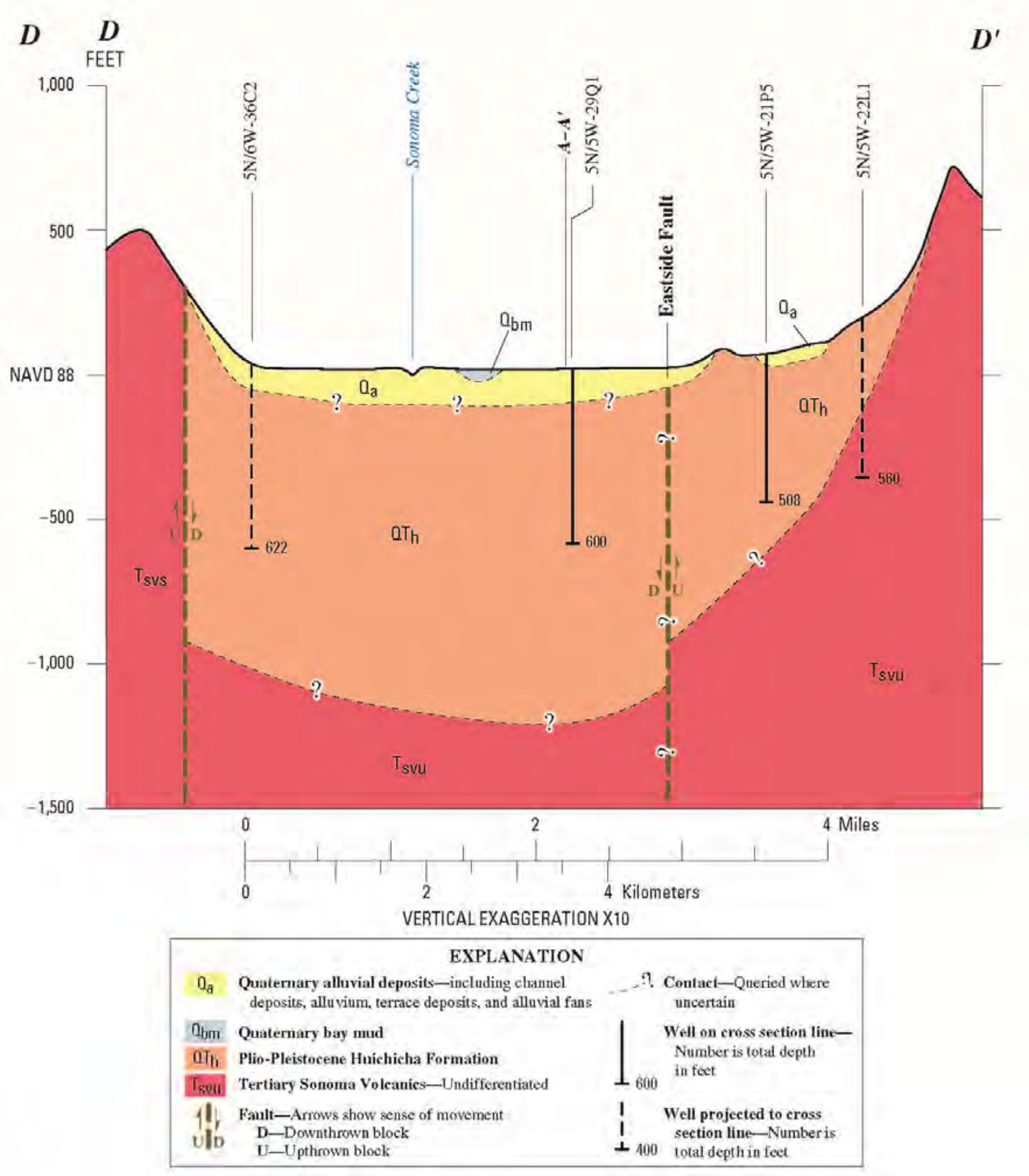
From: USGS, 2006

Figure 2-5: Cross Section A-A'



From: USGS, 2006

Figure 2-6: Cross Section D-D'



From: USGS, 2006

Groundwater in the Sonoma Valley Subbasin occurs under both confined and unconfined conditions. Generally unconfined conditions prevail at depths less than 200 feet below ground surface (ft-bgs). Groundwater is more commonly confined in deeper aquifers found in the Sonoma Volcanics and Huichica and Glen Ellen formations. An unconfined aquifer is saturated with water, and the surface of the water is at atmosphere pressure. The groundwater in a confined aquifer is under pressure. When a well penetrates a relatively impermeable layer (aquitard) that confines the aquifer, the water will rise above the confining layer in the well to the potentiometric (pressure) surface of the confined aquifer. In terms of fate and transport, unconfined aquifers are more vulnerable to releases at the land surface, while for deeper confined aquifers, the confining units provide some protection by limiting downward migration of contaminants. However, improperly constructed and abandoned wells can provide conduits for downward migration of contaminants into confined layers along improperly sealed well casings.

In most parts of the valley and watershed, groundwater is obtained from wells that are less than 700 feet deep.

2.3.2 Surface Water – Groundwater Interaction

Sonoma Valley is drained by Sonoma Creek, which discharges to San Pablo Bay. Seepage testing conducted by the USGS in 2003 showed Sonoma Creek to be a gaining (groundwater discharging to the creek) creek through most of the valley with the exception of a short reach in the northern part of the watershed where the creek enters the Kenwood Valley Basin from the Mayacamas Mountains crossing the alluvial fan between the mountain front and Highway 12 (USGS, 2006).

Based on an average annual rainfall of 29.8 inches per year from 1953 through 2000 measured at the City, the USGS estimated that the Sonoma Creek watershed receives on average 269,000 AFY of precipitation. The mean annual runoff of surface water outflowing from the valley into San Pablo Bay is estimated to be approximately 101,000 AF (USGS, 2006).

3 Existing Groundwater Quality

3.1 Indicator Parameters of Salts and Nutrients

Total dissolved solids (TDS) and nitrate are the indicator salts and nutrients selected for the Sonoma Valley SNMP. Total salinity is commonly expressed in terms of TDS in mg/L. TDS (and electrical conductivity data that can be converted to TDS) are available for source waters (both inflows and outflows) in the valley. While TDS can be an indicator of anthropogenic impacts such as infiltration of runoff, soil leaching, and land use, there is also a natural background TDS concentration in groundwater. The background TDS concentration in groundwater can vary considerably based on purity and crystal size of the formation minerals, rock texture and porosity, the regional structure, origin of sediments, the age of the groundwater, and many other factors (Hem, 1989).

Nitrate is a widespread contaminant in California groundwater. High levels of nitrate in groundwater are associated with agricultural activities, septic systems, confined animal facilities, landscape fertilization, and wastewater treatment facility discharges. Nitrate is the primary form of nitrogen detected in groundwater. Nitrate data are available for source waters (both inflows and outflows) in the valley. Natural nitrate levels in groundwater are generally very low, with concentrations typically less than 10 mg/L for nitrate as nitrate (nitrate-NO_3) or 2 to 3 mg/L for nitrate as nitrogen (nitrate-N). Nitrate is commonly reported as either nitrate nitrate-NO_3 or nitrate-N; and one can be converted to the other. Nitrate-N is the form of nitrate selected for assessment for this SNMP.

3.2 Water Quality Objectives

Water quality objectives provide a reference for assessing groundwater quality in the Sonoma Valley Groundwater Subbasin. The California Department of Public Health (DPH) has adopted a Secondary

Maximum Contaminant Level (SMCL) for TDS. SMCLs address aesthetic issues related to taste, odor, or appearance of the water and are not related to health effects, although elevated TDS concentrations in water can damage crops, affect plant growth, and damage municipal and industrial equipment. The recommended SMCL for TDS is 500 milligrams per liter (mg/L) with an upper limit of 1,000 mg/L. It has a short-term limit of 1,500 mg/L. The San Francisco Bay Regional Water Quality Control Board (Regional Water Board) has established a basin plan objective (BPO) of 500 mg/L for TDS for municipal and domestic supply in their Basin Plan (December 2010). They have also established a limit for livestock watering at 10,000 mg/L. The Regional Water Board has also established a BPO for EC at 900 micromhos per centimeter (mmhos/cm).

The primary Maximum Contaminant Level (MCL) for nitrate-NO_3 is 45 mg/L based on a health concern due to methemoglobinemia, or "blue baby syndrome," which affects infants, ruminant animals (such as cows and sheep) and infant monogastrics (such as baby pigs and chickens). Elevated levels may also be unhealthy for pregnant women (SWRCB, August 2010). The MCL for nitrate plus nitrite as nitrogen (as N) is 10 mg/L. The Regional Water Board has established the BPOs at the MCLs for these constituents. **Table 3-1** lists numeric BPOs for groundwater with municipal and domestic water supply and agricultural water supply beneficial uses in the San Francisco Bay Region.

Table 3-1: Basin Plan Objectives

Constituent	Units	Municipal Concentration	Agricultural Concentration
TDS	mg/L	500	10,000
EC	mmhos/cm	900	
Nitrate (as NO_3)	mg/L	45	
Nitrate + Nitrite (as N)	mg/L	10	

mg/L - milligrams per liter EC – electrical conductivity
mmhos/cm – micromhos per centimeter

3.3 TDS and Nitrate Fate and Transport

Salt and nutrient (S/N) fate and transport describes the way salts and nutrients move through an environment or media. In groundwater, it is determined by groundwater flow directions and rate, the characteristics of individual salts and nutrients, and the characteristics of the aquifer media. The S/N loading and unloading from the groundwater subbasin inflows and outflows are discussed below in Sections 4 and 5. Aquifer characteristics, groundwater flow directions and gradients, and surface water/groundwater interaction were discussed above in Section 2.

Water has the ability to naturally dissolve salts and nutrients along its journey in the hydrologic cycle. The types and quantity of salts and nutrients present determine whether the water is of suitable quality for its intended uses. Salts and nutrients present in natural water result from many different sources including atmospheric gases and aerosols, weathering and erosion of soil and rocks, and from dissolution of existing minerals below the ground surface. Additional changes in concentrations can result due to ion exchange, precipitation of minerals previously dissolved, and reactions resulting in conversion of some solutes from one form to another such as the conversion of nitrate to gaseous nitrogen. In addition to naturally occurring salts and nutrients, anthropogenic activities can add salts and nutrients.

TDS and nitrate are contained in the source water that recharges the Sonoma Valley. Addition of new water supply sources, either through intentional or unintentional recharge, can change the groundwater quality either for the worse by introducing contamination or for the better by diluting some existing contaminants in the aquifer. Another important influence on S/Ns in groundwater is unintentional recharge, which can occur, for example, when irrigation water exceeds evaporation and plant needs and infiltrates into the aquifer (i.e., irrigation return flow). Irrigation return flows can carry fertilizers high in nitrogen and soil amendments high in salts from the yard or field into the aquifer. Similarly, recycled water used for irrigation also introduces salts and nutrients.

TDS is considered conservative in that it does not readily attenuate in the environment. In contrast, processes that affect the fate and transport of nitrogen compounds are complex, with transformation, attenuation, uptake, and leaching in various environments. Nitrate is the primary form of nitrogen detected in groundwater. It is soluble in water and can easily pass through soil to the groundwater table.

3.4 Monitoring Programs

Groundwater quality in the Study Area has historically been monitored under different monitoring programs including:

- California Department of Water Resources (DWR) Monitoring
- California DPH Required Monitoring
- Sonoma Valley Groundwater Management Program Monitoring
- USGS Special Studies

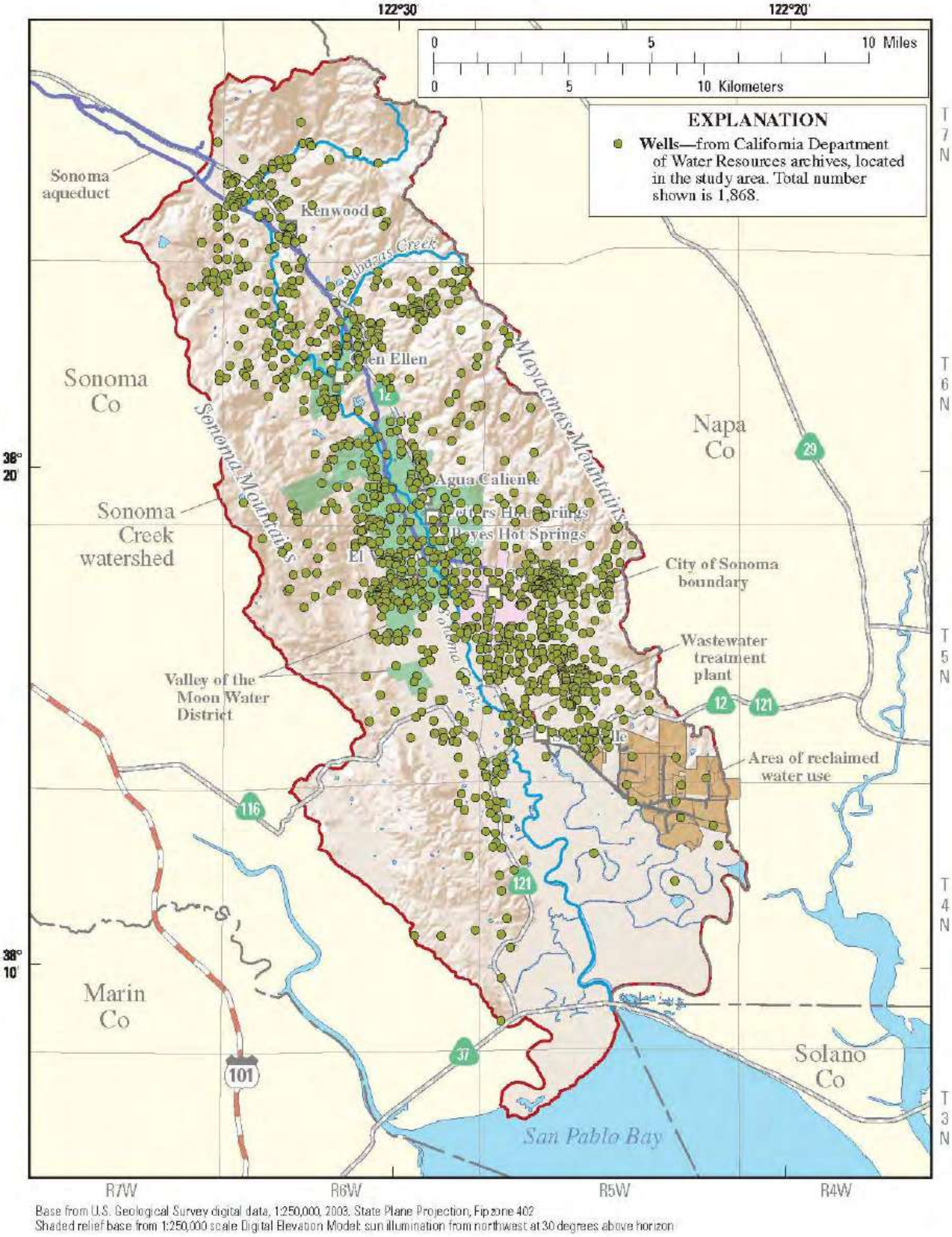
These monitoring programs are described in more detail in the SNMP Monitoring Program TM. All available groundwater quality data have been compiled by the Agency. All available TDS, EC, and nitrate data were used to evaluate S/N groundwater quality in the Sonoma Valley Subbasin for this SNMP.

3.5 Analysis Methodologies

3.5.1 Lateral and Vertical Discretization

Initially, the available groundwater quality data and well completion information were assessed to determine if the subbasin groundwater quality characterization could be divided into subareas and layers to assess differences in groundwater quality laterally and vertically. Unfortunately, well completion information for many of the monitored wells is unavailable, and the available data are considered insufficient to differentiate groundwater quality in the shallow and deep zones. The Baylands Area shown in Figure 2-1 is defined as the area with median TDS concentrations greater than 750 mg/L. This general area was recognized by Kunkel and Upson (1960) and the USGS (2006) as an area of historical saline groundwater. Due to the elevated salt in this area, groundwater pumping is limited, and the area is unlikely to be developed for groundwater supply in the future. Accordingly, this area is considered separately from the remainder of the subbasin referred to as the Inland Area. **Figure 3-1** shows that there were a limited number of wells in the Baylands Area based on DWR well logs acquired for the USGS study (2006). Many of the wells in the Baylands Area have been destroyed and agricultural land use in the area is limited to non-irrigated crops such as hay. Available monitoring data do not indicate clear differences between groundwater quality in the northern and southern portion of the Inland Area. Therefore average groundwater quality in the subbasin is characterized for the Inland Area, the Baylands Area, and the combined Inland and Baylands areas as one aquifer. This approach was presented and approved by the Regional Water Board at the January 2013 project meeting (RMC, January 2013).

Figure 3-1: Wells in Study Area



Base from U.S. Geological Survey digital data, 1:250,000, 2003. State Plane Projection, Fipzone 402
Shaded relief base from 1:250,000 scale Digital Elevation Model: sun illumination from northwest at 30 degrees above horizon

From: USGS, 2006

3.5.2 Groundwater Quality Averaging Period

In accordance with the State Water Resources Control Board (SWRCB) Recycled Water Policy, the available assimilative capacity shall be calculated by comparing the BPOs with the average ambient S/N concentrations in the subbasin over the most recent five years of available data (2007 to 2012) or a time period approved by the Regional Water Board. **Table 3-2** and **Figure 3-2** show the number of wells sampled over the history of sampling in the subbasin. As shown in the figure and table, a significant number of wells were sampled in the 2000 to 2006 time period, predominantly as part of the work conducted by the USGS (2006). In order to provide a more robust dataset, data collected during the 12 year period from 2000 to 2012 are used to assess the average groundwater quality in the subbasin. This approach was presented and approved by the Regional Water Board at the January 2013 project meeting (RMC, January 2013).

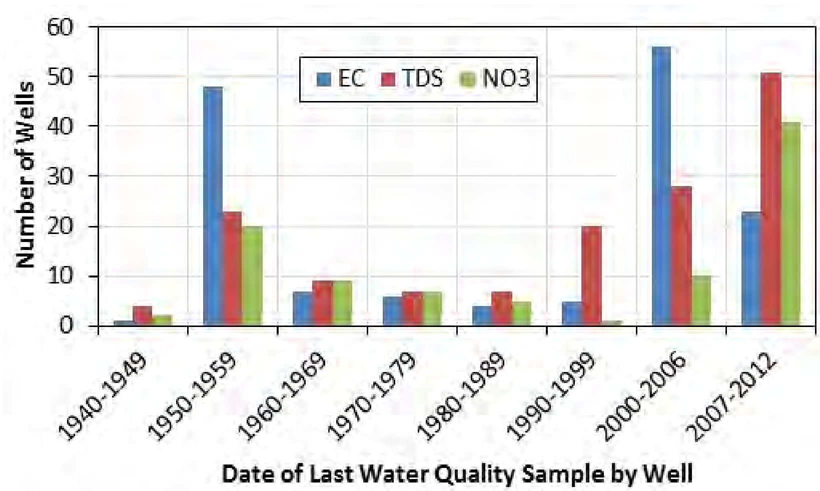
Evaluation of concentration trends finds overall relatively stable or flat trends for TDS and nitrate in most wells in the subbasin, which also supports use of a longer averaging period.

Table 3-2: Summary of Available Water Quality Data

Period	EC	TDS	Nitrate
1940-1949	1	4	2
1950-1959	48	23	20
1960-1969	7	9	9
1970-1979	6	7	7
1980-1989	4	7	5
1990-1999	5	20	1
2000-2006	56	28	10
2007-2012	23	51	41

EC – electrical conductivity
TDS – total dissolved solids

Figure 3-2: Summary of Available Water Quality Data



3.5.3 Calculation of Existing Ambient Groundwater Quality and Assimilative Capacity

The median groundwater concentration for samples collected from individual wells over the 12-year averaging period for TDS and nitrate are plotted on maps with different size and color circles representing median concentrations (dots maps). Well median concentrations were selected over arithmetic average concentrations to represent the ambient groundwater quality in each well. The median statistic is recommended over averages, because the median: 1) does not assume a normal distribution of data, 2) minimizes the effect of potential and/or actual data outliers without removing them from consideration, and 3) can be reliably calculated for datasets with a mix of censored (non-detect) and non-censored values, which is often important for nitrate datasets.

The TDS and nitrate dots maps are then used to develop concentration contour maps for TDS and nitrate. The concentration contour maps were developed by first manually contouring the 2000-2012 median concentrations to address concentration variability in data-dense areas and to control the interpretation in data-poor areas. In some areas, older (pre-2000) water quality data were used to guide contouring (i.e. Baylands Area). Following manual contouring, the contours were used to generate interpolated surfaces representing the concentation of TDS and nitrate using the GIS Spatial Analyst “Topo to Raster” tool. Average TDS and nitrate concentrations in each area were directly extracted from the interpolated surfaces using the GIS Spatial Analyst “Zonal Statistics” tool.

To calculate a volume-weighted average concentration for the combined Inland and Baylands Areas, the average concentration in each area is weighted by the representative volume of water in storage in each area. A uniform saturated aquifer thickness of 400 feet is assumed. Groundwater in storage is calculated by multiplying the constant saturated thickness (400 feet) by a constant effective porosity of 0.1.

The average TDS and nitrate concentrations for each area (Inland and Baylands) and for the entire subbasin are compared to the BPOs to determine the current available assimilative capacity. Assimilative capacity is simply the difference between the average subbasin concentration and the BPO.

3.5.4 Time-Concentration Plots and Trends

Time-concentration plots are prepared and evaluated to assess whether TDS and nitrate groundwater concentrations across the subbasin have been historically increasing, decreasing, or showing no significant change. The trend analysis facilitates the comparison of observed concentration trends in individual wells with simulated average groundwater concentration trends from the mixing model over the baseline period, from water year (WY) 1996-97 (WY 1997) through WY 2005-06 (WY 2006), for calibration purposes. A water year is from October 1 to September 30 of the following year and is commonly used for hydrogeologic analysis in North America.

3.5.5 Simulation of Baseline and Future Groundwater Quality

Groundwater quality concentrations for TDS and nitrate are simulated for the baseline period and future planning period using a mixing model. Concentration estimates are based on water and S/N inflows and outflows (balances) mixed with the volume of water in the aquifer and the average ambient groundwater quality. The baseline period is from WY 1997 to 2006. This baseline period was selected based on the period for which water balances were available from the USGS (2006) groundwater flow model and updated groundwater model (Bauer, 2008). The future planning period is from WY 2014 to WY 2035 based on the planning horizon in supporting planning documents.

The baseline period water balances estimate all groundwater inflows and outflows for the baseline period and the associated change in storage based on estimates provided in the groundwater model and updated model. Not all components of inflow important to the SNMP are specifically quantified by the model. For example, quantified model inflows include areal recharge from precipitation, stream recharge, and mountain front recharge. Mountain front recharge includes both subsurface inflow and stream recharge at the base of the mountains. Other recharge sources such as irrigation return flows and septic system recharge are important sources of S/Ns, but are not specifically quantified in the model water balances. Accordingly these flows are quantified as part of the SNMP analysis as components of other model-defined inflows, while honoring the total modeled water balance flows. For the future planning period, the average of the baseline period water balance is used for each year of the future planning period and any changes in inflows suggested in the area planning documents are superimposed on top of the baseline averages. Future changes simulated include increased use of recycled water for irrigation and managed stormwater capture.

TDS and nitrate concentrations are associated with each water balance inflow and outflow component. The TDS and nitrate concentrations of the various inflow components were estimated as described in Section 4. In order to simulate the effect of current and future S/N loading on groundwater quality in the Sonoma Valley Subbasin, the spreadsheet mixing model mixes the volume and quality of each inflow and outflow with the existing volume of groundwater and mass of TDS and nitrate in storage and tracks the annual change in groundwater storage and S/N mass for the baseline and future planning period. The existing volume of water in the groundwater basin is calculated based on the subbasin or subarea (Inland and Baylands) surface areas, a uniform saturated thickness of 400 feet and a porosity of 0.1. The mixing model produces an average TDS and nitrate concentration for each year of the baseline and future planning period.

The baseline period mixing model simulation is conducted in order to calibrate the loading factors. The simulated baseline period annual concentrations and trends are compared with the predominant observed groundwater quality concentrations and trends. If the observed and simulated concentrations and trends are not in reasonable agreement, loading factors can be adjusted to achieve a more reasonable match. All loading factor assumptions generated from the baseline calibration process are applied to the future loading analysis. Similar to the water balance assumption, for the future planning period, the average of the baseline period S/N balance is used for each year of the future planning period, and any changes in S/N loading are superimposed on top of the baseline averages. As mentioned above, future changes simulated include increased use of recycled water for irrigation and managed stormwater capture.

3.5.6 Use of Assimilative Capacity by Recycled Water Projects

In accordance with the SWRCB Recycled Water Policy, a recycled water irrigation project that meets the criteria for a streamlined irrigation permit and is within a basin where a SNMP is being prepared, may be approved by the local RWQCB by demonstrating through a S/N mass balance or similar analysis that the project uses less than 10% of the available assimilative capacity (or multiple projects use less than 20% of available assimilative capacity). Accordingly, the recycled water irrigation projects in place and planned for the Sonoma Valley Subbasin are assessed in terms of their use of available assimilative capacity.

3.6 TDS in Groundwater

Figure 3-3 shows the median TDS concentrations in wells sampled between 2000 and 2012. EC data were also used for the analysis. For wells with only EC data, EC was converted to TDS. The conversion factor was estimated from the EC/TDS relationship in wells that had both TDS and EC data. The upper chart on **Figure 3-4** shows the strong relationship between TDS and EC. The bottom chart on Figure 3-4 shows ratio between the two measurements used to convert EC to TDS.

Figure 3-3: Median Well Concentrations (2000 to 2012) Total Dissolved Solids

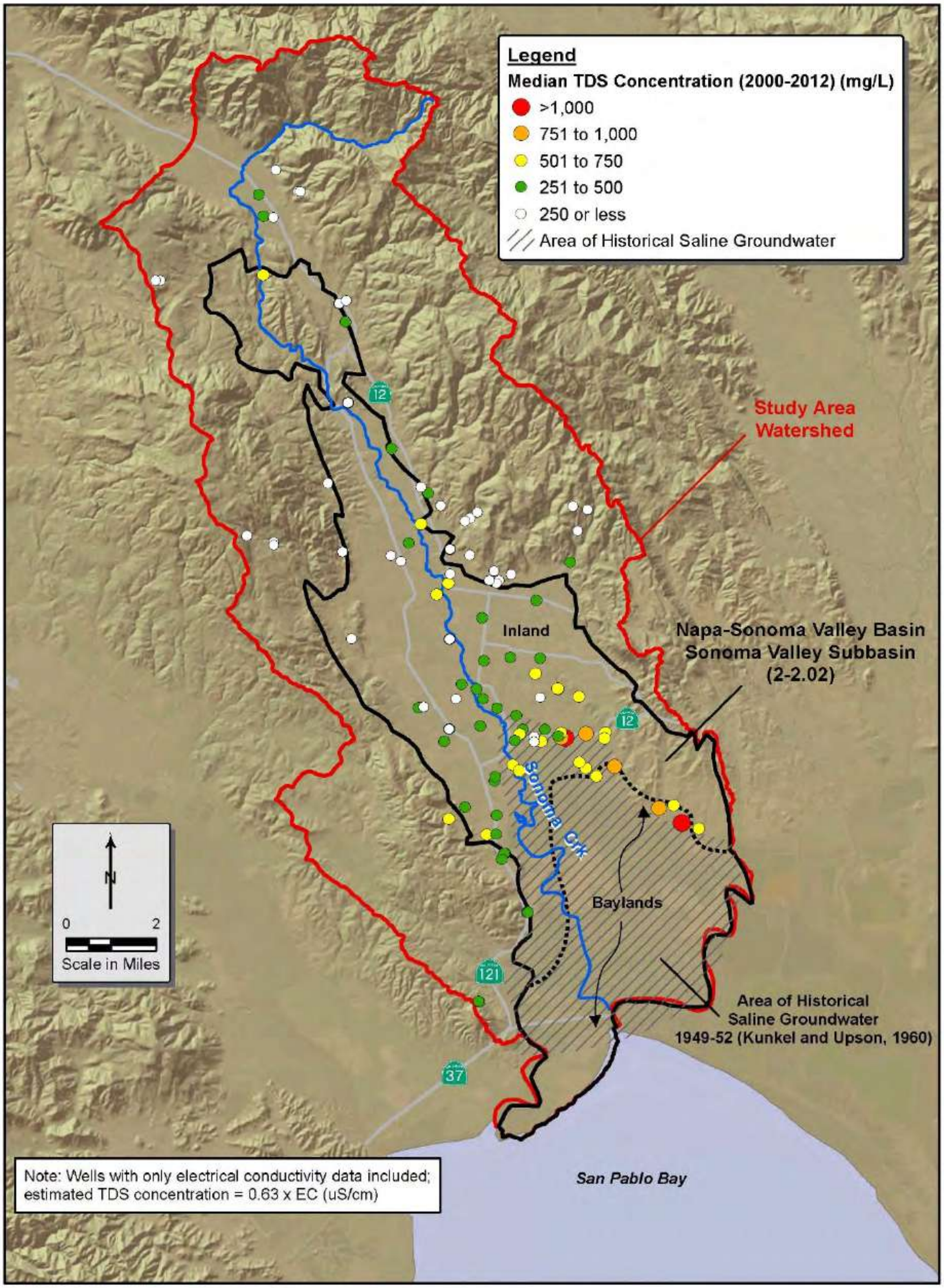
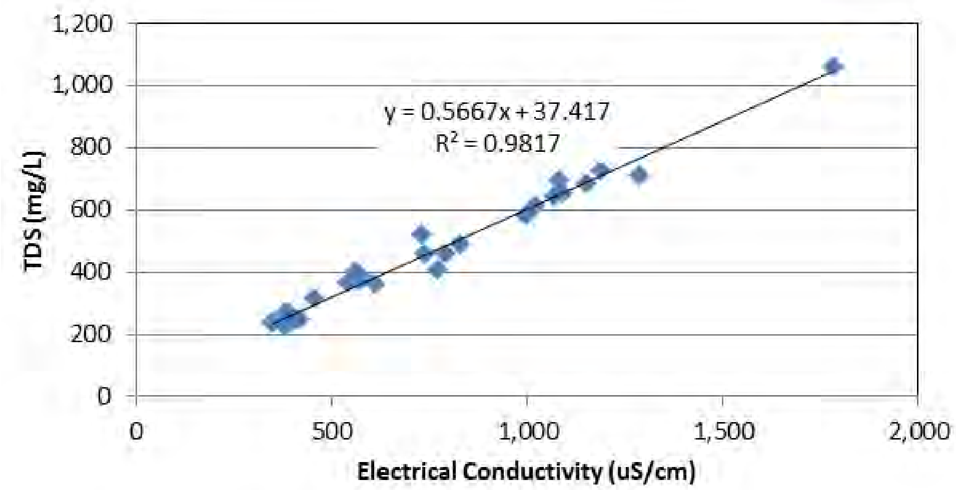
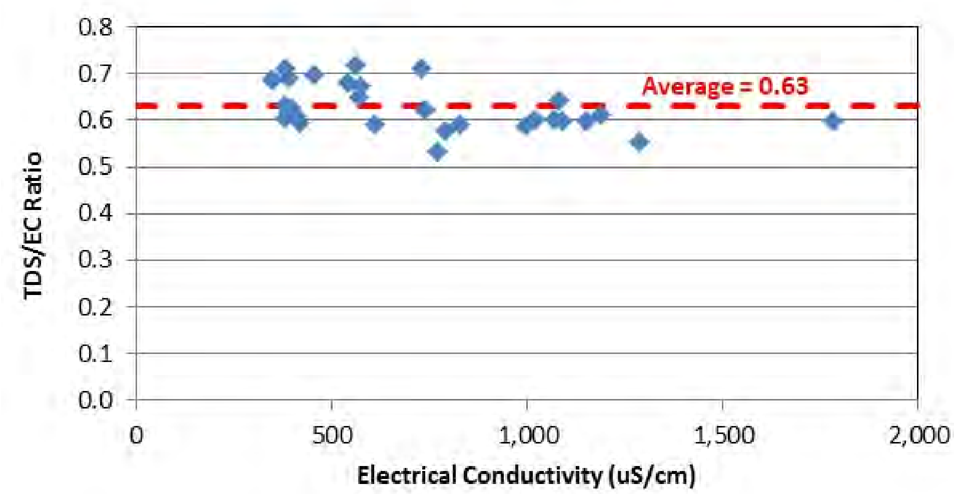


Figure 3-4: Total Dissolved Solids/Electrical Conductivity Relationship





TDS – total dissolved solids mg/L – milligrams per liter
EC – electrical conductivity µS/cm – microsiemens per centimeter

Generally, relatively low TDS concentrations (less than 500 mg/L) are observed throughout most of the subbasin. The BPO for TDS is 500 mg/L. A few wells with elevated concentrations (above 750 mg/L) are seen in the southeastern portion of the subbasin. The southeastern portion of the subbasin is an area of historical brackish groundwater. Kunkel and Upson (1960) mapped the zero groundwater elevation contour and stated that generally, salty water was found south of this contour line in the shallow zone. The area south of the historical zero groundwater elevation contour is shown in the hatched area in Figure 3-3.

A TDS concentration contour map was generated based on the Figure 3-3 well median data plus some available older data in the area near San Pablo Bay. **Figure 3-5** is a TDS concentration contour map. Again, relatively low (less than 500 mg/L) TDS concentrations are seen in most of the subbasin. As discussed above, the Baylands Area is defined as the area beneath the tidal sloughs adjacent to San Pablo Bay generally containing groundwater with TDS concentrations above 750 mg/L. This area along with the historical brackish groundwater area are illustrated on Figure 3-5. The area of very high TDS near San Pablo Bay with TDS greater than 1,500 mg/L is based on older well sampling conducted between 1954 and 1973 by DWR. Use of these older data is conservative in that their use results in higher average concentrations in the Baylands Area and there are no more recent data available for this area.

The average TDS concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in **Table 3-3** and **Figure 3-6**. The average Inland Area TDS concentration is 372 mg/L, well below the BPO of 500 mg/L, resulting in available assimilative capacity of 128 mg/L. As expected the average TDS concentration in the Baylands Area is high, with an average concentration of 1,220 mg/L, resulting in no available capacity. The average TDS concentration for the combined subbasin including both the Inland and Baylands Areas is 635 mg/L, also resulting in no available assimilative capacity.

The analysis indicates the importance of preventing additional saline intrusion into the Inland Area. The USGS (2006) evaluated the change in EC in the southeastern area over time. **Figure 3-7** shows the Kunkel and Upson area of historical brackish groundwater based on the zero groundwater elevation contour and EC contours mapped by the USGS based on September 2003 water quality data. The more recent USGS mapping shows both the 1,000 µS/cm and 500 µS/cm EC contours. USGS stated that the generalized contour lines suggest that the area affected by brackish groundwater in the southern part of the Sonoma Valley shifted between 1949–52 and 2003. The northern edge of the brackish area may have advanced as much as 1 mi north of Highway 12/121. This apparent movement of brackish groundwater may have been in response to groundwater pumping and the resulting depression of hydraulic heads southeast of the City (Figure 2-3). In contrast, the northwestern part of the 1949–52 area of brackish groundwater, near the intersections of Highways 12 and 121 and Sonoma Creek, may have diminished between 1949-52 and 2003.

Figure 3-5: Total Dissolved Solids Concentration Contours (2000 to 2012)

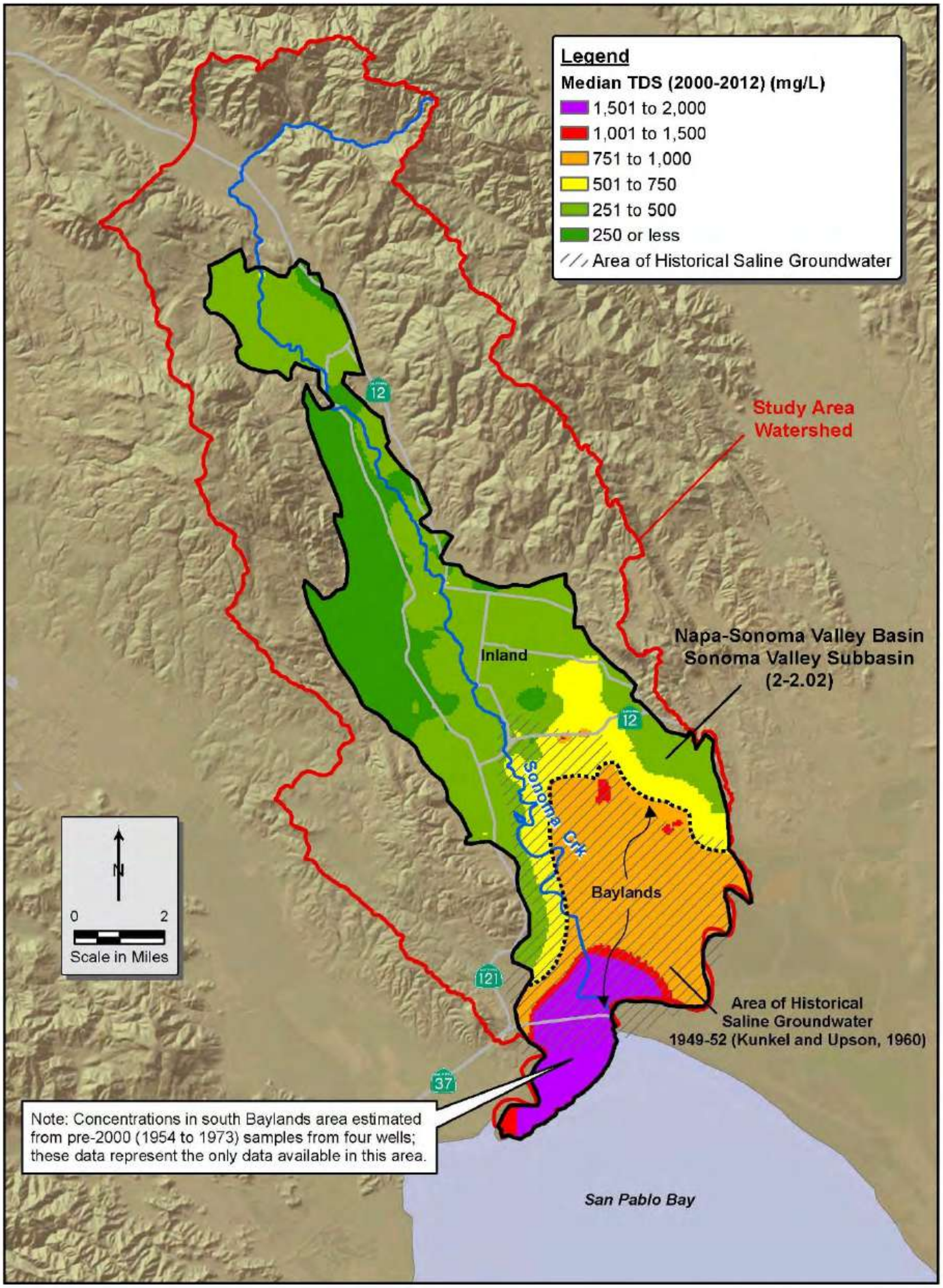


Table 3-3: Average TDS Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	635	372	1,220
BPO	500	500	500
Available Assimilative Capacity	**-135**	**128**	**-720**

TDS – total dissolved solids
mg/L – milligrams per liter

Figure 3-6: Average TDS Concentrations and Available Assimilative Capacity

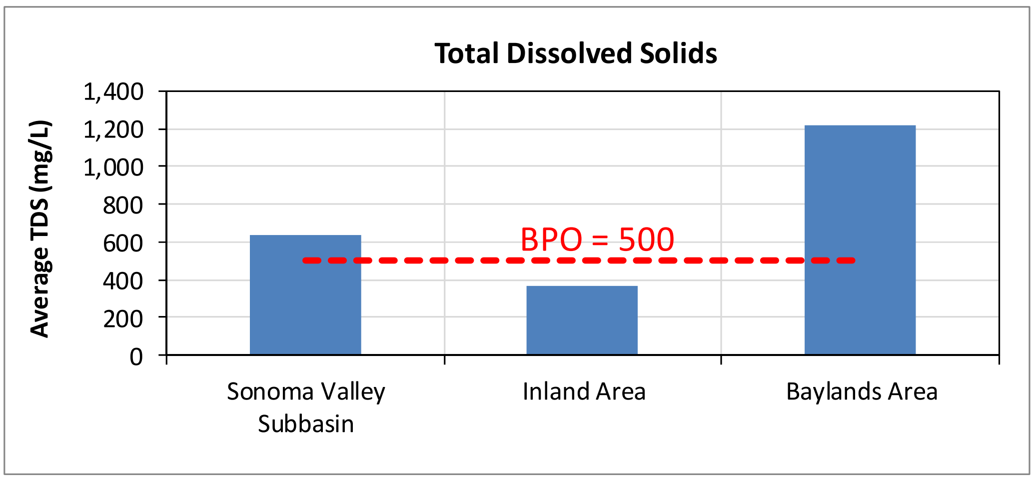
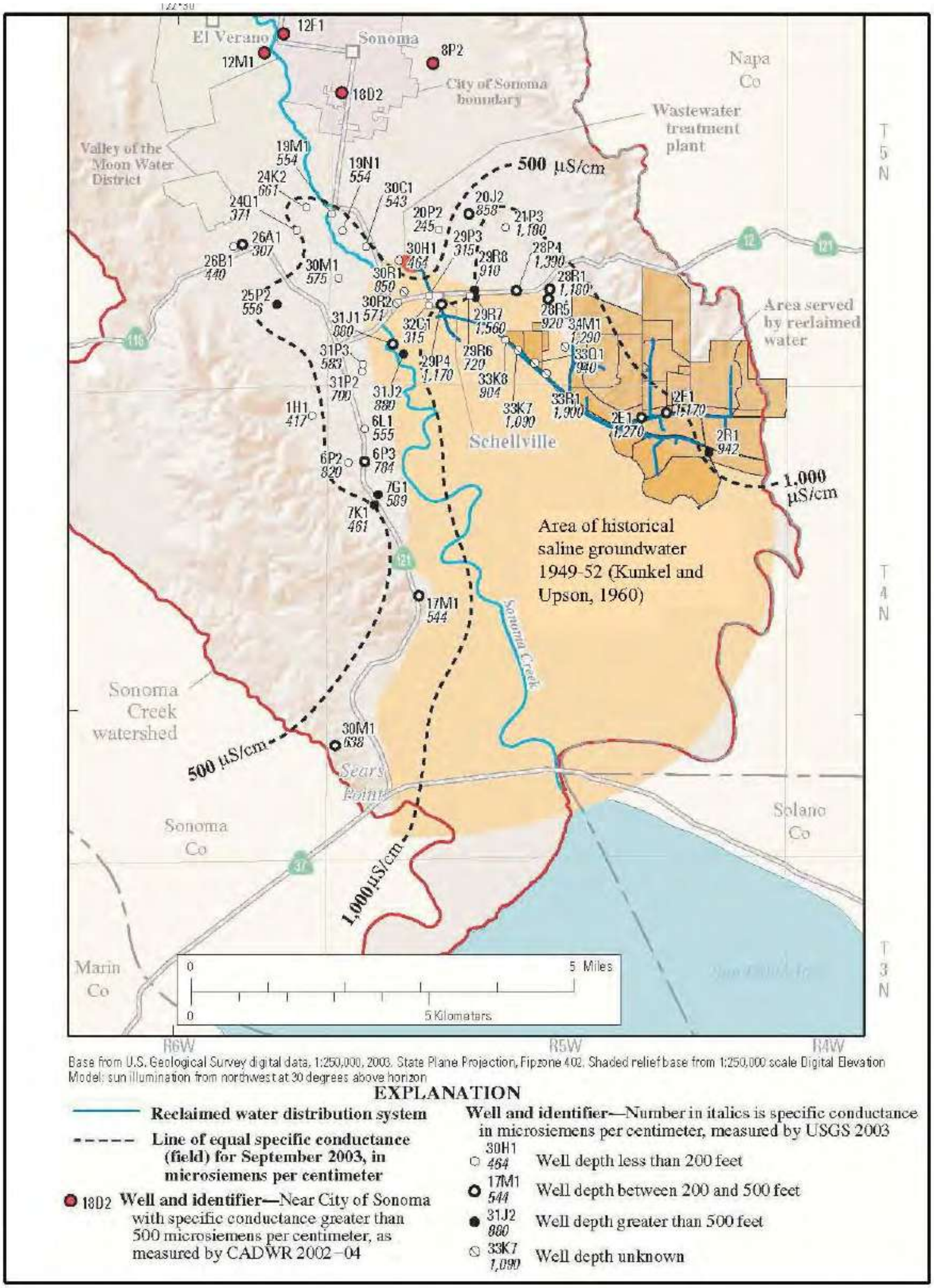


Figure 3-7: Comparison of Saline Area 1949-52 and EC Data 2003



From: USGS, 2006

The USGS report (2006) further concludes that conductivity measurements from September 2003 indicate that significant spatial variability in water quality exists with depth in the vicinity of the saline groundwater area. The vertical variability in conductivity may be illustrated by comparing the values from samples of two adjacent wells of different depths. For example, the conductivities of water from wells 5N/5W-29R6 (less than 200 feet deep) and -29R7 (greater than 500 feet deep), were 720 and 1,560 μS/cm, respectively (Figure 3-7). The variation of conductivity with depth may be indicative of different sources of salinity in the southern part of the Sonoma Valley. The primary source of salinity to shallow wells may be modern saltwater that has intruded the Bay Mud deposits along the tidal sloughs that extend northward from San Pablo Bay. High evaporation rates in the marshlands also could increase salinity in the shallow groundwater in or near the marshes. The source of salinity to intermediate and deep wells may be connate water incorporated into the sediments during deposition or modern saltwater in areas where abandoned or improperly constructed wells may act as conduits for the downward movement of surface water or shallow groundwater.

The Baylands brackish groundwater area is a S/N concern in the Sonoma Valley. One of the objectives of developing and increasing the use of recycled water for irrigation is to reduce groundwater pumping in the southern Sonoma Valley, prevent additional saline intrusion, and potentially reduce the existing inland extent of brackish groundwater. Irrigation with recycled water began in 1992 and is projected to increase in the future. To date, the data are insufficient to determine if the replacement of groundwater with recycled water has reduced the areal extent of brackish groundwater. However, continued monitoring of this area is a key component of the ongoing GMP and SNMP.

Figures 3-8 and **3-9** show time-concentration plots for TDS and EC, respectively along with the applicable BPO. The well dot and charts are shaded to indicate the wells depths with red wells and charts indicating wells less than 200 feet deep, yellow wells and charts indicating wells between 200 and 500 feet deep, and green wells and charts indicating wells greater than 500 feet deep. Wells and charts shaded gray indicated wells with unknown completion depths. Both figures show relatively flat TDS and EC trends in the subbasin indicating generally stable conditions. However, Wells 5N/5W-28R1 and 5N/5W-28N1 located in the southern portion of the subbasin near the Baylands Area show modest increasing concentration trends, which could be attributed increasing saline intrusion as well as other sources. One well is an intermediate zone well (200 to 500 feet deep) and the other is a shallow zone well (less than 200 feet deep). The shallow well (5N/5W-28N1) is owned by a dairy, and this well also shows increasing nitrate concentrations as discussed in the next section. Therefore, it is possible that the increasing TDS/EC concentrations could be associated with local surface sources rather than saline intrusion. The other intermediate well with increasing TDS/EC does not have a similar increasing nitrate trend.

Figure 3-8: Time-Concentration Plots Total Dissolved Solids

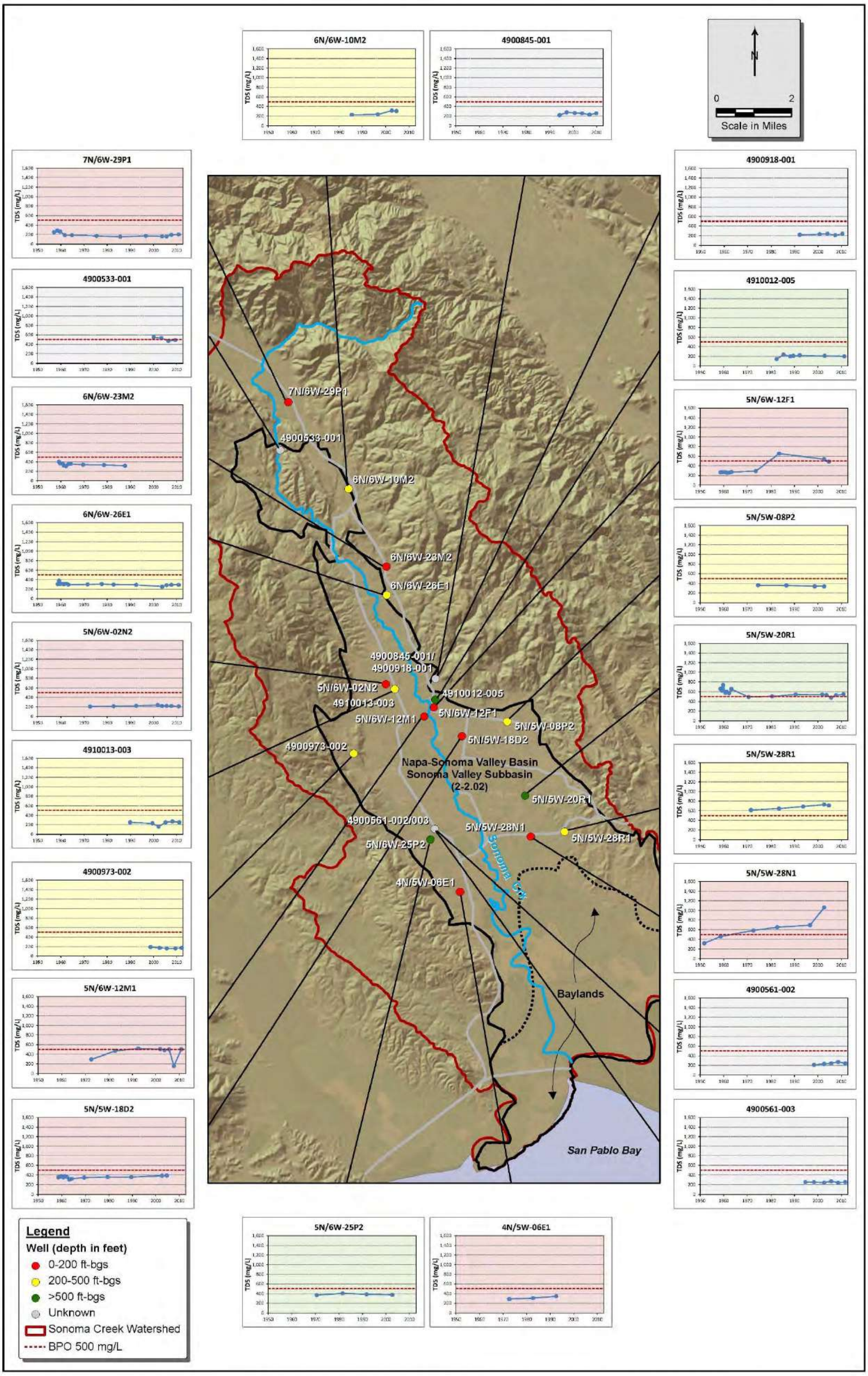
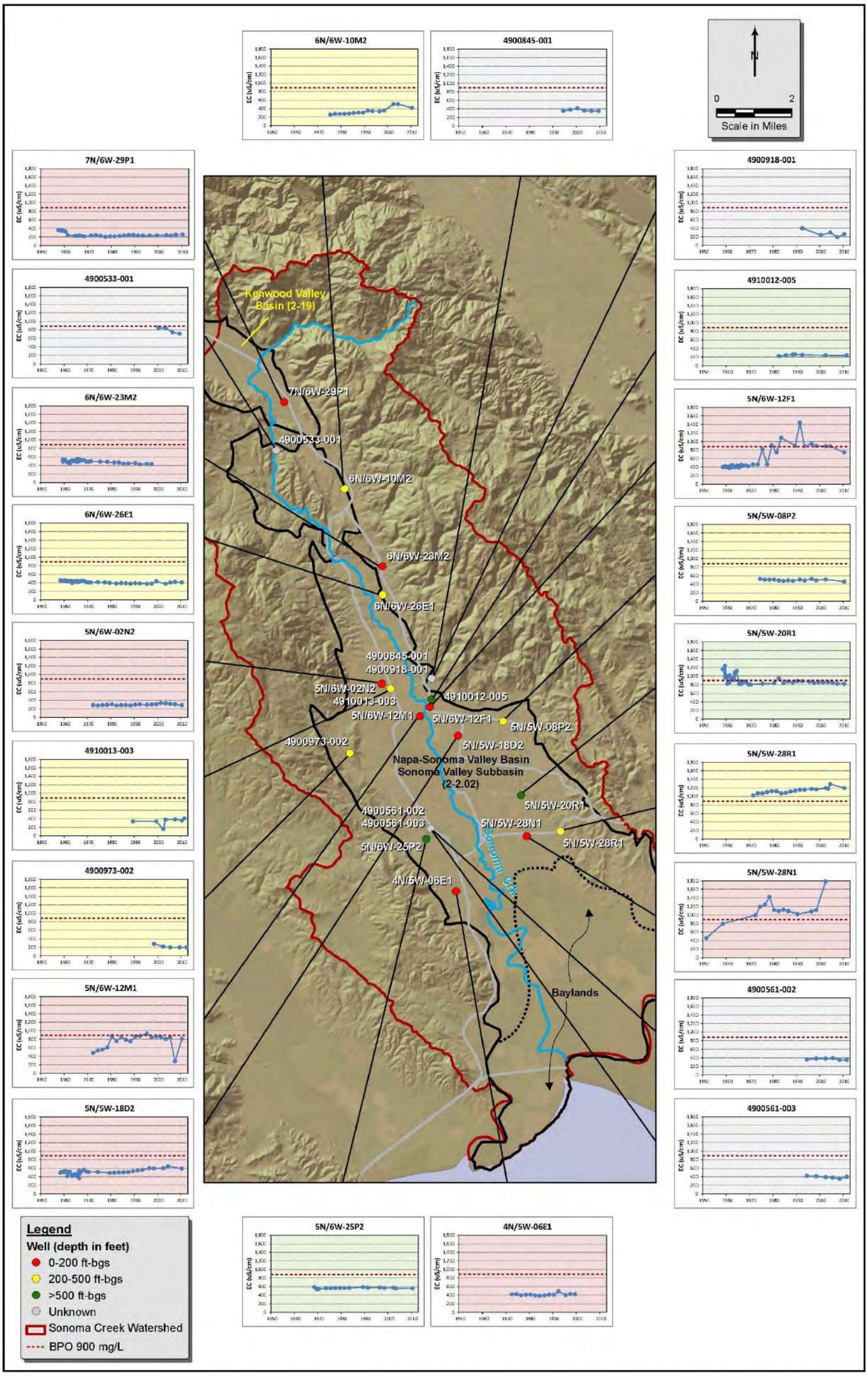


Figure 3-9: Time-Concentration Plots Electrical Conductivity



3.7 Nitrate in Groundwater

Figure 3-10 shows the median nitrate-N concentrations in wells sampled between 2000 and 2012. Generally low nitrate concentrations are observed throughout most of the subbasin. The nitrate-N BPO is 10 mg/L. While median nitrate-N concentrations are below the BPO in all wells, median nitrate concentrations in a few wells are between 5 and 10 mg/L.

A nitrate concentration contour map (**Figure 3-11**) was generated based on the median well data shown on Figure 3-10 plus available older (pre-2000) data in the southern Baylands Area. Again, relatively low (less than 1.0 mg/L) nitrate-N concentrations are seen in most of the subbasin. The area of nitrate between 2.6 and 5.0 mg/L near the San Pablo Bay is based on older well sampling conducted by the DWR between 1954 and 1973.

The average nitrate concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in **Table 3-4** and **Figure 3-12**. The average Inland Area nitrate concentration is 0.06 mg/L, well below the BPO of 10 mg/L, resulting in available assimilative capacity of 9.94 mg/L. The average nitrate concentration in the Baylands Area is 0.07 mg/L, resulting in 9.93 mg/L of available assimilative capacity. The average nitrate concentration for the combined subbasin including both the Inland and Baylands areas is 0.06 mg/L, resulting in 9.94 mg/L of assimilative capacity.

Table 3-4: Average Nitrate-N Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	0.06	0.06	0.07
BPO	10.00	10.00	10.00
Available Assimilative Capacity	**9.94**	**9.94**	**9.93**

TDS – total dissolved solids
mg/L – milligrams per liter

Figure 3-13 show time-concentration plots for nitrate-N along with the applicable BPO. As discussed above, the wells and charts are shaded to indicate relative well depth. Generally flat concentrations are observed in most wells in the subbasin, typically well below the BPO of 10 mg/L.

Figure 3-10: Median Well Concentrations (2000 to 2012) Nitrate as N

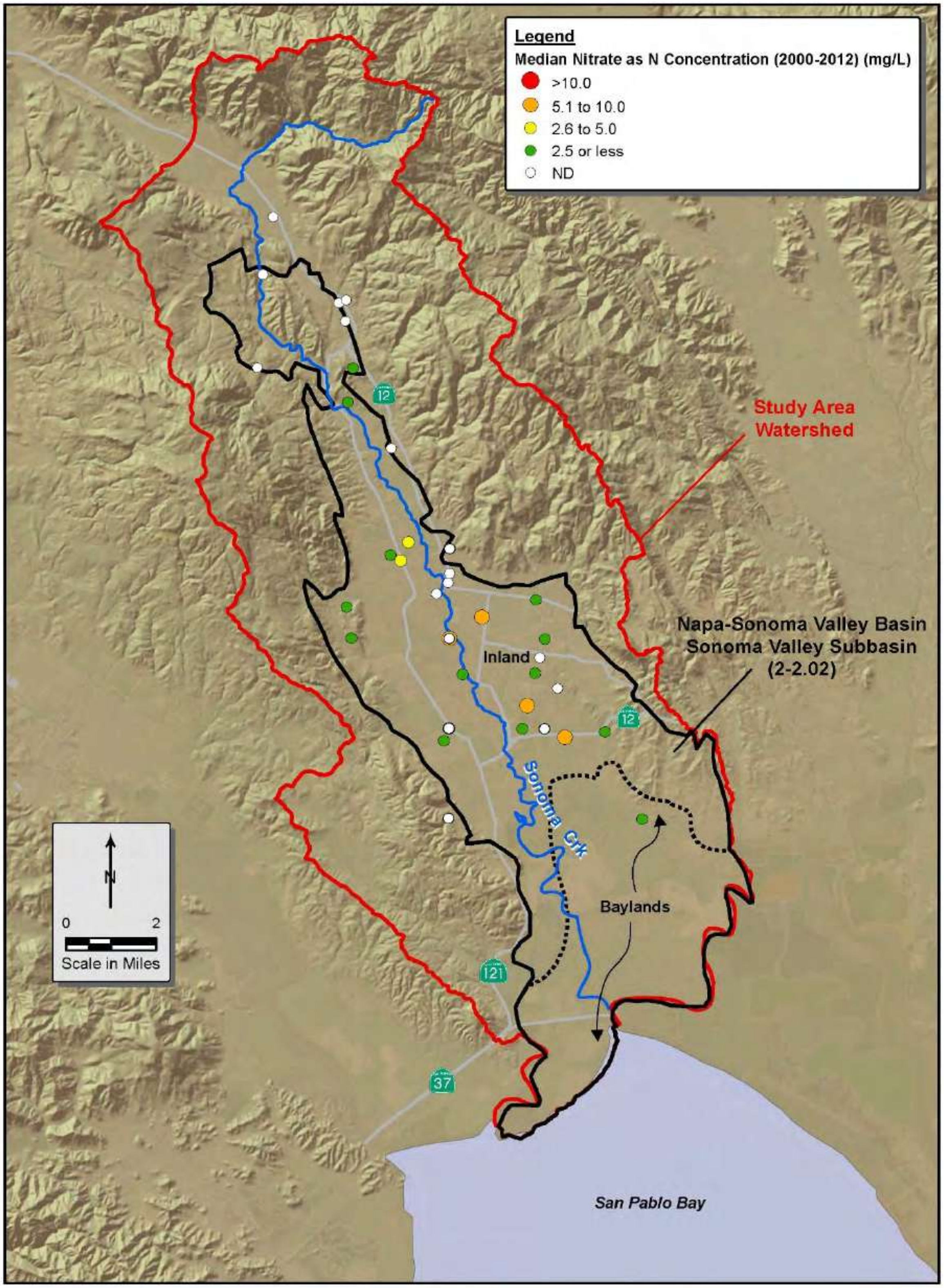


Figure 3-11: Nitrate as N Concentration Contours (2000 to 2012)

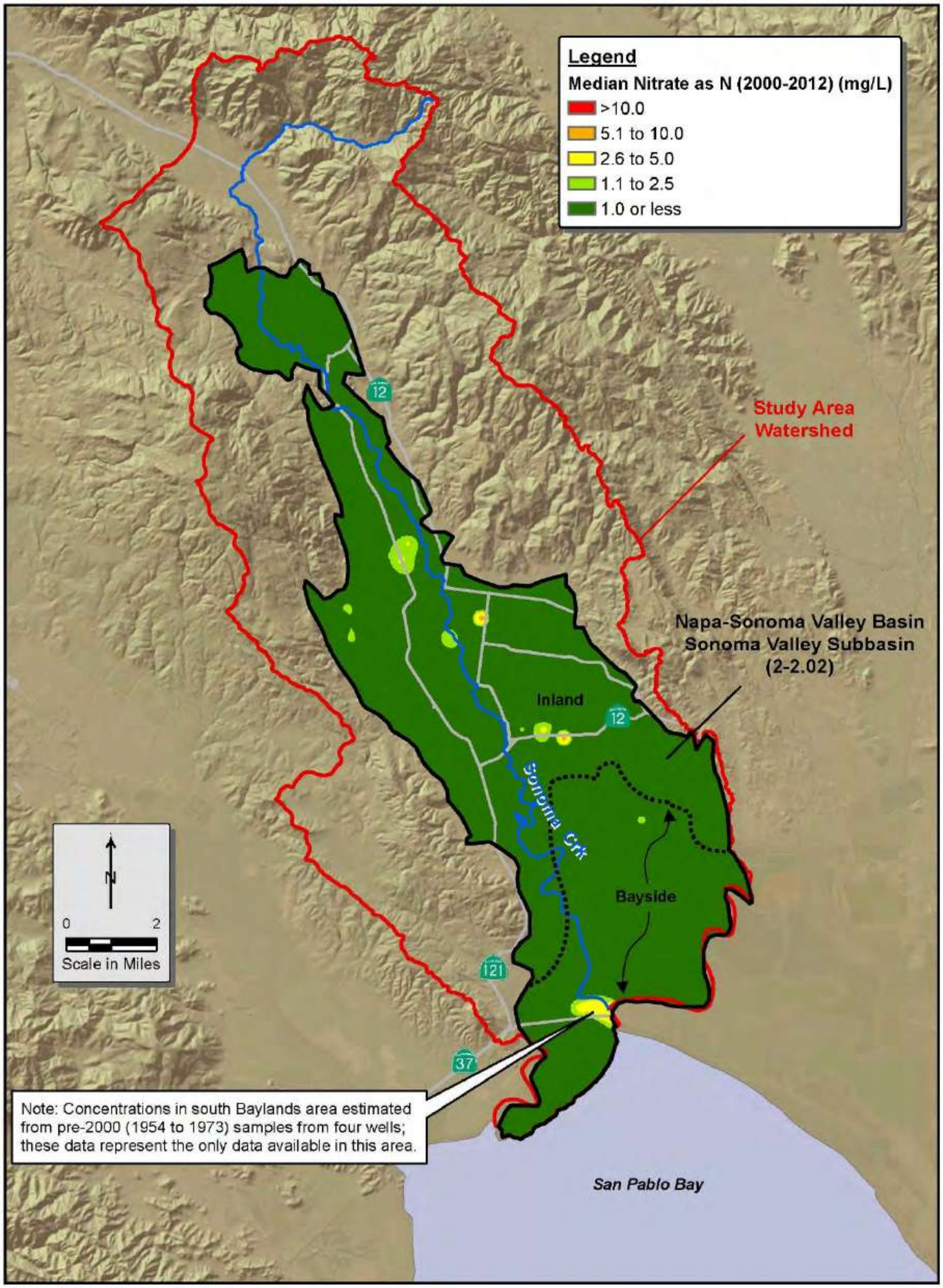


Figure 3-12: Average Nitrate Concentrations and Available Assimilative Capacity

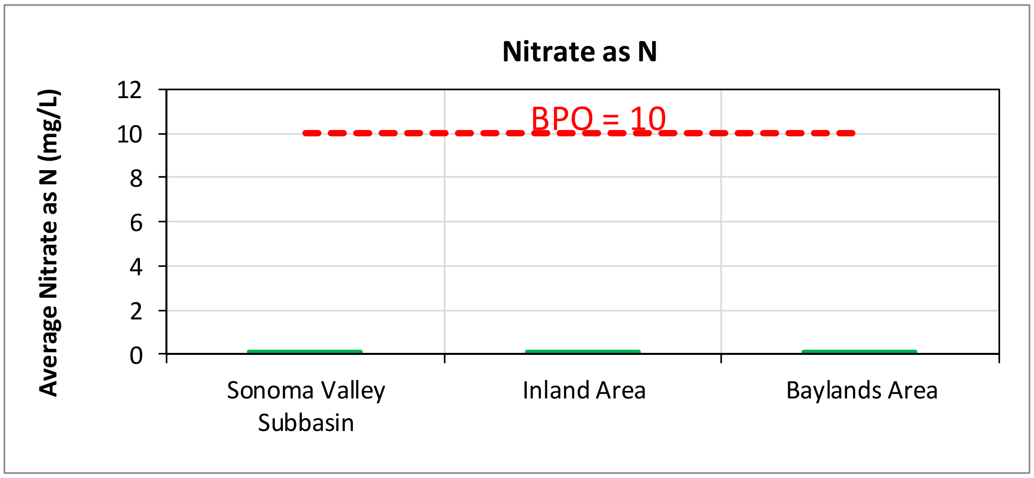
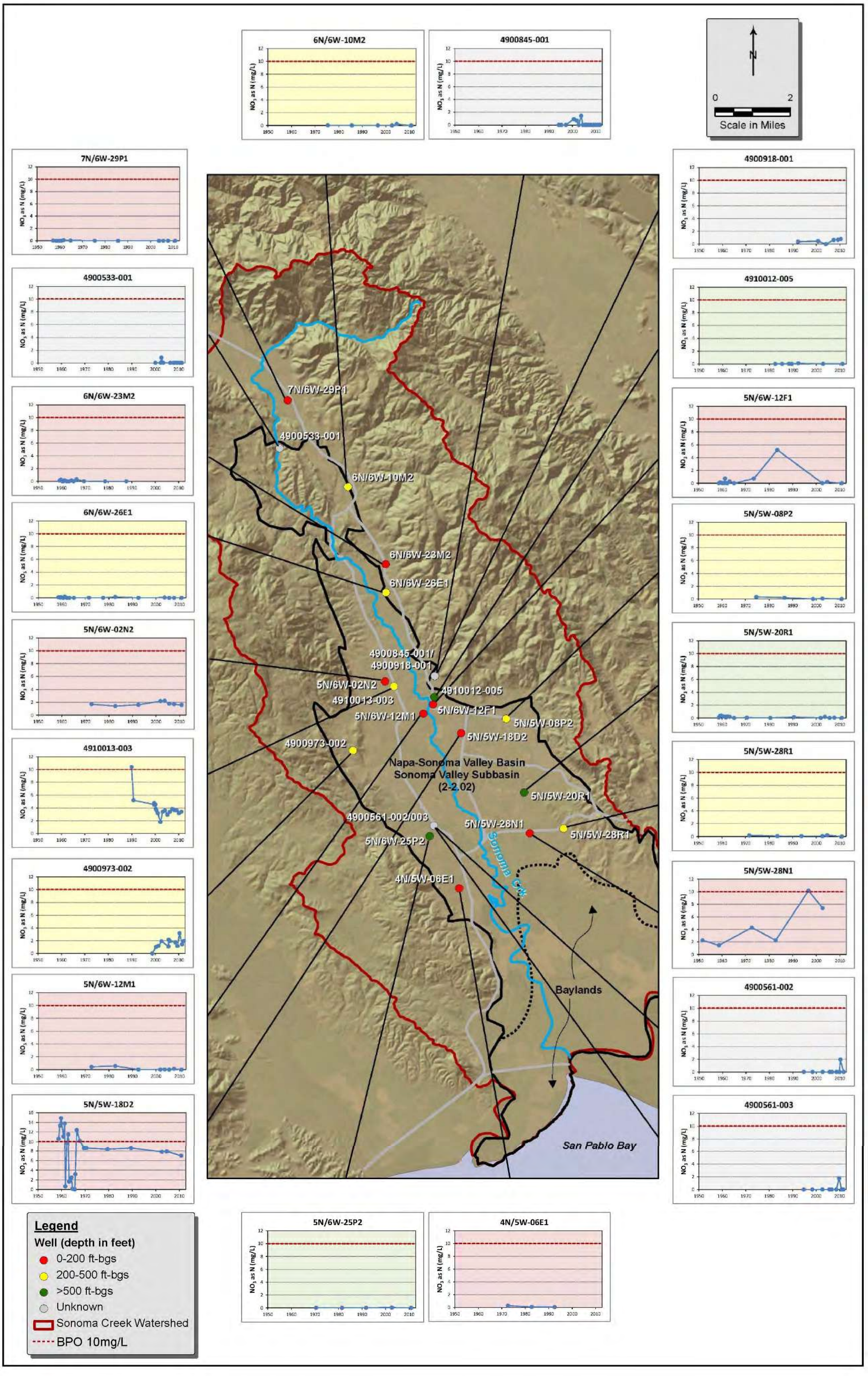


Figure 3-13: Time-Concentration Plots Nitrate as N



4 Baseline Period Analysis

The baseline period water balance tracks groundwater inflows and outflows and storage changes from WY 1996-97 through WY 2005-06. This period represents a recent time period characterized by average climatic conditions. The primary source of information used to develop the water balance is the Sonoma Valley groundwater flow model. The flow model was originally developed by the USGS (2006) and later updated by Bauer (2008). Annual water balances in the flow model were developed from WY 1974-75 through WY 2005-06 (historical flow model period). Groundwater recharge from natural precipitation in the flow model for the baseline period represented 94% of the natural recharge over the historical flow model period.

Major inflows accounted for in the baseline water balance include:

- deep percolation of precipitation and mountain front recharge,
- natural stream recharge,
- agricultural irrigation water return flow,
- domestic/municipal irrigation water (including recycled water) return flow,
- septic system return flow, and
- subsurface groundwater inflow (from Baylands Area)

Major outflows accounted for in the water balance include:

- groundwater pumping,
- groundwater discharge to streams, and
- subsurface groundwater outflow (to Baylands Area)

Areal anthropogenic recharge sources (return flows from agricultural and municipal irrigation and septic systems) are not independently considered in the flow model but instead subsumed within the model areal recharge rates. Model areal recharge rates were apportioned into natural sources (precipitation) and anthropogenic sources (return flows) based on the results of the S/N loading evaluation conducted for the SNMP (RMC, 2013).

4.1 Baseline Water Balance

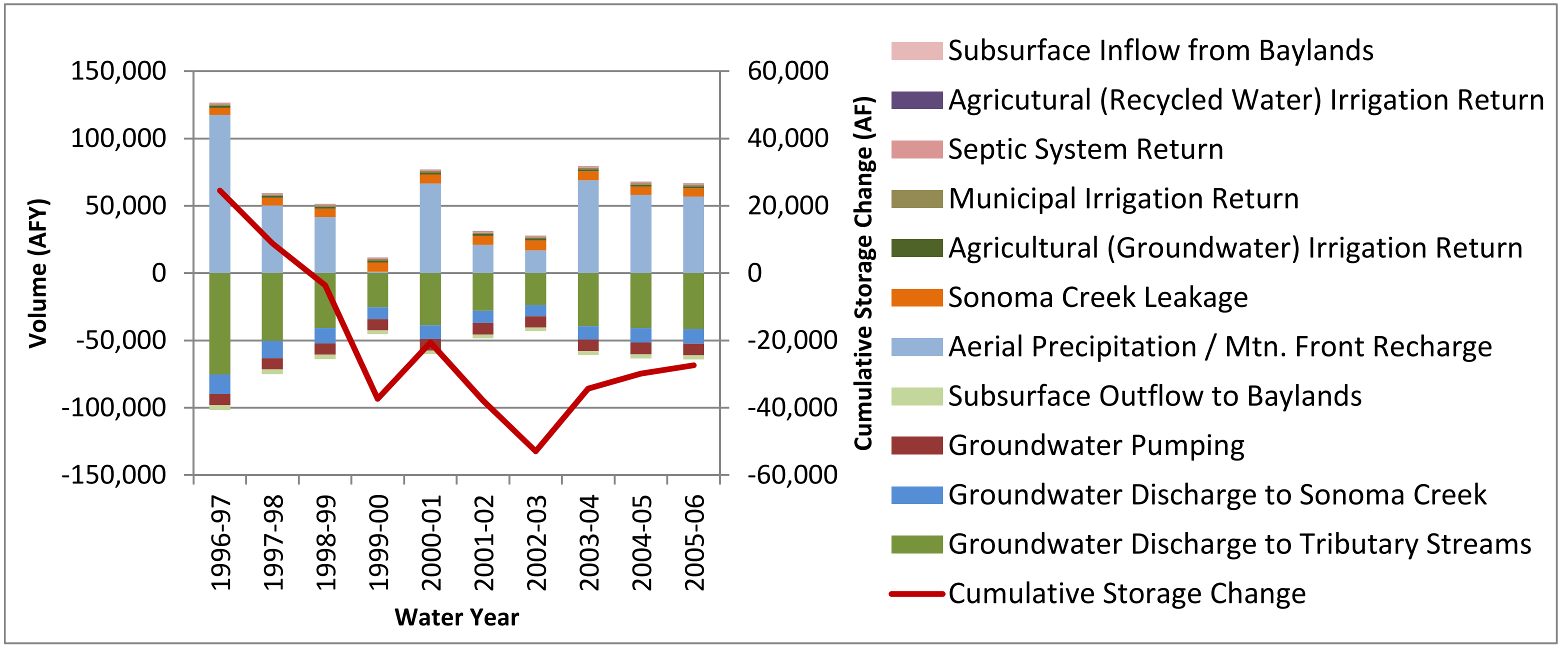
Table 4-1 summarizes the baseline water balance for the Inland Area of the subbasin. **Figure 4-1** graphically illustrates the water balance. Inflows are stacked on top of one another above the zero line in the figure, while outflows are stacked below the zero line. The cumulative change in groundwater storage over the baseline period is depicted by the red line in the figure.

Table 4-1: Baseline Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)

	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	Average
	All values in acre-feet per year (AFY) unless otherwise noted										
INFLOWS											
Aerial Precipitation / Mtn. Front Recharge	117,453	50,265	41,773	1,081	66,655	20,883	17,009	69,074	58,101	56,852	49,915
Sonoma Creek Leakage	5,350	5,596	6,017	6,891	6,662	6,737	7,266	6,675	6,256	6,180	6,363
Agricultural (Groundwater) Irrigation Return	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415
Agricultural (Recycled Water) Irrigation Return	91	91	91	91	91	91	91	91	91	91	91
Municipal Irrigation Return	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074
Septic System Return	899	899	899	899	899	899	899	899	899	899	899
Subsurface Inflow from Baylands	54	56	54	49	48	49	47	48	51	52	51
TOTAL INFLOWS	**126,335**	**59,396**	**51,322**	**11,500**	**76,844**	**31,147**	**27,801**	**79,276**	**67,887**	**66,563**	**59,807**
OUTFLOWS											
Groundwater Pumping	-8,204	-8,281	-8,411	-8,466	-8,484	-8,476	-8,472	-8,654	-8,832	-8,576	-8,486
Groundwater Discharge to Tributary Streams	-75,270	-50,379	-40,834	-25,375	-38,768	-27,899	-23,797	-39,308	-40,798	-41,599	-40,403
Groundwater Discharge to Sonoma Creek	-14,599	-12,864	-11,375	-8,737	-10,071	-9,186	-8,154	-9,955	-10,668	-10,821	-10,643
Subsurface Outflow to Baylands	-3,667	-3,562	-3,218	-2,656	-2,802	-2,738	-2,481	-2,811	-3,070	-3,111	-3,011
TOTAL OUTFLOWS	**-101,739**	**-75,086**	**-63,838**	**-45,234**	**-60,125**	**-48,298**	**-42,905**	**-60,727**	**-63,368**	**-64,108**	**-62,543**
ANNUAL STORAGE CHANGE (AF)	24,596	-15,690	-12,515	-33,734	16,719	-17,151	-15,104	18,549	4,520	2,456	-2,736
CUMULATIVE STORAGE CHANGE (AF)	24,596	8,906	-3,609	-37,343	-20,625	-37,776	-52,880	-34,331	-29,812	-27,356	

AF – acre-feet
Mtn. – mountain
WY – water year

Figure 4-1: Baseline Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)



4.1.1 Inflows

As shown in Table 4-1 and Figure 4-1, total annual subbasin inflows over the baseline period ranged from 11,500 AF in WY 2000 up to 126,335 AF in WY 1997, averaging 59,807 AFY. The large variability in annual inflows is dependent primarily on the volume of natural recharge derived from areal precipitation and mountain front recharge, which averaged 49,915 AFY (or 83% of total inflows). It is noted that mountain front recharge is simulated using the recharge package in the flow model and, while concentrated along the basin margins, is not separated from areal precipitation recharge. Sonoma Creek leakage is the second largest source of recharge (6,363 AFY on average; or 11% of total inflows). Return flows from agricultural irrigation (1,415 AFY), municipal irrigation (1,074 AFY), and septic systems (899 AFY) collectively contribute about 6% of total inflows. Agricultural recycled water return flows (91 AFY) and subsurface inflow from the Baylands Area (51 AFY) represent minor inflows.

4.1.2 Outflows

As shown in Table 4-1 and Figure 4-1, total annual subbasin outflows over the baseline period averaged -62,543 AFY. The largest subbasin outflow is represented by groundwater discharge to streams. The model differentiates between groundwater discharge to tributary streams of Sonoma Creek (-40,403 AFY on average; 65% of total outflows) and groundwater discharge to Sonoma Creek (-10,643 AFY on average; 17% of total outflows). The next largest outflow is groundwater pumping (-8,486 AFY on average, 14% of total outflows) followed by subsurface outflow to the southern Baylands Area (-3,011 AFY; 5% of total outflows). While net subsurface flow is from the Inland area to the Baylands Area, a small portion of groundwater flows from the Baylands area to the Inland area (51 AFY).

4.1.3 Change in Storage

Over the baseline period, a total of -27,356 AF was lost from groundwater storage, equivalent to -2,736 AFY on average.

4.2 Water Quality of Inflows and Outflows

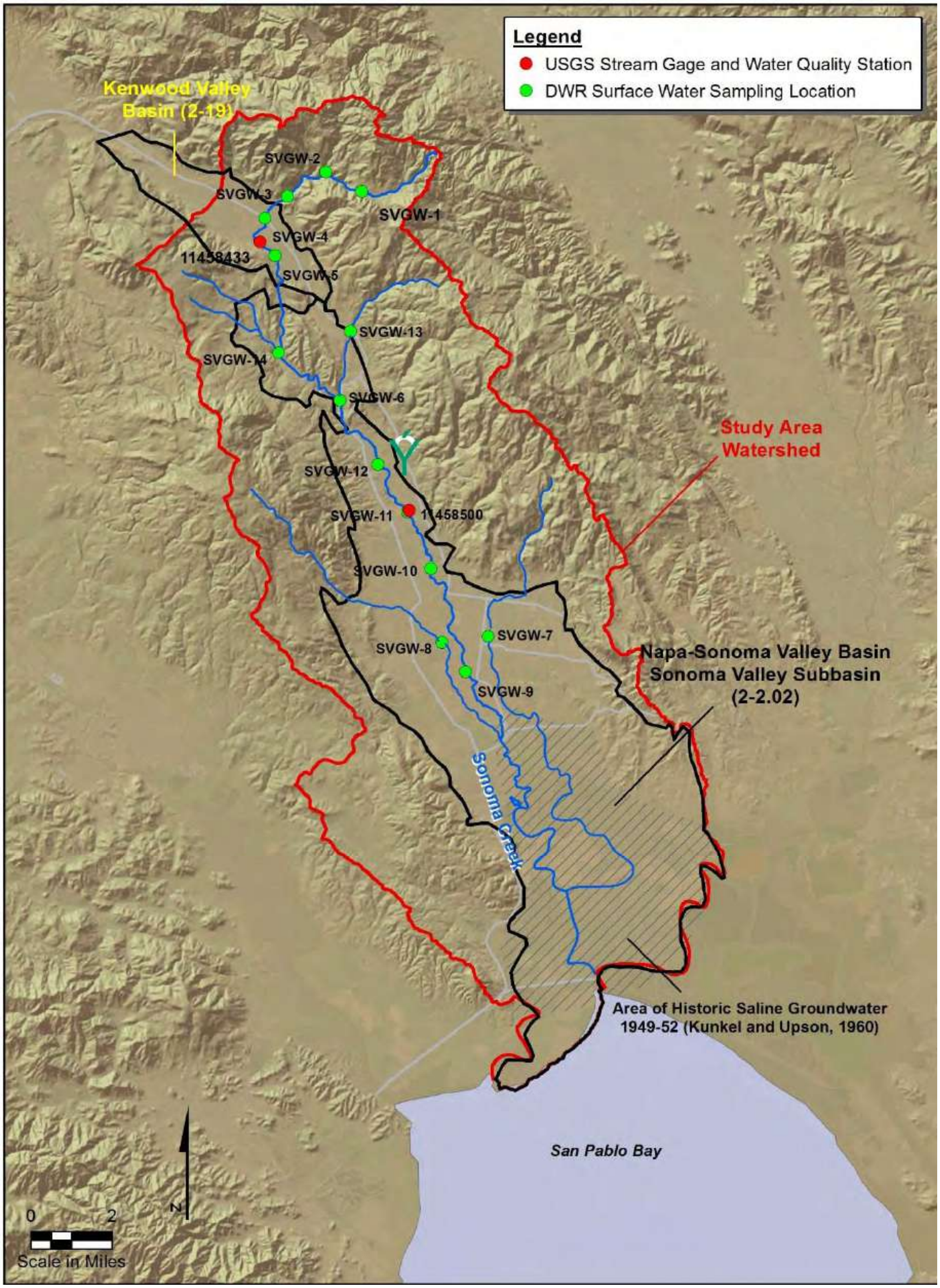
Initial and adjusted TDS and nitrate concentration estimates for subbasin inflows and outflows in the water balance are described below followed by a discussion of the baseline mixing model calibration and results.

4.2.1 Sonoma Creek Leakage

TDS and nitrate data from available surface water quality monitoring stations in the watershed were assessed to characterize the water quality of stream leakage from Sonoma Creek, the second largest subbasin inflow.

Figure 4-2 shows the locations of DWR and USGS surface water quality monitoring stations along Sonoma Creek and its tributaries. As shown in the figure, there are two USGS and fourteen DWR surface water monitoring stations with water quality data.

Figure 4-2: Surface Water Monitoring Locations



USGS stations

USGS Sonoma Creek station 11458433 – Since October 2008, daily EC has been measured for this station located in the northern portion of the subbasin. From October 2008 through March 2013, daily TDS concentrations (estimated from EC data using the regression equation on Figure 3-3) ranged from 95 to 238 mg/L, averaging 191 mg/L. No nitrate data are available.

USGS Sonoma Creek station 11458500 – While continuous EC data are not available for this station located in the central portion of the subbasin, discrete water quality data are available for two sampling events in 2002 and 2003:

- TDS concentrations were 248 and 210 mg/l in November 2002 and June 2003, respectively.
- Nitrate concentrations were non-detect (<0.06 mg/L) and 0.25 mg/L in November 2002 and June 2003, respectively.

DWR stations

Water quality sampling was conducted in May and November 2010 at fourteen DWR surface water monitoring stations shown on Figure 4-2. **Table 4-2** summarizes the TDS and nitrate results.

TDS concentrations for the fourteen DWR stations range from 140 to 301 mg/L. On average, TDS concentrations for the May 2010 samples (191 mg/L) were slightly lower than for the November 2010 samples (229 mg/L). This difference is expected given that the flow rate in Sonoma Creek (measured at USGS station 11458500) was much higher on May 4 and 5 (above 30 cubic feet per second [cfs]) (i.e. comprised predominantly of storm runoff versus groundwater discharge), compared to approximately 8 cfs on average from November 1 through 16. Average TDS concentrations of Sonoma Creek samples were only slightly higher (216 mg/L) compared to those collected from the other four tributary creeks (190 mg/L). The overall average TDS concentration for the fourteen DWR stations was 209 mg/L. **For the SNMP, a constant TDS concentration of 210 mg/L was applied to Sonoma Creek leakage for the baseline period of WY 1996-97 to WY 2005-06.**

Nitrate concentrations for the fourteen DWR stations range from 0.01 to 1.2 mg/L. There is no significant difference in nitrate concentrations between the May and November samples. Average nitrate concentrations of samples collected from Sonoma Creek were lower (0.19 mg/L) compared to those collected from the other four tributary creeks (0.40 mg/L). The average nitrate concentration for the fourteen DWR stations was 0.24 mg/L. **For the SNMP, a constant nitrate-N concentration of 0.19 mg/L was applied to Sonoma Creek leakage for the baseline period of WY 1996-97 to WY 2005-06.**

4.2.2 Deep Percolation of Areal Precipitation and Mountain Front Recharge

Recharge from deep percolation of areal precipitation and mountain front recharge represents 65% of total subbasin inflows and is the primary controlling S/N load factor. Generally, precipitation contains minimal salts and nutrients. However, due to its low solute content, precipitation also dissolves (or leaches) salts and nutrients along its subsurface flow path from near-surface soils through the vadose zone sediments and saturated zone sediments. The degree of leaching is dependent on numerous site-specific factors and is difficult to predict reliably.

Table 4-2: 2010 DWR Surface Water Quality Monitoring Results

Station ID	Stream	Sampling Date	TDS (mg/L)	Nitrate-N (mg/L)
SVGW-1	Sonoma Creek	05/04/10	198	0.07
		11/01/10	214	0.16
SVGW-2	Sonoma Creek	05/04/10	213	0.05
		11/15/10	301	
SVGW-3	Sonoma Creek	05/04/10	225	0.02
		11/01/10	231	0.14
		11/15/10		0.20
SVGW-4	Sonoma Creek	05/04/10	218	0.02
		11/01/10	230	0.32
		11/16/10		0.01
SVGW-5	Sonoma Creek	05/04/10	204	0.36
		11/16/10	234	0.09
SVGW-6	Sonoma Creek	05/04/10	186	0.32
		11/01/10	196	0.20
SVGW-7	Nathanson Creek	05/05/10	202	1.20
		11/02/10	235	0.97
SVGW-8	Carriger Creek	05/05/10	171	0.07
SVGW-9	Sonoma Creek	05/05/10	204	0.27
		11/01/10	231	0.27
SVGW-10	Sonoma Creek	05/05/10	194	0.25
		11/02/10	222	0.23
SVGW-11	Sonoma Creek	05/05/10	187	0.27
		11/01/10	221	0.20
SVGW-12	Sonoma Creek	05/05/10	189	0.32
		11/01/10	214	0.23
SVGW-13	Calabazas Creek	05/05/10	140	0.27
		11/01/10	213	0.23
SVGW-14	Yulupa Creek	05/05/10	140	0.05
		11/01/10	230	0.02
Average	**May 2010 Samples**		**191**	**0.25**
	November 2010 Samples		**229**	**0.25**
	Sonoma Creek Samples Only		**216**	**0.19**
	All Samples		**209**	**0.24**

TDS – total dissolved solids
Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter
Conf. – confluence
Hwy - Highway

TDS concentrations for deep percolation of areal precipitation and mountain front recharge were estimated from available groundwater quality of wells located in the watershed outside of the subbasin. **Figure 4-3** shows the median TDS concentrations (from 2000 to 2012) of 43 wells in the watershed outside of the subbasin. Median TDS concentrations for these wells ranged from 160 to 580 mg/L with an average of 245 mg/L. Based on these data, **an initial constant concentration of 245 mg/L TDS was applied to deep percolation of areal precipitation and mountain front recharge for the loading estimate**. Based on the mixing model calibration, **a final adjusted TDS concentration of 250 mg/L for deep percolation of areal precipitation and mountain front recharge was applied**. The basis for this TDS adjustment is discussed in Section 4.3.

The process by which airborne pollutants are deposited on the ground surface is known as dry deposition. Nitrogen is one of the pollutants commonly associated with dry deposition. Additionally, nitrogen leaching from dry deposition can occur. Nitrate concentrations for deep percolation of areal precipitation and mountain front recharge could not be estimated in the same manner as TDS, because there are no nitrate data for wells in the watershed outside of the subbasin. The USEPA manages the Clean Air Status and Trends Network (CASTNET), a national air quality monitoring network that provides data to assess trends in atmospheric deposition, among other purposes. The closest CASTNET monitoring station to the Sonoma Valley is in Hopland, California (CASTNET ID CA45) approximately 60 miles to the northwest of the valley. Annual data for the Hopland station show that precipitation nitrate concentrations ranged from 0.01 to 0.04 mg/L over the baseline period, with an average of 0.02 mg/L. Available nitrate deposition maps indicate that precipitation nitrate concentrations increase slightly to the south of the station toward Sonoma Valley. For the loading estimate, **a constant nitrate concentration of 0.06 mg/L, equivalent to the ambient average nitrate concentration in the subbasin, was applied to deep percolation of areal precipitation and mountain front recharge**.

4.2.3 Return Flows – Agricultural (Groundwater and Recycled Water), Municipal, and Septic System

Source water used for irrigation includes imported water, groundwater, and recycled water. In order to determine the quality of irrigation return flows that percolate to groundwater, the S/N concentrations for each source water used for irrigation was characterized. In addition to the S/N concentrations of the source water, S/Ns are added through use and concentrated by evapotranspiration, added through fertilizer use, and removed by plant uptake and attenuation processes in the root zone. Nutrient plant uptake is the process by which plants absorb nutrients from applied water and surrounding soil.

For the loading estimate, TDS and nitrogen mass loads for agricultural (groundwater and recycled water source water) and municipal (groundwater and imported water source water) irrigation and septic system return flows were estimated. Documentation of the loading estimates for these return flows are provided in the *Salt and Nutrient Source Identification and Loading* TM (RMC, 2013) included in Appendix C. Salt and nutrient loading for the return flows were extracted from the RMC loading model based on the land use category, irrigation source water, and presence of septic systems. Loading from agricultural return flows include grasslands, irrigated and non-irrigated agricultural lands, farmsteads, concentrated animal feed operations (CAFOs) and dairies. Municipal return flows include paved areas, urban, commercial, and industrial sources. For the mixing model, the TDS and nitrogen mass load for each return flow component was mixed with its respective annual return flow volume to obtain a concentration. For the loading estimate, it was conservatively assumed that all nitrogen mass is converted to nitrate. Based on initial simulation results for the baseline period, nitrate loading from return flows was reduced by 15% to account for attenuation processes beneath the soil root zone and septic system, in order to provide a better match between simulated average concentrations and observed regional trends.

Figure 4-3: Median TDS Concentration (2000 to 2012) Watershed Area Wells Outside Subbasin

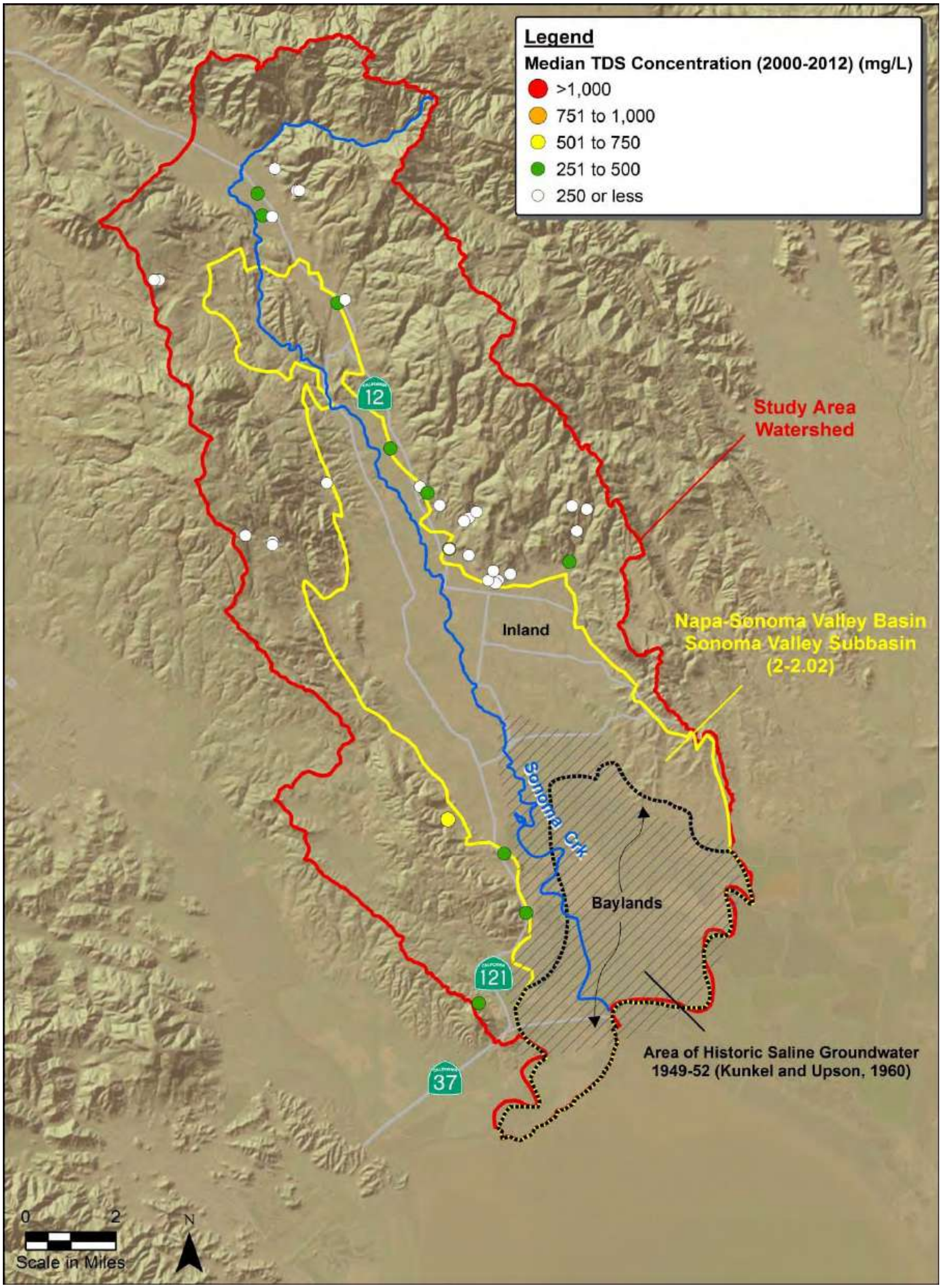


Table 4-3 shows the initial calculated and adjusted (during calibration) TDS and nitrate mass and concentrations for each return flow component. The adjusted concentrations are applied as a constant concentration over the baseline period.

Table 4-3: Return Flow TDS and Nitrate-N Mass and Concentrations for Baseline Period Analysis

Return Flows	Volumetric Rate	Initial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Return	1,415	**4,347**	**28.0**	**23.8**
Agricultural (Recycled Water) Return	91	**4,344**	**28.0**	**23.8**
Municipal Return	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,552**	**27.0**	**23.0**

[1]Initial TDS and nitrate concentrations calculated from mass loading estimates in *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013). Initial TDS concentrations for return flows were not adjusted during calibration. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.
TDS – total dissolved solids
Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter

As shown in Table 4-3, the initial and final adjusted TDS concentration of agricultural return flow (groundwater and recycled water source water) at about 4,300 mg/L is the highest of the return flow components. Differences between agricultural return flow concentrations/mass for groundwater and recycled water are attributable to differences in source water quality. The TDS concentration of municipal return flow (1,182 mg/L) is lower than for agricultural return flows. Septic system return flows have the lowest TDS concentration (572 mg/L) compared to the agricultural and municipal return flows. Overall, the volume weighted-average TDS concentration of the agricultural, municipal, and septic system return flows is 2,552 mg/L.

Initial nitrate concentrations in the table represent the concentration of return flows at the base of the soil root zone or at the septic system. Based on the mixing model calibration, **the nitrate concentration for each individual return flow component was adjusted downward by 15% in the mixing model to account for additional nitrate attenuation by soil bacteria below the root zone/septic system**. The basis for this adjustment is described in more detail in Section 4.3.

For nitrate, initial and adjusted agricultural return flow (groundwater and recycled water source water) have the same concentrations (28.0 mg/L and 23.8 mg/L, respectively). Similar to TDS, the initial and adjusted nitrate concentration of municipal return flow (23.9 mg/L and 20.3, respectively) are lower than for agricultural returns. Septic system return flows have a higher initial and adjusted nitrate concentrations (30.0 mg/L and 25.5 mg/L, respectively) compared to the agricultural and municipal return flows. Overall, the volume weighted-average initial and adjusted nitrate concentrations of the agricultural, municipal, and septic system return flows are 27.0 mg/L and 23.0 mg/L, respectively.

4.2.4 Subsurface Inflows from Baylands Area

While groundwater levels and the flow model-based water balance indicate that subsurface groundwater flows generally from the Inlands area to the Baylands Area, there is a small component of subsurface inflow from the Baylands Area. This is likely caused by groundwater pumping, which has created a pumping depression in the southern portion of the subbasin.

The concentrations applied to subsurface inflows from the Baylands Area were assumed to be the current average concentration in the Baylands Area (1,220 mg/L for TDS and 0.07 mg/L for nitrate-N).

4.3 Mixing Model Calibration and Salt and Nutrient Balance

In order to simulate the effect of current S/N loading on groundwater quality in the Inland Area of the subbasin, a spreadsheet mixing model was developed. As discussed in Section 3.5.5, the simulated baseline period concentrations and trends are compared to the predominant pattern of observed concentrations and trends. Loading factors may be adjusted (calibrated) to achieve a better match between simulated and observed concentrations and trends.

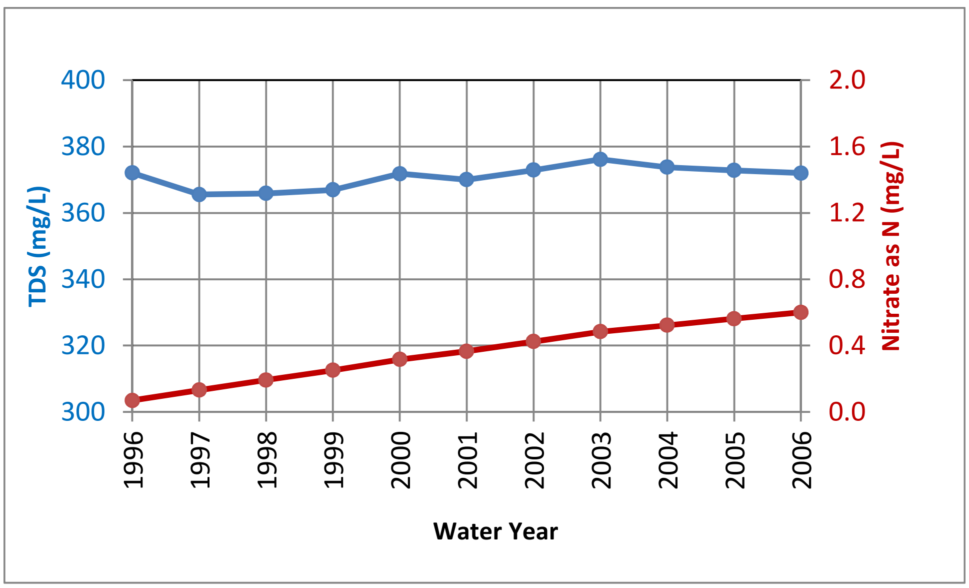
Based on initial baseline simulations, the estimated concentration for one TDS loading factor was adjusted. For the final calibration, the TDS concentration for deep percolation of areal precipitation and mountain front recharge was adjusted upwards from 245 mg/L to 250 mg/L. This adjustment resulted in a more reasonable match between simulated and observed TDS trends.

With respect to nitrate, preliminary mixing model results indicated that initial nitrate loading to groundwater was likely overestimated, resulting in the average concentration of nitrate in the Inland Area to increase measurably over the baseline period. For the final calibration, nitrate loading from return flows was reduced by 15% in the mixing model to account for additional attenuation by soil bacteria below the root zone and septic system, which was not considered in the *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013).

No other inflow loading estimates were adjusted for the baseline period calibration.

Figure 4-4 shows the final simulated average subbasin TDS and nitrate concentrations over the 10-year baseline period (WY 1996 represents the hypothetical initial water quality condition equivalent to the current ambient condition).

Figure 4-4: Final Simulated Baseline Average Groundwater Concentrations for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)



As shown in the figure, simulated average subbasin TDS concentrations vary slightly from year to year, but exhibit no change over the 10-year baseline period. This flat trend compares well to observed flat trends in wells across the subbasin over the baseline period, as indicated in TDS and EC time-concentration plots shown in Figures 3-8 and 3-9, respectively.

In contrast to the TDS trend, simulated average nitrate-N concentrations increase by about 0.5 mg/L over the baseline period, despite nitrate loading from return flows being reduced by 15% to account for additional attenuation below the root zone/septic system. Observed nitrate concentrations in monitoring wells across the subbasin (see Figure 3-13) are not increasing regionally, but instead show overall flat or stable concentrations over time. The discrepancy between simulated and observed trends may be caused by an overestimate of the nitrate load due to one or more of the following:

1. assumption that 100% of nitrogen is converted to nitrate;
2. potential underestimation of ambient average groundwater nitrate concentrations due to limited spatial distribution of wells with recent nitrate data;
3. Application of all nitrate loading associated with recycled water use within the Inlands area in the mixing model, despite portions of existing (and proposed future) recycled water use areas being located south of the Inlands area in the Baylands area (see Figure 2-1),
4. Underestimation of nitrate attenuation below the root zone/septic system in the mixing model

For the reasons mentioned above, simulated nitrate concentrations generated from the calibrated mixing model are likely conservative and overestimated for both baseline and future nitrogen loading. While application of higher nitrate attenuation rate was considered, given the limited distribution of monitoring wells with long-term nitrate trend data in the subbasin, a 15% attenuation rate was maintained.

Table 4-4 and **Figure 4-5** show the baseline period TDS mass balance for the Inland Area of the Sonoma Valley Subbasin. The mass balance is based on the annual volumetric flows and final calibrated TDS concentrations applied to each S/N loading factor. As shown in table and figure, the largest TDS load is from deep percolation of areal precipitation and mountain front recharge, which represents 57% of the overall TDS loading to the subbasin. Agricultural (groundwater source water) return is the second largest TDS load (28% of total loading), followed by Sonoma Creek leakage (6%) and municipal return (6%). Septic system return, agricultural (recycled water) return, and subsurface inflow from the Baylands Area each represent less than 2% of the total TDS loading in the subbasin.

The annual change in TDS mass varies annually from about -9,000 tons to +5,600 tons. Over the baseline period, TDS mass decreased by about 15,300 tons. It is noted that the direction (positive or negative) of the change in mass does not necessarily correlate to a change in average TDS concentration in the same direction (increase or decrease). This is best explained by an example: in WY 2000-01, TDS mass in the subbasin increased by 5,400 tons. However, the average subbasin TDS concentration decreased by 1.8 mg/L that year, because groundwater storage gains outweighed the positive change in TDS mass that year due to the large influx of low-TDS areal precipitation and mountain front recharge. This example demonstrates the importance of evaluating the mass balance within the context of the water balance.

Table 4-5 and **Figure 4-6** show the nitrate mass balance for the baseline period for the Inland area of the Sonoma Valley Subbasin. As shown in table and figure, the largest nitrate load is agricultural (groundwater source water) return, which represents approximately 43% of the overall nitrate loading to the subbasin. Municipal return is the second largest TDS load (28% of total loading), followed by septic system return (20%), deep percolation of areal precipitation and mountain front recharge (4%) and agricultural (recycled water source water) return (3%). Sonoma Creek leakage and subsurface inflow from the Baylands Area represent minor nitrate loading factors in the subbasin. The change in nitrate mass varies annually from about +60 tons to +101 tons. Over the baseline period, nitrate mass increased by about 807 tons.

Table 4-4: Baseline TDS Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)

	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	Average
					All values in tons						
INFLOWS											
Aerial Precipitation / Mtn. Front Recharge	39,988	17,113	14,222	368	22,694	7,110	5,791	23,517	19,781	19,356	16,994
Sonoma Creek Leakage	1,527	1,598	1,718	1,968	1,902	1,924	2,075	1,906	1,786	1,765	1,817
Agricultural (Groundwater) Irrigation Return	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363
Agricultural (Recycled Water) Irrigation Return	538	538	538	538	538	538	538	538	538	538	538
Municipal Irrigation Return	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726
Septic System Return	483	483	483	483	483	483	483	483	483	483	483
Subsurface Inlow from Baylands	89	93	89	82	79	81	77	79	85	86	84
TOTAL INFLOWS	**52,714**	**29,913**	**27,138**	**13,526**	**35,783**	**20,223**	**19,051**	**36,611**	**32,761**	**32,315**	**30,003**
OUTFLOWS											
Groundwater Pumping	-4,149	-4,116	-4,184	-4,223	-4,289	-4,264	-4,296	-4,425	-4,488	-4,347	-4,278
Groundwater Discharge to Tributary Streams	-38,072	-25,039	-20,313	-12,658	-19,597	-14,036	-12,066	-20,100	-20,733	-21,085	-20,370
Groundwater Discharge to Sonoma Creek	-7,384	-6,393	-5,658	-4,359	-5,091	-4,621	-4,134	-5,091	-5,421	-5,485	-5,364
Subsurface Outflow to Baylands	-1,855	-1,770	-1,601	-1,325	-1,416	-1,377	-1,258	-1,437	-1,560	-1,577	-1,518
TOTAL OUTFLOWS	**-51,460**	**-37,319**	**-31,755**	**-22,565**	**-30,393**	**-24,298**	**-21,754**	**-31,053**	**-32,203**	**-32,493**	**-31,529**
Annual TDS Mass Change	1,254	-7,406	-4,618	-9,040	5,390	-4,076	-2,702	5,558	558	-178	-1,526
Cumulative TDS Mass Change	1,254	-6,152	-10,769	-19,809	-14,419	-18,495	-21,197	-15,639	-15,081	-15,259	

Mtn. – mountain
TDS – total dissolved solids
WY – water year

Figure 4-5: Baseline TDS Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)

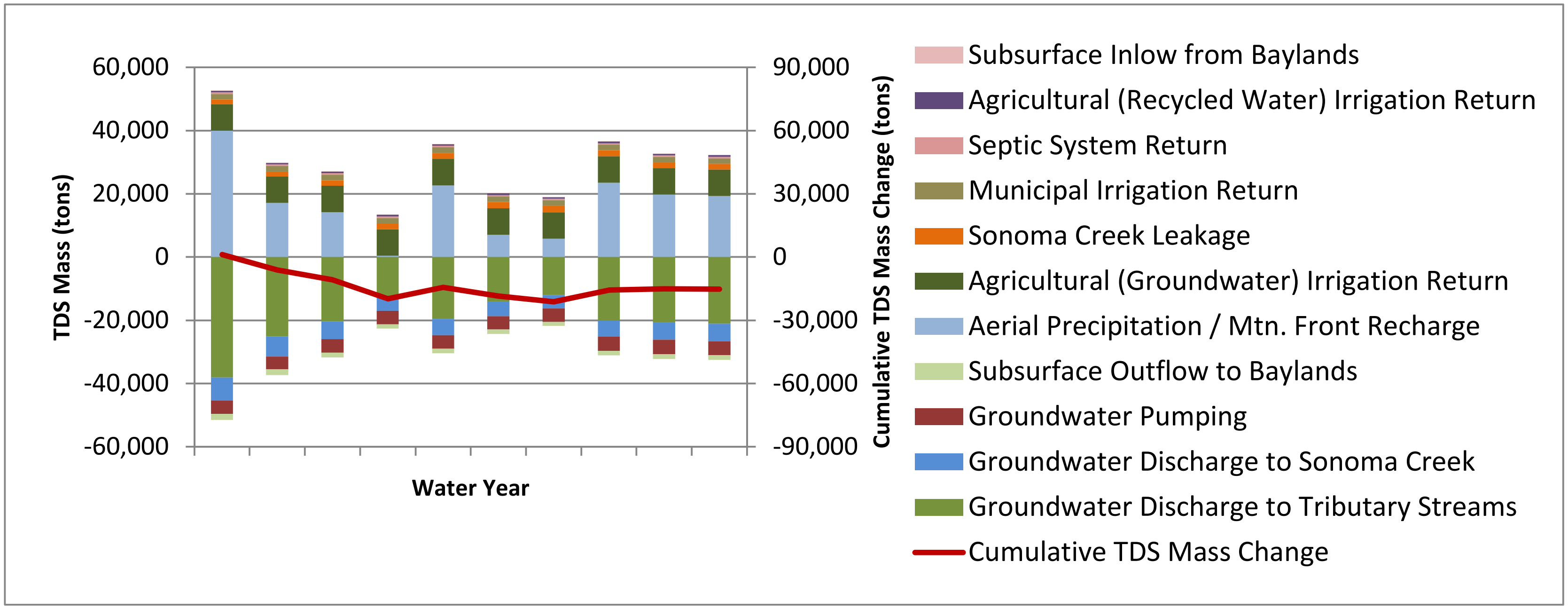
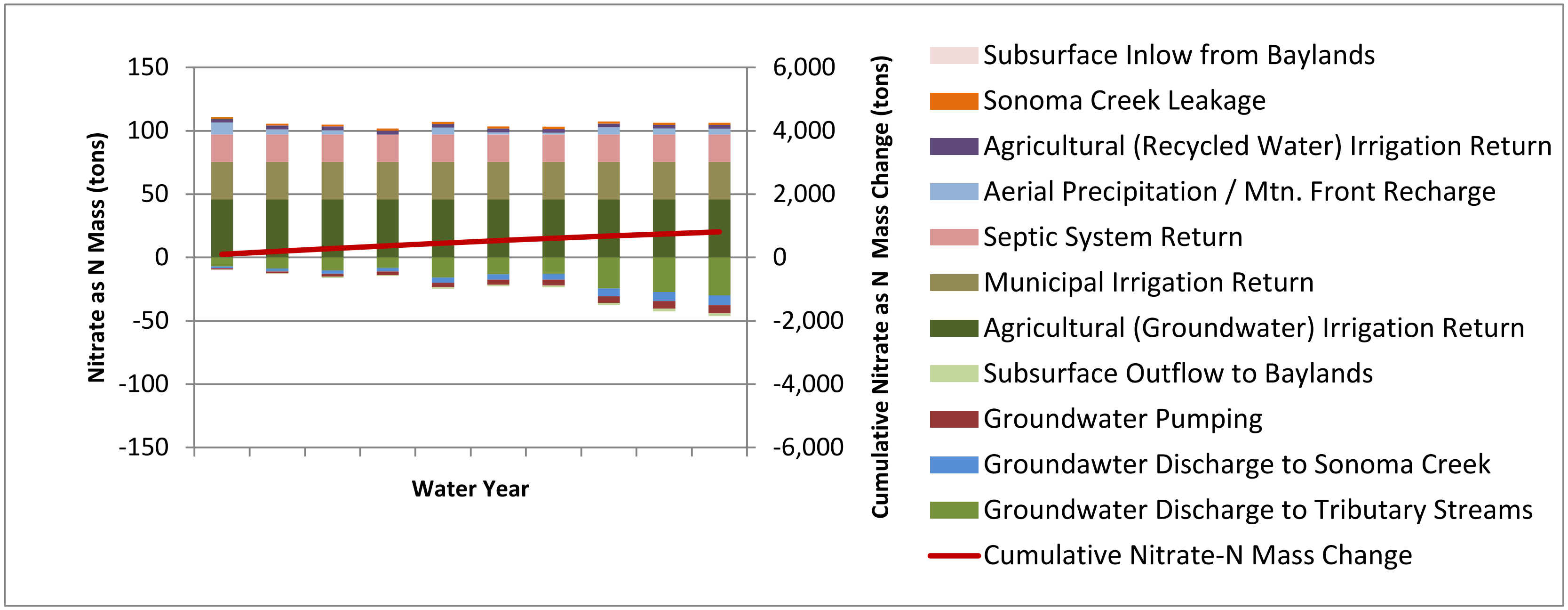


Table 4-5: Baseline Nitrate-N Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)

	1996-97	1997-98	1998-99	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	Average
					All values in tons						
INFLOWS											
Aerial Precipitation / Mtn. Front Recharge	9.6	4.1	3.4	0.1	5.4	1.7	1.4	5.6	4.7	4.6	4.1
Sonoma Creek Leakage	1.4	1.4	1.6	1.8	1.7	1.7	1.9	1.7	1.6	1.6	1.6
Agricultural (Groundwater) Irrigation Return	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8
Agricultural (Recycled Water) Irrigation Return	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Municipal Irrigation Return	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
Septic System Return	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Subsurface Inflow to Baylands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL INFLOWS	**110.9**	**105.5**	**104.9**	**101.9**	**107.1**	**103.4**	**103.2**	**107.3**	**106.3**	**106.2**	**105.7**
OUTFLOWS											
Groundwater Pumping	-0.8	-1.4	-2.1	-2.8	-3.5	-4.0	-4.6	-5.4	-5.9	-6.2	-3.7
Groundwater Discharge to Tributary Streams	-7.2	-8.8	-10.2	-8.3	-15.8	-13.1	-13.0	-24.4	-27.3	-29.9	-15.8
Groundwater Discharge to Sonoma Creek	-1.4	-2.2	-2.9	-2.8	-4.1	-4.3	-4.4	-6.2	-7.1	-7.8	-4.3
Subsurface Outflow to Baylands	-0.3	-0.6	-0.8	-0.9	-1.1	-1.3	-1.4	-1.7	-2.1	-2.2	-1.2
TOTAL OUTFLOWS	**-9.7**	**-13.1**	**-16.0**	**-14.7**	**-24.5**	**-22.7**	**-23.4**	**-37.7**	**-42.4**	**-46.2**	**-25.0**
Annual Nitrate-N Mass Change	101.3	92.5	88.9	87.1	82.6	80.7	79.9	69.7	63.9	60.1	80.7
Cumulative Nitrate-N Mass Change	101.3	193.7	282.7	369.8	452.4	533.1	612.9	682.6	746.6	806.6	

Mtn. – mountain
Nitrate-N – nitrate as nitrogen
WY – water year

Figure 4-6: Baseline Nitrate-N Balance for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)



5 Future Planning Period Water Quality

The *Salt and Nutrient Source Identification and Loading* TM (RMC, 2013) identified future projections for imported water use, and increased recycled water use through the future planning period. These projections define the future projects simulated in this TM. Future project changes are superimposed over average water balance conditions during the 10-year baseline period to simulate future groundwater quality. The spreadsheet mixing model developed for the baseline analysis was modified to evaluate the effects of planned future S/N loading on overall groundwater quality in the Sonoma Valley Subbasin for the future planning period (WY 2013-14 through WY 2034-35).

The mixing model methodology is described in Sections 3.5.5. Baseline conditions for the Inland Area of Sonoma Valley Subbasin between WY 1996-97 through WY 2005-06 were simulated with the mixing model. Comparison of simulated and actual observed water quality concentrations and trends during the baseline period were used to adjust key loading factors. The calibrated loading factors are then applied to the future loading assumptions. The mixing model is used to predict future water quality, water quality trends, and the percentage of the existing available assimilative capacity used by recycled water projects in the subbasin during the future planning period. The mixing model is designed to incorporate the existing volume of groundwater and mass of TDS and nitrate in storage and track the annual change in groundwater storage and S/N mass for the subbasin as a whole.

A No-Project scenario was simulated to evaluate the impacts of future recycled water projects. For the No-Project scenario, average water balance conditions (WY 1996-97 through WY 2013-14) over the baseline conditions were reproduced for each year of the future planning period.

Future projected changes included the following:

- Increased use of recycled water for agricultural irrigation (replacing groundwater). Two future scenarios were simulated:
    - Planned recycled water use by 2035 (Scenario 1)
    - Planned recycled water use by 2035 plus an additional 5,000 AFY of recycled water (Scenario 2)

While recycled water use is projected to ramp up gradually over time, the maximum 2035 recycled water use conditions were applied beginning in WY 2013-14 and applied over the entire future planning period (from WY 2013-14 through WY 2034-35). Additionally, while portions of existing and proposed future recycled water use areas are located south of the Inlands Area in the Baylands Area (see Figure 2-1), all S/N loading associated with recycled water use was applied in the Inlands Area. Thus, the simulated groundwater quality impacts from recycled water projects are considered highly conservative. Also, while future conditions within the Baylands Area were not explicitly simulated, it is expected that replacing groundwater with recycled water for irrigation will lower TDS levels in groundwater because recycled water has lower TDS concentrations than the average groundwater in the Baylands Area.

Although future stormwater capture and recharge is planned for the area (approximately 50 AFY), to maintain a conservative projection, this recharge source water was not applied to the model.

5.1 Scenarios

Three future scenarios were simulated:

- Future Scenario 0 (No-Project): Assumes average baseline water balance conditions and no additional enhanced stormwater capture and recharge is applied.

- Future Scenario 1: Assumes 2035 planned recycled water use of about 4,100 AFY (applied consistently from WY 2013-14 through WY 2034-35)
- Future Scenario 2: Assumes 2035 planned recycled water use plus an additional 5,000 AFY of recycled water (applied consistently from WY 2013-14 through WY 2034-35).

5.2 Water Balances

The water balance for Scenario 0 (No-Project) is shown in **Table 5-1** and **Figure 5-1**. The water balance for Future Scenario 1 is shown in **Table 5-2** and **Figure 5-2**. The water balance for Future Scenario 2 is shown in **Table 5-3** and **Figure 5-3**. The table and figure shows that for all three future scenarios a total of 66,299 AF is lost from groundwater storage over the 22-year future planning horizon, corresponding to an average annual loss of 3,014 AFY. Agricultural (recycled water) irrigation return flows increase from No-Project (91 AFY) to Scenario 1 (508 AFY) to Scenario 2 (1,132 AFY), while agricultural (groundwater) irrigation return flows decrease from No-Project (1,415 AFY) to Scenario 1 (998 AFY) to Scenario 2 (374 AFY).

5.3 Water Quality

The average TDS and nitrate concentrations for the baseline period were applied to all future scenarios for the following inflows:

- deep percolation of areal precipitation and mountain front recharge
- leakage from Sonoma Creek
- subsurface inflow from Baylands area

Concentrations for future return flow components are described below.

5.3.1 Return Flows – Agricultural and Municipal Irrigation and Septic System

The same methodology used to estimate TDS and nitrogen loading from return flows over the baseline period was used to estimate future return flow loading. Documentation of future loading estimates for return flows is provided in the *Salt and Nutrient Source Identification and Loading* TM (RMC, 2013). For the mixing model, mass loads for each return flow component were mixed with respective annual return flow volumes to obtain a concentration. Similar to the baseline period analysis, 100% of the nitrogen mass is assumed to convert to nitrate. To account for attenuation below the root zone, the same 15% reduction in nitrate loading from return flows applied in the baseline calibration was also applied in future simulations.

Table 5-1: Future Scenario 0 (No-Project) Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
	All values in acre-feet per year (AFY) unless otherwise noted																					
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915
Sonoma Creek Leakage	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363
Agricultural (Groundwater) Irrigation Return	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415	1,415
Agricultural (Recycled Water) Irrigation Return	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91
Municipal Irrigation Return	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074
Septic System Return	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621
Subsurface Inflow from Baylands	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
TOTAL INFLOWS	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**
OUTFLOWS																						
Groundwater Pumping	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486
Groundwater Discharge to Tributary Streams	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403
Groundwater Discharge to Sonoma Creek	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643
Subsurface Outflow to Baylands	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011
TOTAL OUTFLOWS	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**
ANNUAL STORAGE CHANGE (AF)	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014
CUMULATIVE STORAGE CHANGE (AF)	-3,014	-6,027	-9,041	-12,054	-15,068	-18,081	-21,095	-24,109	-27,122	-30,136	-33,149	-36,163	-39,176	-42,190	-45,204	-48,217	-51,231	-54,244	-57,258	-60,271	-63,285	-66,299

Mtn. – mountain
AF – acre-feet
WY – water year

Figure 5-1: Future Scenario 0 (No-Project) Water Balance for Inland Area of Sonoma Valley (WYs 2014-2035)

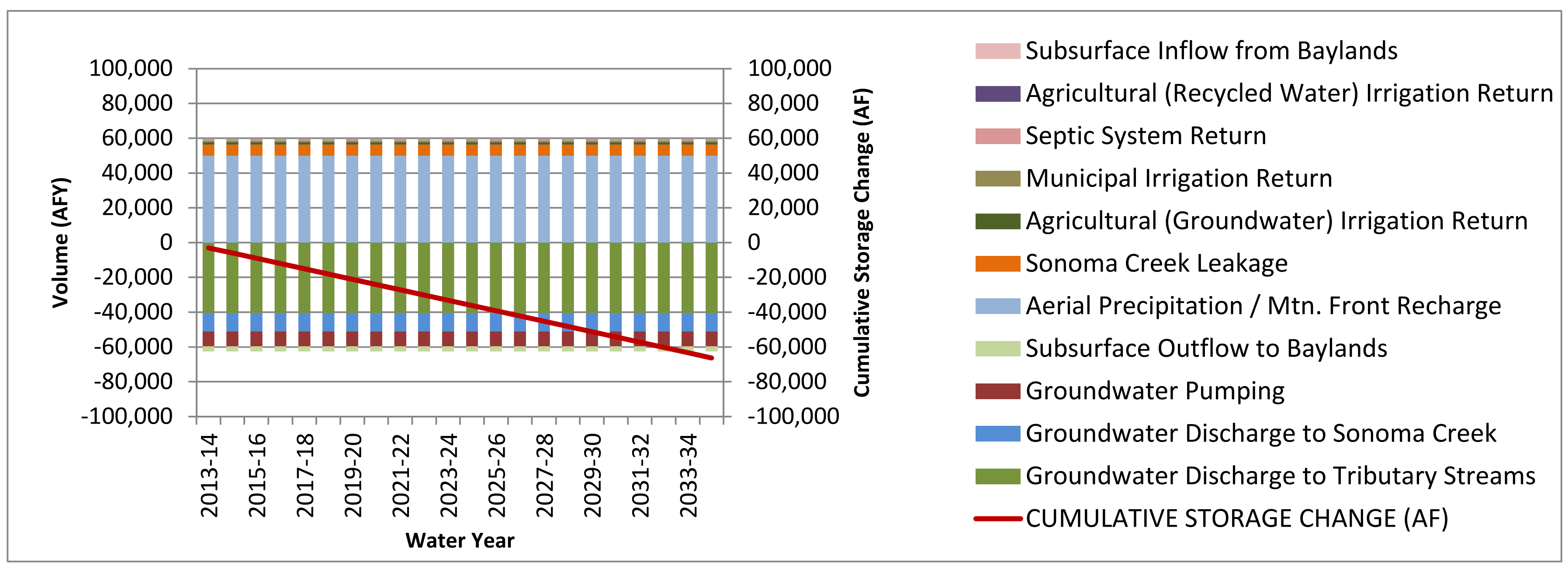


Table 5-2: Future Scenario 1 (2035 recycled water conditions) Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
	All values in acre-feet per year (AFY) unless otherwise noted																					
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915
Sonoma Creek Leakage	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363
Agricultural (Groundwater) Irrigation Return	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998
Agricultural (Recycled Water) Irrigation Return	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508	508
Municipal Irrigation Return	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074
Septic System Return	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621
Subsurface Inflow from Baylands	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
TOTAL INFLOWS	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**
OUTFLOWS																						
Groundwater Pumping	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486
Groundwater Discharge to Tributary Streams	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403
Groundwater Discharge to Sonoma Creek	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643
Subsurface Outflow to Baylands	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011
TOTAL OUTFLOWS	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**
ANNUAL STORAGE CHANGE (AF)	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014
CUMULATIVE STORAGE CHANGE (AF)	-3,014	-6,027	-9,041	-12,054	-15,068	-18,081	-21,095	-24,109	-27,122	-30,136	-33,149	-36,163	-39,176	-42,190	-45,204	-48,217	-51,231	-54,244	-57,258	-60,271	-63,285	-66,299

Mtn. – mountain
AF – acre-feet
WY – water year

Figure 5-2: Future Scenario 1 (2035 recycled water conditions) Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

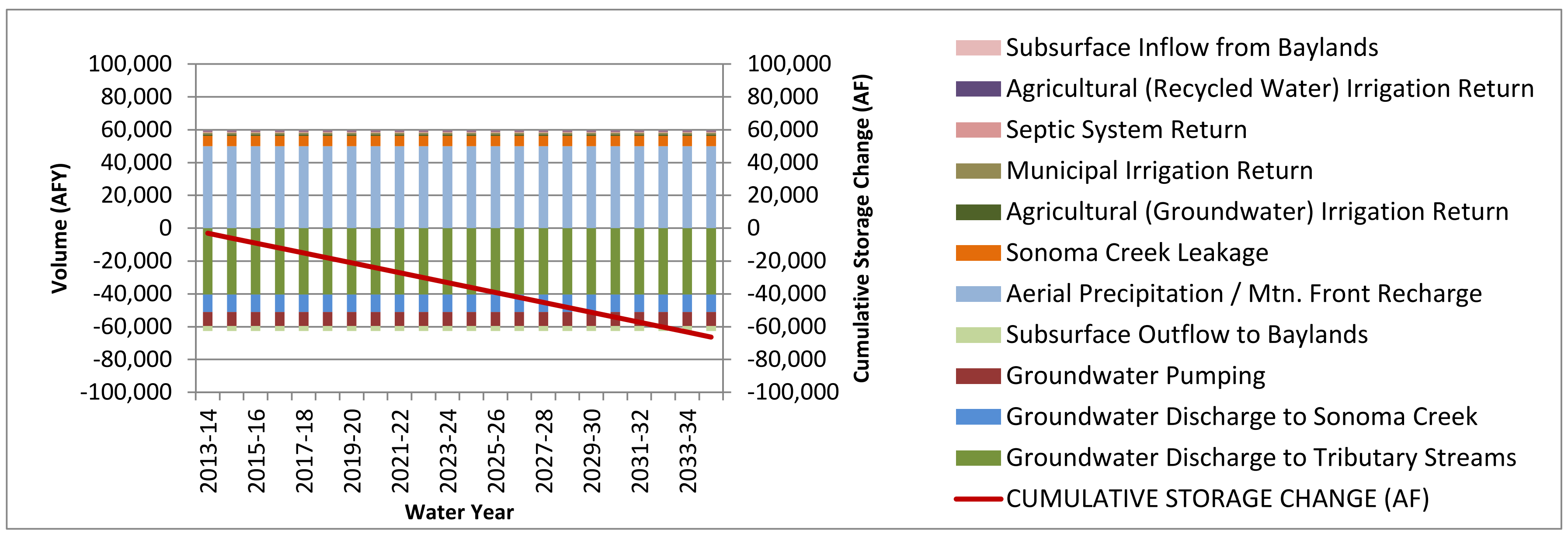
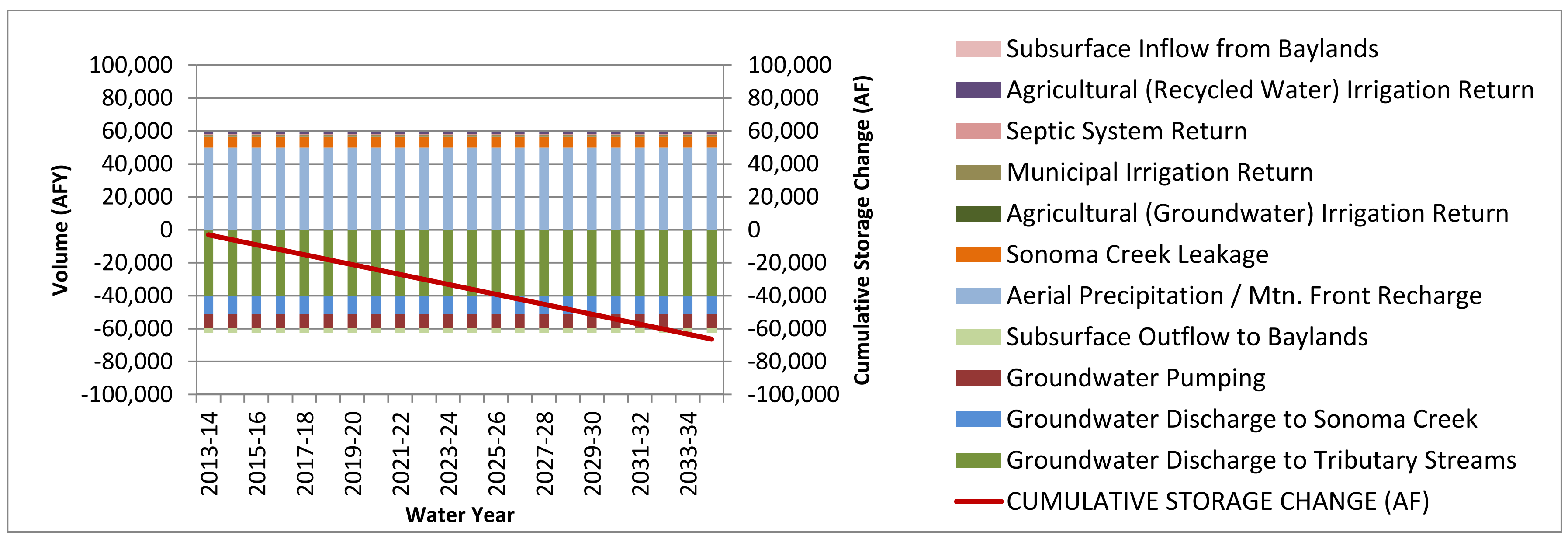


Table 5-3: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
	All values in acre-feet per year (AFY) unless otherwise noted																					
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915	49,915
Sonoma Creek Leakage	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363	6,363
Agricultural (Groundwater) Irrigation Return	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374	374
Agricultural (Recycled Water) Irrigation Return	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132	1,132
Municipal Irrigation Return	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074	1,074
Septic System Return	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621	621
Subsurface Inflow from Baylands	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51
TOTAL INFLOWS	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**	**59,529**
OUTFLOWS																						
Groundwater Pumping	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486	-8,486
Groundwater Discharge to Tributary Streams	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403	-40,403
Groundwater Discharge to Sonoma Creek	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643	-10,643
Subsurface Outflow to Baylands	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011	-3,011
TOTAL OUTFLOWS	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**	**-62,543**
ANNUAL STORAGE CHANGE (AF)	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014	-3,014
CUMULATIVE STORAGE CHANGE (AF)	-3,014	-6,027	-9,041	-12,054	-15,068	-18,081	-21,095	-24,109	-27,122	-30,136	-33,149	-36,163	-39,176	-42,190	-45,204	-48,217	-51,231	-54,244	-57,258	-60,271	-63,285	-66,299

Mtn. – mountain
AF – acre-feet
WY – water year

Figure 5-3: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) Water Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)



Tables 5-4 through **5-6** show the calculated TDS and nitrate mass and concentrations of each return flow for Scenario 0 (No-Project), Scenario 1, and Scenario 2, respectively. The adjusted values are applied as a constant concentration over the entire future planning period.

For both TDS and nitrate, the total cumulative mass and weighted-average concentration of return flows increases slightly from Scenario 0 (No-Project) to Scenario 1 to Scenario 2.

Table 5-4: Future Scenario 0 (No-Project)
Return Flow TDS and Nitrate-N Concentrations

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	1,415	**4,347**	**28.0**	**23.8**
Agircultural (Recycled Water) Irrigation	91	**4,344**	**28.0**	**23.8**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,552**	**27.0**	**23.0**

[1]Initial TDS and nitrate concentrations calculated from mass loading estimates in *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013). Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.
TDS – total dissolved solids
Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter

Table 5-5: Future Scenario 1 (2035 recycled water conditions)
Return Flow TDS and Nitrate-N Concentrations

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	998	**4,481**	**29.3**	**24.9**
Agircultural (Recycled Water) Irrigation	508	**4,479**	**29.3**	**24.9**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,615**	**27.6**	**23.5**

[1]Initial TDS and nitrate concentrations calculated from mass loading estimates in *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013). Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.
TDS – total dissolved solids
Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter

Table 5-6: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) Return Flow TDS and Nitrate-N Concentrations

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	374	**4,706**	**31.6**	**26.8**
Agircultural (Recycled Water) Irrigation	1,132	**4,706**	**31.6**	**26.8**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,722**	**28.7**	**24.4**

[1]Initial TDS and nitrate concentrations calculated from mass loading estimates in *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013). Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.
TDS – total dissolved solids
Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter

5.4 Future Salt and Nutrient Mass Balances

5.4.1 TDS Mass Balances

Table 5-7 through **5-9** show the TDS mass balances for the three future scenarios. The mass balances are also depicted in **Figures 5-4** through **5-6**. The tables and figures show that the cumulative change in TDS mass from WY 2013-14 through WY 2034-35 is negative for all three scenarios. For Scenario 0 (No-Project), the cumulative change in TDS mass is -34,941 tons. The negative cumulative change in TDS mass is slightly smaller for Scenario 1 (-31,315 tons) and even smaller for Scenario 2 (-25,213 tons).

For Scenario 0 (No-Project), TDS mass loading factors presented from largest to smallest are as follows:

1) areal precipitation and mountain front recharge
2) agricultural (groundwater source water) irrigation return
3) Sonoma Creek leakage
4) municipal irrigation return
5) agricultural (recycled water source water) return
6) septic system return
7) subsurface inflow from the Baylands Area

For Scenario 1, TDS mass loading from agricultural (recycled water source water) irrigation return flow increases and represents the third largest TDS loading factor. Agricultural (groundwater source water) irrigation return flow decreases but remains the second largest TDS mass loading factor. All other factors have the same TDS mass loading as in the No-Project scenario.

For Scenario 2, TDS mass loading from agricultural (recycled water source water) irrigation return increases and replaces agricultural (groundwater source water) irrigation return as the second largest TDS loading factor. Agricultural (groundwater source water) irrigation return decreases and represents the third largest TDS mass loading factor. All other factors have the same TDS mass loading as in the No-Project scenario.

Table 5-7: Future Scenario 0 (No-Project) TDS Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

All values in tons

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994
Sonoma Creek Leakage	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817
Agricultural (Groundwater) Irrigation Return	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363	8,363
Agricultural (Recycled Water) Irrigation Return	538	538	538	538	538	538	538	538	538	538	538	538	538	538	538	538	538	538	538	538	538	538
Municipal Irrigation Return	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182	1,182
Septic System Return	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483
Subsurface Inflow from Baylands	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84
TOTAL INFLOWS	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**	**30,003**
OUTFLOWS																						
Groundwater Pumping	-4,292	-4,290	-4,288	-4,286	-4,284	-4,282	-4,281	-4,279	-4,278	-4,276	-4,275	-4,274	-4,272	-4,271	-4,270	-4,269	-4,268	-4,267	-4,266	-4,265	-4,264	-4,263
Groundwater Discharge to Tributary Streams	-20,436	-20,426	-20,416	-20,407	-20,398	-20,390	-20,382	-20,374	-20,367	-20,360	-20,354	-20,348	-20,342	-20,336	-20,331	-20,326	-20,321	-20,316	-20,312	-20,308	-20,304	-20,300
Groundwater Discharge to Sonoma Creek	-5,383	-5,381	-5,378	-5,376	-5,373	-5,371	-5,369	-5,367	-5,365	-5,363	-5,362	-5,360	-5,358	-5,357	-5,356	-5,354	-5,353	-5,352	-5,351	-5,349	-5,348	-5,347
Subsurface Outflow to Baylands	-1,523	-1,522	-1,522	-1,521	-1,520	-1,520	-1,519	-1,519	-1,518	-1,518	-1,517	-1,517	-1,516	-1,516	-1,515	-1,515	-1,515	-1,514	-1,514	-1,514	-1,513	-1,513
TOTAL OUTFLOWS	**-31,634**	**-31,629**	**-31,624**	**-31,619**	**-31,614**	**-31,610**	**-31,605**	**-31,601**	**-31,597**	**-31,594**	**-31,590**	**-31,587**	**-31,583**	**-31,580**	**-31,578**	**-31,575**	**-31,572**	**-31,570**	**-31,567**	**-31,565**	**-31,563**	**-31,561**
Annual TDS Mass Change	-1,631	-1,625	-1,620	-1,615	-1,611	-1,606	-1,602	-1,598	-1,594	-1,590	-1,587	-1,583	-1,580	-1,577	-1,574	-1,571	-1,569	-1,566	-1,564	-1,562	-1,559	-1,557
Cumulative TDS Mass Change	-1,631	-3,256	-4,876	-6,492	-8,102	-9,708	-11,310	-12,908	-14,502	-16,092	-17,678	-19,262	-20,842	-22,419	-23,993	-25,564	-27,133	-28,699	-30,263	-31,824	-33,383	-34,941

Mtn. – mountain
TDS – total dissolved solids
WY – water year

Figure 5-4: Future Scenario 0 (No-Project) TDS Mass Balance for Inland Area of Sonoma Valley (WYs 2014-2035)

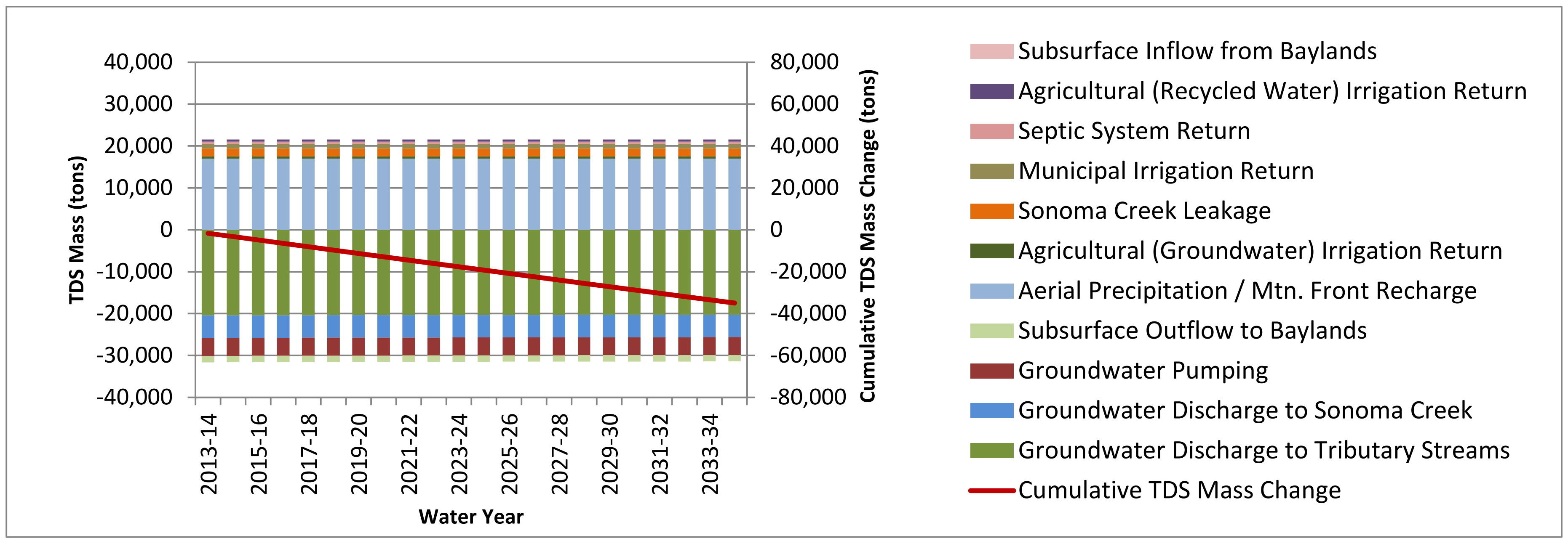


Table 5-8: Future Scenario 1 (2035 recycled water conditions) TDS Mass Balance for Inland Area of Sonoma Valley (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
											All values in tons											
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994
Sonoma Creek Leakage	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817
Agricultural (Groundwater) Irrigation Return	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081	6,081
Agricultural (Recycled Water) Irrigation Return	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094	3,094
Municipal Irrigation Return	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726
Septic System Return	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483
Subsurface Inflow from Baylands	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84
TOTAL INFLOWS	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**	**30,278**
OUTFLOWS																						
Groundwater Pumping	-4,292	-4,293	-4,294	-4,295	-4,296	-4,297	-4,298	-4,299	-4,300	-4,301	-4,302	-4,302	-4,303	-4,304	-4,304	-4,305	-4,305	-4,306	-4,306	-4,307	-4,307	-4,317
Groundwater Discharge to Tributary Streams	-20,436	-20,441	-20,447	-20,452	-20,456	-20,461	-20,465	-20,469	-20,473	-20,477	-20,481	-20,484	-20,487	-20,491	-20,494	-20,496	-20,499	-20,502	-20,504	-20,506	-20,509	-20,555
Groundwater Discharge to Sonoma Creek	-5,383	-5,385	-5,386	-5,387	-5,389	-5,390	-5,391	-5,392	-5,393	-5,394	-5,395	-5,396	-5,397	-5,398	-5,398	-5,399	-5,400	-5,401	-5,401	-5,402	-5,402	-5,415
Subsurface Outflow to Baylands	-1,523	-1,524	-1,524	-1,524	-1,525	-1,525	-1,525	-1,526	-1,526	-1,526	-1,527	-1,527	-1,527	-1,527	-1,528	-1,528	-1,528	-1,528	-1,528	-1,528	-1,529	-1,532
TOTAL OUTFLOWS	**-31,634**	**-31,643**	**-31,651**	**-31,659**	**-31,666**	**-31,673**	**-31,680**	**-31,686**	**-31,692**	**-31,698**	**-31,704**	**-31,709**	**-31,714**	**-31,719**	**-31,724**	**-31,728**	**-31,732**	**-31,736**	**-31,740**	**-31,743**	**-31,747**	**-31,818**
Annual TDS Mass Change	-1,356	-1,365	-1,373	-1,381	-1,388	-1,395	-1,402	-1,408	-1,415	-1,420	-1,426	-1,431	-1,436	-1,441	-1,446	-1,450	-1,454	-1,458	-1,462	-1,466	-1,469	-1,472
Cumulative TDS Mass Change	-1,356	-2,721	-4,094	-5,475	-6,863	-8,258	-9,660	-11,069	-12,483	-13,904	-15,330	-16,761	-18,197	-19,638	-21,084	-22,534	-23,988	-25,446	-26,908	-28,374	-29,843	-31,315

Mtn. – mountain
TDS – total dissolved solids
WY – water year

Figure 5-5: Future Scenario 1 (2035 recycled water conditions) TDS Mass Balance for Inland Area of Sonoma Valley (WYs 2014-2035)

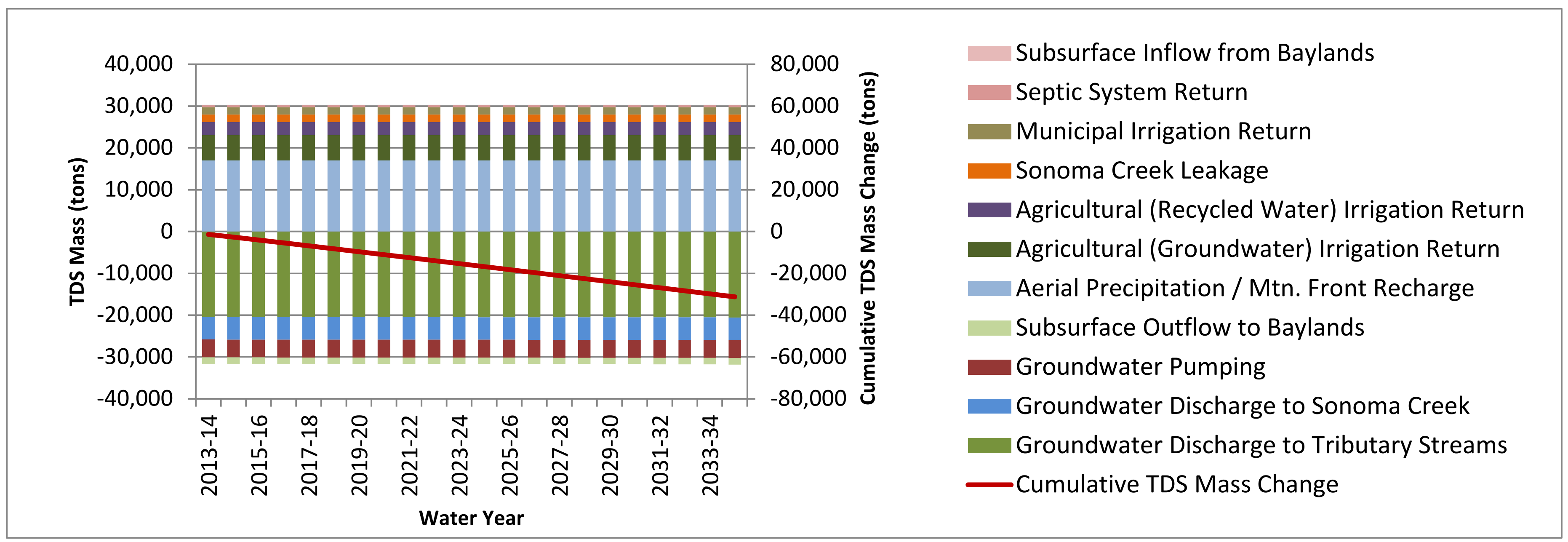
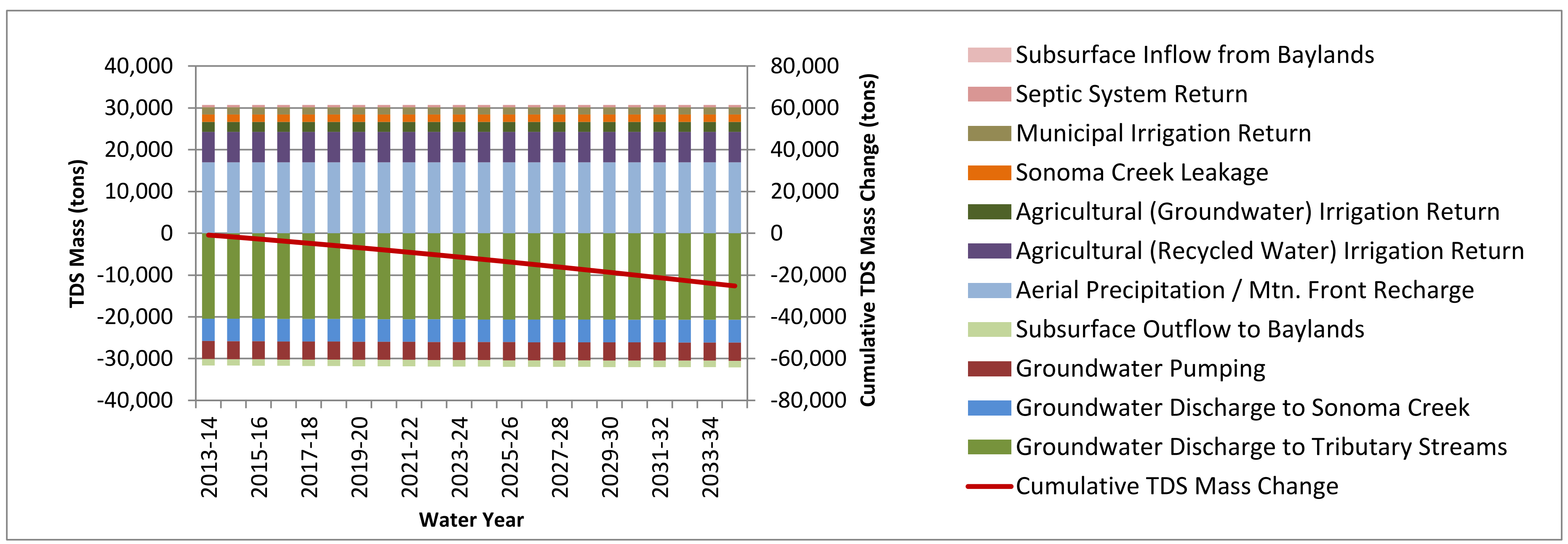


Table 5-9: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) TDS Mass Balance for Inland Area of Sonoma Valley (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
											All values in tons											
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994	16,994
Sonoma Creek Leakage	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817	1,817
Agricultural (Groundwater) Irrigation Return	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393	2,393
Agricultural (Recycled Water) Irrigation Return	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244	7,244
Municipal Irrigation Return	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726	1,726
Septic System Return	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483	483
Subsurface Inflow from Baylands	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84	84
TOTAL INFLOWS	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**	**30,740**
OUTFLOWS																						
Groundwater Pumping	-4,292	-4,296	-4,301	-4,305	-4,308	-4,312	-4,315	-4,319	-4,322	-4,325	-4,328	-4,330	-4,333	-4,335	-4,338	-4,340	-4,342	-4,344	-4,346	-4,348	-4,349	-4,351
Groundwater Discharge to Tributary Streams	-20,436	-20,456	-20,476	-20,495	-20,513	-20,530	-20,547	-20,562	-20,577	-20,591	-20,605	-20,617	-20,630	-20,641	-20,652	-20,663	-20,673	-20,683	-20,692	-20,700	-20,709	-20,717
Groundwater Discharge to Sonoma Creek	-5,383	-5,389	-5,394	-5,399	-5,404	-5,408	-5,412	-5,416	-5,420	-5,424	-5,428	-5,431	-5,434	-5,437	-5,440	-5,443	-5,446	-5,448	-5,451	-5,453	-5,455	-5,457
Subsurface Outflow to Baylands	-1,523	-1,525	-1,526	-1,528	-1,529	-1,530	-1,531	-1,533	-1,534	-1,535	-1,536	-1,537	-1,538	-1,539	-1,539	-1,540	-1,541	-1,542	-1,542	-1,543	-1,544	-1,544
TOTAL OUTFLOWS	**-31,634**	**-31,666**	**-31,697**	**-31,726**	**-31,754**	**-31,780**	**-31,806**	**-31,830**	**-31,853**	**-31,875**	**-31,896**	**-31,915**	**-31,934**	**-31,952**	**-31,970**	**-31,986**	**-32,002**	**-32,016**	**-32,031**	**-32,044**	**-32,057**	**-32,069**
Annual TDS Mass Change	-894	-926	-957	-986	-1,014	-1,040	-1,066	-1,090	-1,113	-1,135	-1,156	-1,175	-1,194	-1,212	-1,230	-1,246	-1,262	-1,276	-1,291	-1,304	-1,317	-1,329
Cumulative TDS Mass Change	-894	-1,821	-2,778	-3,764	-4,778	-5,818	-6,884	-7,973	-9,086	-10,221	-11,376	-12,552	-13,746	-14,959	-16,188	-17,434	-18,696	-19,973	-21,263	-22,567	-23,884	-25,213

Mtn. – mountain
TDS – total dissolved solids
WY – water year

Figure 5-6: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) TDS Mass Balance for Inland Area of Sonoma Valley (WYs 2014-2035)



5.4.2 Nitrate-N Mass Balances

Table 5-10 through **5-12** show the nitrate-N mass balances for the three future scenarios. The mass balances are also depicted in **Figures 5-7** through **5-9**. The tables and figures show that the cumulative change in nitrate-N mass from WY 2013-14 through WY 2034-35 is positive for all three scenarios. For Scenario 0 (No-Project), the cumulative change in nitrate-N mass is +1,410 tons. The cumulative change in nitrate-N mass is slightly higher for Scenario 1 (+1,440 tons) and even higher for Scenario 2 (+1,491 tons).

For Scenario 0 (No-Project), nitrate mass loading factors presented from largest to smallest are as follows:

1) agricultural (groundwater) return
2) municipal return
3) septic system return
4) areal precipitation and mountain front recharge
5) agricultural (recycled water) return
6) Sonoma Creek leakage
7) subsurface inflow from Baylands

For Scenario 1, nitrate mass loading from agricultural (recycled water) return increases and represents the fourth largest nitrate loading factor. Agricultural (groundwater) return decreases but remains the largest nitrate mass loading factor. All other factors have the same nitrate mass loading as in the No-Project scenario.

For Scenario 2, nitrate mass loading from agricultural (recycled water) return increases and replaces agricultural (groundwater) return as the largest nitrate loading factor. Agricultural (groundwater) return decreases and represents the fourth largest nitrate mass loading factor, behind municipal and septic system return. All other factors have the same nitrate mass loading as in the No-Project scenario.

5.5 Assimilative Capacity and Use by Recycled Water Projects

5.5.1 Future TDS Groundwater Concentrations

Figure 5-10 shows the simulated future TDS concentrations from the calibrated mixing model for the three future scenarios from WY 2013-14 through 2034-35 for the Inland area of the Sonoma Valley Subbasin. Also shown on the chart is the 10% assimilative capacity threshold. Values depicted in the chart are tabulated in **Table 5-13**. The cumulative concentration change is translated into assimilative capacity use at the bottom of the table. The table also shows the difference between each of future Scenarios 1 and 2 and the Scenario 0 (No-Project). This difference represents the water quality and assimilative capacity impact of just the future project(s) with the background impacts of the No Project conditions removed.

As depicted in Figure 5-10 and shown in Table 5-13, the following conclusions can be made:

- Average TDS concentrations in the subbasin are projected to decrease from WY 2013 through WY 2035 by 0.9 mg/L for Scenario 0 (No-Project).
- Average TDS concentrations in the subbasin are projected to increase from WY 2013 through WY 2035 by 1.4 mg/L for Scenario 1 and by 3.5 mg/L for Scenario 2.

Table 5-10: Future Scenario 0 (No-Project) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
	All values in tons																					
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Sonoma Creek Leakage	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Agricultural (Groundwater) Irrigation Return	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8
Agricultural (Recycled Water) Irrigation Return	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Municipal Irrigation Return	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
Septic System Return	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Subsurface Inflow from Baylands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL INFLOWS	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**	**105.7**
OUTFLOWS																						
Groundwater Pumping	-0.8	-1.5	-2.2	-2.8	-3.4	-4.0	-4.5	-5.0	-5.5	-6.0	-6.4	-6.9	-7.3	-7.7	-8.0	-8.4	-8.7	-9.0	-9.3	-9.6	-9.9	-10.2
Groundwater Discharge to Tributary Streams	-3.8	-7.1	-10.3	-13.3	-16.1	-18.8	-21.4	-23.9	-26.3	-28.5	-30.6	-32.7	-34.6	-36.5	-38.2	-39.9	-41.5	-43.0	-44.5	-45.9	-47.2	-48.4
Groundwater Discharge to Sonoma Creek	-1.0	-1.9	-2.7	-3.5	-4.2	-5.0	-5.6	-6.3	-6.9	-7.5	-8.1	-8.6	-9.1	-9.6	-10.1	-10.5	-10.9	-11.3	-11.7	-12.1	-12.4	-12.8
Subsurface Outflow to Baylands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL OUTFLOWS	**-6.0**	**-11.0**	**-15.9**	**-20.5**	**-24.9**	**-29.2**	**-33.2**	**-37.0**	**-40.6**	**-44.1**	**-47.4**	**-50.6**	**-53.6**	**-56.5**	**-59.2**	**-61.8**	**-64.3**	**-66.6**	**-68.9**	**-71.0**	**-73.1**	**-75.0**
Annual Nitrate-N Mass Change	99.7	94.7	89.8	85.2	80.8	76.5	72.5	68.7	65.1	61.6	58.3	55.1	52.1	49.2	46.5	43.9	41.4	39.1	36.8	34.7	32.6	30.7
Cumulative Nitrate-N Mass Change	99.7	194.4	284.2	369.4	450.1	526.7	599.2	667.9	732.9	794.5	852.8	907.9	960.0	1,009.2	1,055.7	1,099.6	1,141.0	1,180.1	1,216.9	1,251.6	1,284.2	1,314.9

Mtn. – mountain
Nitrate-N – nitrate as nitrogen
WY – water year

Figure 5-7: Future Scenario 0 (No-Project) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

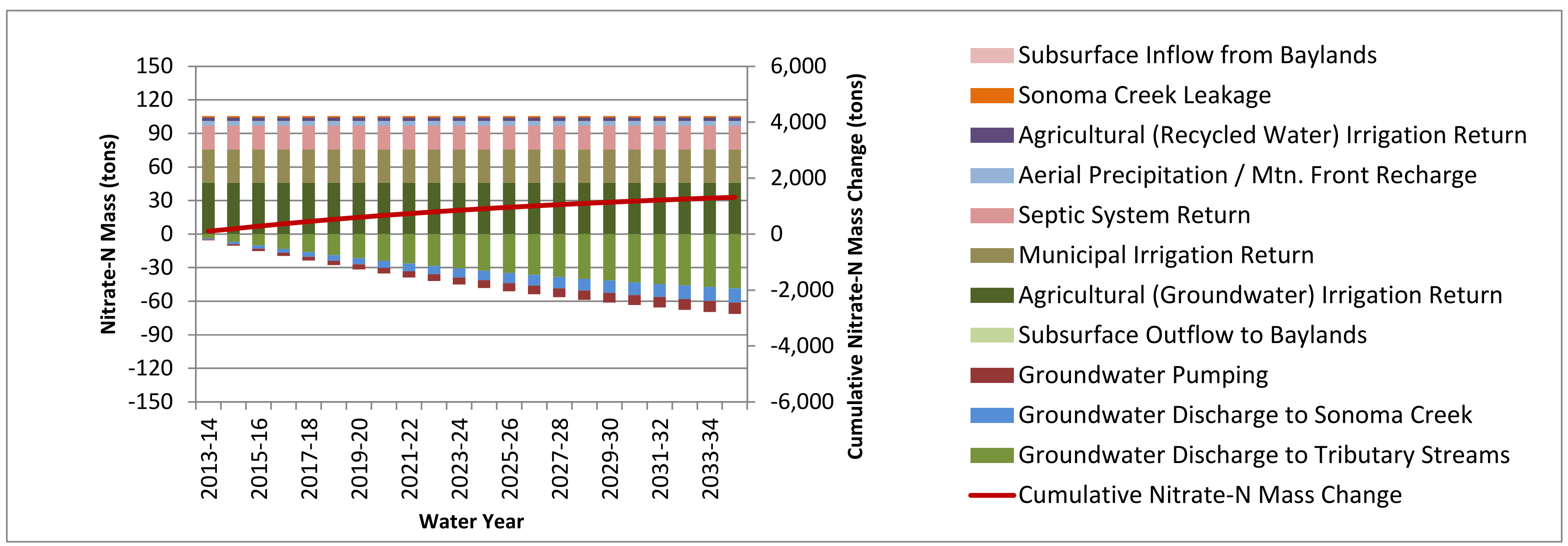


Table 5-11: Future Scenario 1 (2035 recycled water conditions) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
											All values in tons											
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Sonoma Creek Leakage	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Agricultural (Groundwater) Irrigation Return	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8
Agricultural (Recycled Water) Irrigation Return	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2	17.2
Municipal Irrigation Return	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
Septic System Return	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Subsurface Inflow from Baylands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL INFLOWS	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**	**108.0**
OUTFLOWS																						
Groundwater Pumping	-0.8	-1.5	-2.2	-2.8	-3.4	-4.0	-4.6	-5.1	-5.6	-6.1	-6.6	-7.0	-7.4	-7.8	-8.2	-8.6	-8.9	-9.2	-9.5	-9.8	-10.1	-10.4
Groundwater Discharge to Tributary Streams	-3.8	-7.2	-10.4	-13.5	-16.4	-19.2	-21.8	-24.4	-26.8	-29.1	-31.3	-33.3	-35.3	-37.2	-39.0	-40.8	-42.4	-43.9	-45.4	-46.8	-48.2	-49.5
Groundwater Discharge to Sonoma Creek	-1.0	-1.9	-2.7	-3.6	-4.3	-5.1	-5.8	-6.4	-7.1	-7.7	-8.2	-8.8	-9.3	-9.8	-10.3	-10.7	-11.2	-11.6	-12.0	-12.3	-12.7	-13.0
Subsurface Outflow to Baylands	-0.3	-0.5	-0.8	-1.0	-1.2	-1.4	-1.6	-1.8	-2.0	-2.2	-2.3	-2.5	-2.6	-2.8	-2.9	-3.0	-3.2	-3.3	-3.4	-3.5	-3.6	-3.7
TOTAL OUTFLOWS	**-6.0**	**-11.2**	**-16.1**	**-20.9**	**-25.4**	**-29.7**	**-33.8**	**-37.7**	**-41.4**	**-45.0**	**-48.4**	**-51.6**	**-54.7**	**-57.6**	**-60.4**	**-63.1**	**-65.6**	**-68.0**	**-70.3**	**-72.5**	**-74.6**	**-76.6**
Annual Nitrate-N Mass Change	102.0	96.8	91.9	87.1	82.6	78.3	74.2	70.3	66.5	63.0	59.6	56.4	53.3	50.4	47.6	44.9	42.4	40.0	37.7	35.5	33.4	31.4
Cumulative Nitrate-N Mass Change	102.0	198.9	290.7	377.9	460.5	538.8	613.0	683.2	749.8	812.8	872.4	928.7	982.0	1,032.4	1,080.0	1,124.9	1,167.2	1,207.2	1,244.9	1,280.4	1,313.8	1,345.2

Mtn. – mountain
Nitrate-N – nitrate as nitrogen
WY – water year

Figure 5-8: Future Scenario 1 (2035 recycled water conditions) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

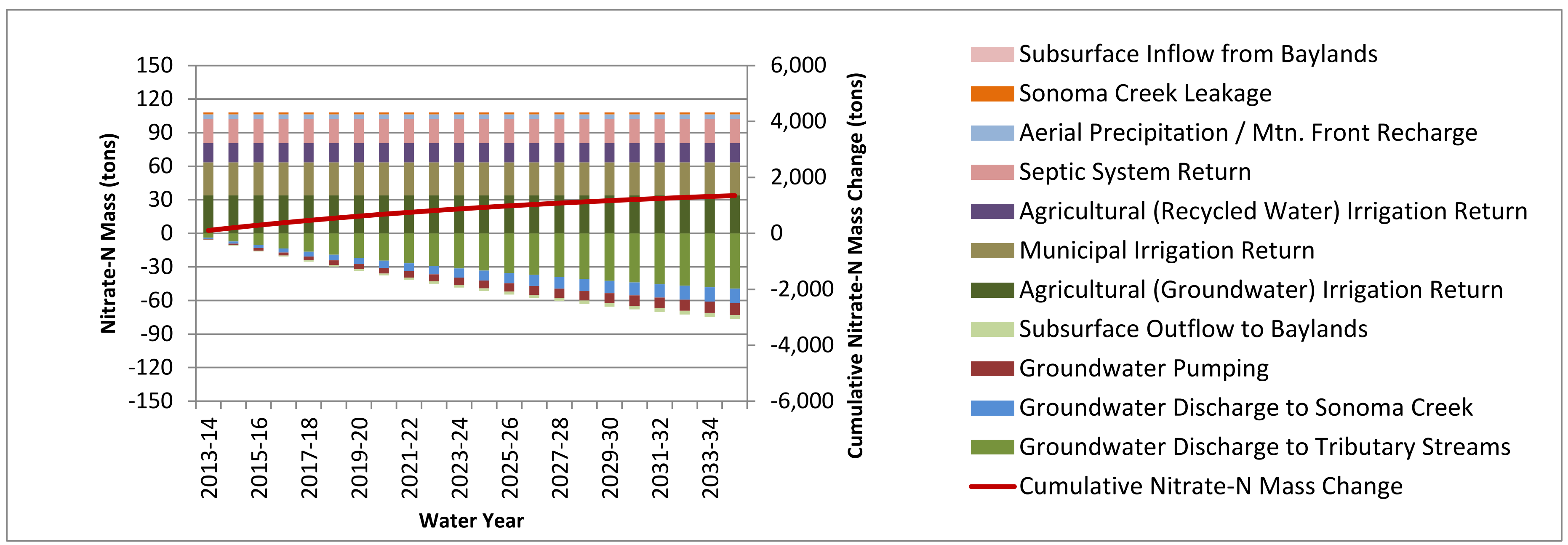


Table 5-12: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

All values in tons

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33	2033-34	2034-35
INFLOWS																						
Aerial Precipitation / Mtn. Front Recharge	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Sonoma Creek Leakage	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Agricultural (Groundwater) Irrigation Return	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6	13.6
Agricultural (Recycled Water) Irrigation Return	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3	41.3
Municipal Irrigation Return	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7	29.7
Septic System Return	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Subsurface Inflow from Baylands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL INFLOWS	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**	**111.8**
OUTFLOWS																						
Groundwater Pumping	-0.8	-1.5	-2.2	-2.9	-3.5	-4.1	-4.7	-5.3	-5.8	-6.3	-6.8	-7.2	-7.7	-8.1	-8.5	-8.9	-9.2	-9.5	-9.9	-10.2	-10.5	-10.7
Groundwater Discharge to Tributary Streams	-3.8	-7.3	-10.7	-13.8	-16.9	-19.8	-22.5	-25.1	-27.6	-30.0	-32.3	-34.5	-36.5	-38.5	-40.4	-42.1	-43.8	-45.5	-47.0	-48.5	-49.9	-51.2
Groundwater Discharge to Sonoma Creek	-1.0	-1.9	-2.8	-3.6	-4.4	-5.2	-5.9	-6.6	-7.3	-7.9	-8.5	-9.1	-9.6	-10.1	-10.6	-11.1	-11.5	-12.0	-12.4	-12.8	-13.1	-13.5
Subsurface Outflow to Baylands	-0.3	-0.5	-0.8	-1.0	-1.3	-1.5	-1.7	-1.9	-2.1	-2.2	-2.4	-2.6	-2.7	-2.9	-3.0	-3.1	-3.3	-3.4	-3.5	-3.6	-3.7	-3.8
TOTAL OUTFLOWS	**-6.0**	**-11.4**	**-16.5**	**-21.4**	**-26.1**	**-30.6**	**-34.8**	**-38.9**	**-42.8**	**-46.5**	**-50.0**	**-53.3**	**-56.5**	**-59.6**	**-62.5**	**-65.2**	**-67.9**	**-70.4**	**-72.7**	**-75.0**	**-77.2**	**-79.2**
Annual Nitrate-N Mass Change	105.9	100.5	95.3	90.4	85.7	81.3	77.0	72.9	69.1	65.4	61.9	58.5	55.3	52.3	49.4	46.6	44.0	41.5	39.1	36.8	34.7	32.6
Cumulative Nitrate-N Mass Change	105.9	206.4	301.7	392.1	477.9	559.2	636.2	709.1	778.2	843.5	905.4	963.9	1,019.2	1,071.5	1,120.8	1,167.5	1,211.4	1,252.9	1,292.0	1,328.9	1,363.5	1,396.1

Mtn. – mountain
Nitrate-N – nitrate as nitrogen
WY – water year

Figure 5-9: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water) Nitrate-N Mass Balance for Inland Area of Sonoma Valley Subbasin (WYs 2014-2035)

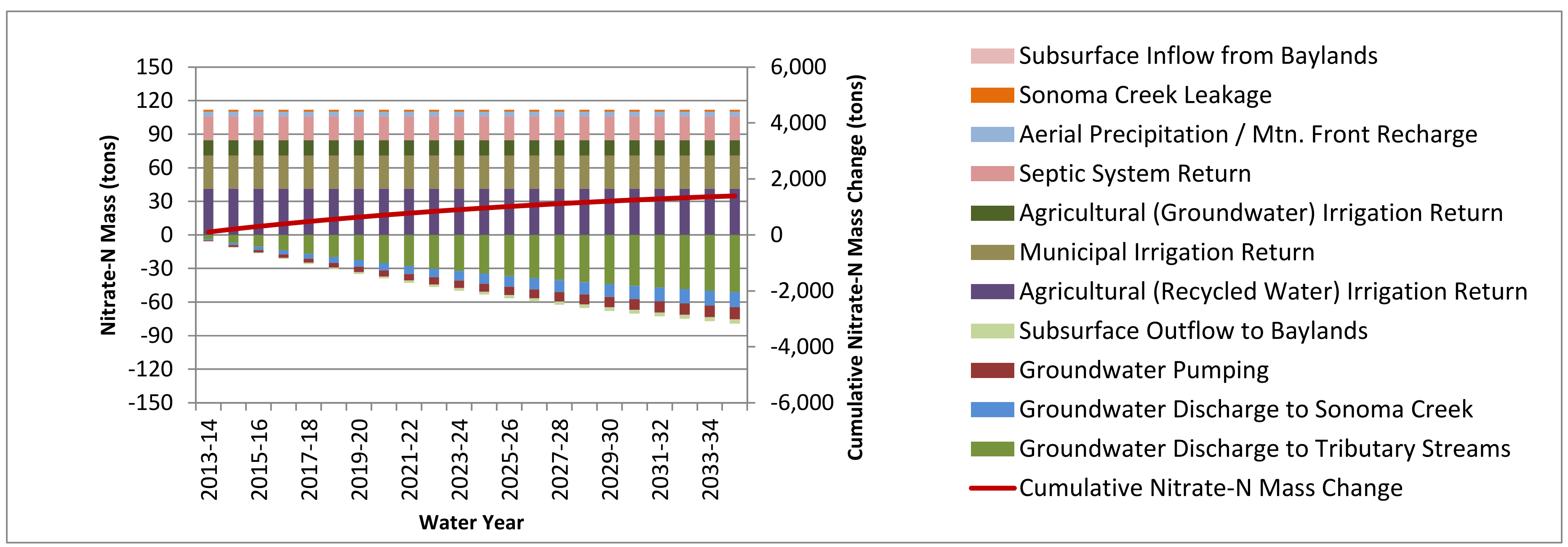


Figure 5-10: Simulated Future Groundwater TDS Concentrations

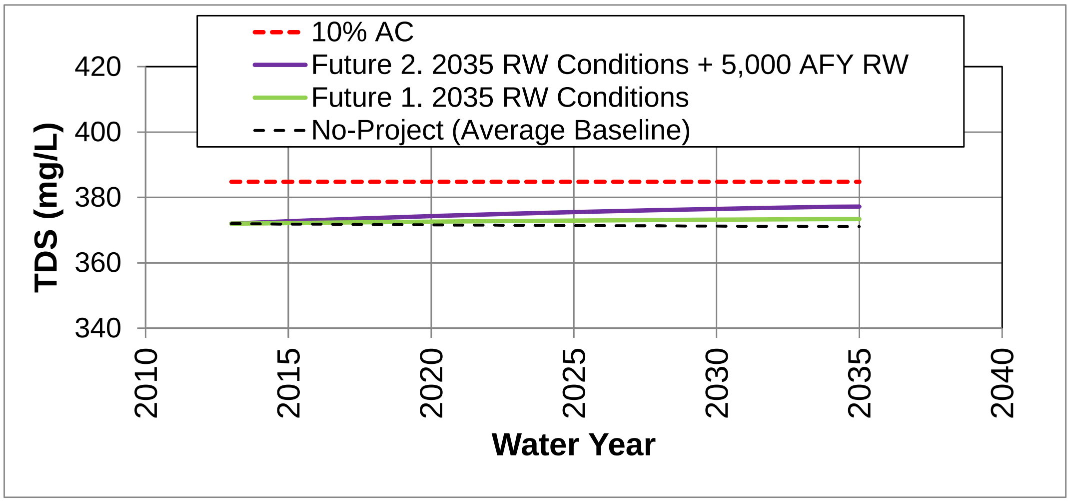


Table 5-13: Simulated Future Groundwater TDS Concentrations and Assimilative Capacity Use

Water Year	TDS (mg/L)		
	Future Scenario 0 (No-Project)	Future Scenario 1 (2035 Recycled Water Conditions)	Future Scenario 2. (2035 RW Conditions + 5,000 AFY RW)
2013	372.0	372.0	372.0
2014	371.9	372.1	372.4
2015	371.9	372.2	372.7
2016	371.8	372.3	373.1
2017	371.8	372.4	373.4
2018	371.7	372.5	373.7
2019	371.7	372.5	374.0
2020	371.6	372.6	374.3
2021	371.6	372.7	374.6
2022	371.5	372.8	374.8
2023	371.5	372.8	375.1
2024	371.4	372.9	375.3
2025	371.4	372.9	375.5
2026	371.4	373.0	375.7
2027	371.3	373.1	375.9
2028	371.3	373.1	376.1
2029	371.3	373.2	376.3
2030	371.2	373.2	376.5
2031	371.2	373.2	376.7
2032	371.2	373.3	376.8
2033	371.2	373.3	377.0
2034	371.1	373.4	377.1
2035	371.1	373.4	377.2
Basin Plan Objective	500.0		
Average Ambient TDS Concentration (mg/L)	372.0		
Assimilative Capacity (mg/L)	128.0		
10% AC concentration change (mg/L)	12.8		
10% AC concentration (mg/L)	384.8		
WY 2035 concentration (mg/L)	371.1	373.4	377.2
WY 2013 to WY 2035 change (mg/L)	(0.9)	1.4	5.2
WY 2013 to WY 2035 (% AC Used)	0%	1.1%	4.1%
Difference compared to No-Project (mg/L)		2.3	6.1
Difference compared to No-Project (% AC)		1.8%	4.8%

TDS – total dissolved solids
mg/L – milligrams per liter
AFY – acre-feet per year
RW – recycled water
WY – water year
AC – assimilative capacity

- For all three scenarios, recycled water projects use less than 10% of the available assimilative capacity, and projected TDS concentrations remain well below the BPO of 500 mg/L.

When considering the differences between Scenarios 1 and 2 and the No-Project Scenario (i.e., loading associated with the No Project components is removed), Scenarios 1 uses 1.8% (2.3 mg/L) of the available assimilative capacity, while Scenario 2 use 4.8% (6.1 mg/L) of the assimilative capacity.

5.5.2 Nitrate-N Groundwater Concentrations

Figure 5-11 shows the simulated results of the calibrated mixing model for nitrate for the three future scenarios from WY 2013-14 through 2034-35 for the Inland area of the Sonoma Valley Subbasin. The chart shows the simulated concentration trends for each scenario and the 10% assimilative capacity threshold. **Table 5-14** shows the mixing model simulated nitrate concentration change over the future planning period for each scenario in mg/L. The cumulative concentration change is translated into assimilative capacity use at the bottom of the table. The table also shows the difference between each of future Scenarios 1 and 2 and the Scenario 0 (No-Project). This difference represents the water quality and assimilative capacity impact of just the future project(s) with the background impacts of the No Project conditions removed.

As depicted in Figure 5-11 and shown in Table 5-14, the following conclusions can be made:

- Average nitrate concentrations in the subbasin are projected to increase similarly for all three scenarios from WY 2013 to WY 2035 (between 0.83 and 0.88 mg/L).
- For all three scenarios, recycled water projects use less than 10% of the available assimilative capacity, and projected nitrate concentrations remain well below the BPO of 10 mg/L.

When considering the difference between Scenarios 1 and 2 and the No-Project Scenario (i.e., loading associated with the No Project components is removed), Scenarios 1 uses 0.2% (0.02 mg/L) of the available assimilative capacity (9.93 mg/L), while Scenario 2 uses 0.5% (0.05 mg/L) of the available assimilative capacity. It is noted that projected increases in nitrate concentrations in the Inland area of the subbasin are considered conservative given the assumptions incorporated in the calibration of the mixing model for nitrate (see discussion in Section 4.3). Additionally, despite portions of existing and proposed future recycled water use areas being located south of the Inlands area in the Baylands area (see Figure 2-1), all TDS and nitrate loading associated with recycled water use was applied within the Inlands area in the mixing model and S/N balance. Average groundwater nitrate concentrations are predicted to increase asymptotically toward the volume-weighted average nitrate concentration of basin inflows for each scenario (1.31 mg/L for Scenario 0, 1.33 mg/L for Scenario 1, and 1.38 mg/L for Scenario 2).

Figure 5-11: Simulated Future Groundwater Nitrate-N Concentrations

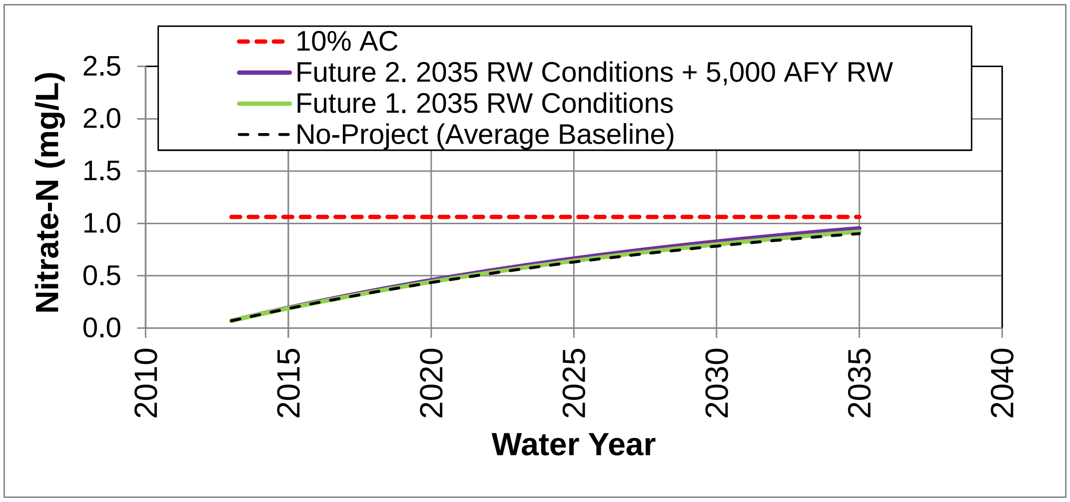


Table 5-14: Simulated Future Groundwater Nitrate-N Concentrations and Assimilative Capacity Use

Water Year	Nitrate-N (mg/L)		
	Future Scenario 0 (No-Project)	Future Scenario 1 (2035 Recycled Water Conditions)	Future Scenario 2 (2035 RW Conditions + 5,000 AFY RW)
2013	0.07	0.07	0.07
2014	0.13	0.13	0.13
2015	0.19	0.19	0.19
2016	0.24	0.25	0.25
2017	0.29	0.30	0.31
2018	0.34	0.35	0.36
2019	0.39	0.40	0.41
2020	0.44	0.44	0.46
2021	0.48	0.49	0.50
2022	0.52	0.53	0.55
2023	0.56	0.57	0.59
2024	0.60	0.61	0.63
2025	0.63	0.64	0.66
2026	0.66	0.68	0.70
2027	0.70	0.71	0.73
2028	0.73	0.74	0.77
2029	0.76	0.77	0.80
2030	0.78	0.80	0.83
2031	0.81	0.83	0.86
2032	0.84	0.85	0.88
2033	0.86	0.88	0.91
2034	0.88	0.90	0.93
2035	0.90	0.92	0.95
Basin Plan Objective	10.00		
Average Ambient TDS Concentration (mg/L)	0.07		
Assimilative Capacity (mg/L)	9.93		
10% AC concentration change (mg/L)	0.99		
10% AC concentration (mg/L)	1.06		
WY 2035 concentration (mg/L)	0.90	0.92	0.95
WY 2013 to WY 2035 change (mg/L)	0.83	0.85	0.88
WY 2013 to WY 2035 (% AC Used)	8.4%	8.6%	8.9%
Difference compared to No-Project (mg/L)		0.02	0.05
Difference compared to No-Project (% AC)		0.2%	0.5%

Nitrate-N – nitrate as nitrogen
mg/L – milligrams per liter
AFY – acre-feet per year
RW – recycled water
WY – water year
AC – assimilative capacity

6 References

Bauer, Jacob P., December 2008, "Update to Regional Groundwater Flow Model simulation of Sonoma Valley Including a New Model for Recharge and Three Future Scenarios", A Thesis Submitted to the Department of Geological and Environmental Sciences and the committee on graduate studies at Stanford University

City of Sonoma, 2011, "Annual Water Quality Report"

Hem, J.D., 1989, "Study and Interpretation of the Chemical Characteristics of Natural Water (third edition)", U. S. Geological Survey Water-Supply Paper 2254

RMC, January 10, 2013, "Meeting Notes, Sonoma Valley Salt & Nutrient Management Plan, Meeting with SF Bay Region RWQCB"

RMC Water and Environment, May 2013, "Salt and Nutrient Source Identification and Loading"

Sonoma County Water Agency (SCWA), 2010, "Sonoma Valley Groundwater Management Program: 2010 Annual Report"

Sonoma County Water Agency (SCWA), December 2007, "Sonoma Valley Groundwater Management Plan"

San Francisco Bay Regional Water Quality Control Board (Regional Water Board), December 31, 2010, "San Francisco Bay Region (Region 2) Water Quality Control Plan (Basin Plan)"

RMC, January 10, 2013, "Meeting Notes, Sonoma Valley Salt & Nutrient Management Plan, Meeting with SF Bay Region RWQCB"

State Water Resources Control Board (SWRCB), May 2009 Draft, amended September 2012, October 2012, and January 2013, approved January 2013, "Recycled Water Policy"

State Water Resources Control Board (SWRCB), revised August 2010, "Groundwater Information Sheet Nitrate"

United States Geological Survey, 2006, "Geohydrologic Characterization, Water-Chemistry, and Ground-Water Flow Simulation Model of the Sonoma Valley Area, Sonoma County, California", Scientific Investigation Report 2006-5092.

Valley of the Moon Water District, 2011, "Annual Water Quality Report"

Appendix B - Meeting Summaries for Regional Water Quality Control Board Meetings

Meeting Minutes

Sonoma Valley - Salt & Nutrient Management Plan

Subject:	**Meeting with SF Bay Region RWQCB**
Prepared For:	Sonoma County Water Agency
Prepared By:	Christy Kennedy
Date/Time:	January 10, 2013: 2-3pm
Location:	SFRWQCB Office, Oakland
Project Number:	0047-008.00

Attendees:
Ralph Lambert, Alec Naugle, Barbara Baginska (RWQCB); Marcus Trotta, Kevin Booker (SCWA); Dave Richardson, Christy Kennedy (RMC); Tim Parker (Parker Groundwater); Sally McCraven (Todd Engineers)

1. Purpose of Meeting

The purpose of the meeting was to communicate process and progress of the Sonoma Valley Salt and Nutrient Management Plan (SNMP), and to confirm the approach to the analysis.

2. Discussion Summary

The Sonoma County Water Agency (Water Agency) and RMC provided an overview of the Sonoma Valley groundwater basin, the Groundwater Management Plan and the Salt and Nutrient Plan process and progress to date. The Water Agency manages and operates the Sonoma Valley County Sanitation District (CSD), which is the primary purveyor of recycled water within the basin, and is leading development of the SNMP for Sonoma Valley. Handouts were provided and attached that highlight the key discussion items below.

2.1 Groundwater Management in Sonoma Valley

1. The Water Agency described the current groundwater basin setting and water management in Sonoma Valley. Currently, there is not a robust system of dedicated groundwater monitoring wells, and the Water Agency does not operate supply wells in the basin.

2. There are around 1,800 rural/domestic wells and 60% of the water use in the basin is groundwater, 40% is imported Russian River water for urban supplies.

3. The basin has an AB303 Groundwater Management Plan (GMP) and groundwater management group, which is a voluntary and non-regulatory program.

4. The Water Agency is the lead agency for the AB303 GMP, but does not have regulatory powers related to groundwater within the basin.

2.2 SNMP Approach

1. The approach to developing the SNMP collaboratively in Sonoma Valley is to hold a series of stakeholder workshops at key milestones within the technical analysis process. The workshops are held in conjunction with the Technical Advisory Committee and the Basin Advisory Panel for the Groundwater Management Plan. The next workshop being held on January 17, 2013 was discussed and the Regional Water Quality Control Board (RWQCB) was invited to attend.

2.3 Baseline Groundwater Quality

1. Data sources include the Department of Water Resources (DWR), California Department of Public Health (CDPH), United States Geological Survey (USGS), State Water Resources Control Board's (SWRCB) Groundwater Ambient Monitoring and Assessment (GAMA) program, and the Water Agency. While the SWRCB Recycled Water Policy recommends using the most recent five years of data to establish average groundwater quality for the basin, significant data from older studies will be used to provide a more robust data set. Specifically, the SNMP proposes using the 2003-2006 data from the USGS Study to supplement the data set in order to calculate basin averages. RWQCB staff agreed that it is reasonable to use the 2000-2012 period for establishing current basin averages.

2. Historic total dissolved solids (TDS) and nitrate concentration trends in shallow and deep aquifer zones are fairly flat across the period of record.

3. The areal distribution of water quality data and depth-discrete data were analyzed with the intent of developing local area and depth-discrete salt and nutrient averages and assimilative capacity estimates; however, it was determined that the data are too limited to support such an analysis. Accordingly, the proposed approach for establishing average TDS and nitrate and available assimilative capacity, is to average across the basin and all depth intervals to estimate one average TDS and nitrate concentration for the entire basin.

    a. RWQCB staff (BB) asked that shallow and deep zones be taken into account in the monitoring plan and potential implementation measures. While a depth discrete analysis of the assimilative capacity is preferred, the consultant team stated that it was not possible for this basin with the available data.

    b. Areas exceeding Basin Plan Objectives (BPOs) for TDS or nitrate would be considered when developing implementation measures, however, the source of elevated concentration may not be able to be determined based on available data.

4. Overall the basin has good water quality with very low nitrate levels and mostly flat trends for TDS. The southwestern portion of the basin (called "Baylands" area) is an area with historical saline groundwater due to the proximity of and possible intrusion from San Pablo Bay. The area is a marshy tidally-influenced wetland adjacent to the Bay. There are no active public water supply wells in the area and available water quality data is limited to data collected from seven wells prior to 1973 and three former public water supply wells prior to 1988 located at the former Skaggs Island Naval Communication Center which was decommissioned in 1993 (note: details on dates and number of wells added to minutes for reader clarification after the meeting with RWQCB). All historical water quality samples collected from these wells (between 1954 and 1988) exhibit TDS concentrations exceeding the BPO for TDS of 500 milligrams per liter (mg/l), ranging from 520 to 2,740 mg/l. The Sonoma Valley SNMP approach is to develop an assimilative capacity estimate for the inland portion of the valley excluding this historically intruded area. RWQCB staff agreed that it made sense to break out the two areas (Inland and Baylands). There is available assimilative capacity for both TDS and nitrate in the Sonoma Valley basin when the historically saline groundwater from the Baylands area is excluded from the average calculations.

2.4 Loading Model

1. A GIS model is being used for the loading analysis, which looks at loading of TDS and nitrate to the groundwater basin. Key model assumptions and preliminary loading estimates for land cover categories with similar salt and nutrient characteristics were shared with the group.

2.5 Water Recycling and Stormwater Recharge Goals

1. For goal setting, the approach is to use the recycling water use goals from Urban Water Management Plans developed by the City of Sonoma and Valley of the Moon Water District, and for stormwater recharge, numeric goals will not be set for the SNMP. The SNMP will reference stormwater recharge efforts within the Valley and indicate that updates to the SNMP will be made when stormwater recharge projects are further developed. The RWQCB staff agreed with our proposed approach for goal setting.

2.6 SNMP Template for the Bay Area Region

1. The Sonoma Valley SNMP is being funded through a Prop. 84 Planning Grant, and as part of that grant the team will develop SNMP template. The template will be available to other agencies within the region to use as a guide when preparing their own SNMP. Specific direction was not provided for template development but RWQCB staff noted these templates could be useful, and that they had done outreach to Napa and the Westside basin along the San Francisco Peninsula.

2.7 Basin Plan Amendment

1. RWQCB staff (BB) requested that the SNMP Executive Summary (or other similar section) include text that could be readily used for the Basin Plan Amendment (BPA) description of the SNMP, should a BPA be required for the basin (note: there is still ongoing discussion of this requirement internally within RWQCB). The summary should include goals, why the plan was developed, where the region/basin is located, major components of the SNMP and should be a short summary of what was done as part of the SNMP process and how.

2. The group discussed the California Environmental Quality Act (CEQA) needs for the SNMP. While some basins with extensive implementation measures (example: Zone 7) will require a CEQA analysis to amend the Basin Plan, it is unclear at this time if CEQA is necessary for the Sonoma Valley plan where implementation measures beyond what is currently being done in the basin. The Sonoma Valley team is not intending to complete a CEQA analysis on the SNMP at this time. RWQCB staff will be discussing this item with their management and will follow-up with the Sonoma Valley team.

Meeting Minutes

Sonoma Valley - Salt & Nutrient Management Plan

Subject:	**Coordination Meeting with SF Bay RWQCB**
Prepared For:	Sonoma Valley County Sanitation District
Prepared By:	Christy Kennedy
Date/Time:	May 14, 2013: 1:30-3:30pm
Location:	SFBRWQCB Office, Oakland
Project Number:	0047-008.00

Attendees:
Alec Naugle, Barbara Baginska, Ben Livsey (RWQCB); Marcus Trotta, Kevin Booker, Jay Jasperse (SCWA); Dave Richardson, Christy Kennedy (RMC); Edwin Lin (Todd Engineers)

1. Purpose of Meeting

The purpose of the meeting was to communicate progress of the Sonoma Valley Salt and Nutrient Management Plan (SNMP), convey the technical analysis findings, obtain input on approach to management measures and monitoring plan, and understand what is needed for plan finalization and approval by the Regional Water Quality Control (RWQCB).

2. Discussion Summary

The Sonoma Valley team (SCWA/SVCSD, RMC and Todd Engineers) provided an overview of the Sonoma Valley SNMP process and progress to date. Handouts (amended in the attached version to include the dairy loading table) were provided and attached that highlight the key discussion items below.

2.1 Introduction

Around the table introduction were made and Christy Kennedy, RMC, gave an overview of the SNMP progress to-date. The SNMP is being conducted in a collaborative manner utilizing the stakeholder infrastructure developed through the Sonoma Valley Groundwater Management Plan (GMP) process. This consists of a Technical Advisory Committee (TAC) which meets monthly and Basin Advisory Panel (BAP) that meets quarterly. Stakeholders include a wide cross-section of municipal agencies, non-profit organizations, environmental groups, private well owners, dairy owners, and various vineyard and agricultural groups that represent those with interest in groundwater management and salt and nutrient impacts within the basin.

2.2 Existing Water Quality and Assimilative Capacity

1. Edwin Lin, Todd Engineers, gave an overview of the existing water quality within the basin, utilizing a baseline period dataset from 2000-2012. The basin is divided into the Inland and Baylands areas at a dividing line of 750 mg/L TDS. The average concentration of total dissolved solids (TDS) and nitrate-N in the Inland area is 372 mg/L and 0.07 mg/L, respectively. Both constituents are well below the Basin Plan Objectives (BPOs) of 500 mg/L for TDS, and 10 mg/L for nitrate-N. Trends for TDS and nitrate are generally flat across the full data set representing up to about 50 years of data.

2. RWQCB staff (BB) asked if hotspots were present around dense septic areas. Edwin responded that no hotspots are visible within the existing dataset however the data is fairly limited and well completion reports are not available for all of the wells to denote their depth (shallow or deep).

3. Edwin gave an overview of the water balance and answered calibration questions, then described the mixing model. The mixing model was developed as one-layer or box for the Inland Area, and mixes over a reasonable depth of the basin (limited to a saturated depth of 400 feet for operating volume).

4. Christy described the loading model and gave an overview of loading parameters. It was noted that the TDS and nitrate-N values for septic system return are currently being refined (increased) but were not expected to change the findings.

2.3 Future Water Quality and Assimilative Capacity

1. Edwin gave an overview of the future water quality assessment. Three scenarios were run, 1- No project, 2 – Future recycled water estimates of 4,069 AFY, and 3 – Future recycled water estimates plus an additional 5,000 acre-feet per year (AFY) of recycled water. Scenarios showed that recycled water projects will use <10% of the available assimilative capacity and average concentrations stay below BPOs for both TDS and nitrate.

2. Marcus Trotta, Sonoma County Water Agency, noted that recycled water programs are in place to help alleviate a pumping depression in the deeper aquifer zones by offsetting groundwater pumping through deliveries of recycled water for irrigation. Increasing the use of recycled water can reduce the potential for saline water intrusion into the groundwater basin.

2.4 Implementation Measures

1. The results of the technical analysis show good water quality with relatively flat trends through 2035, therefore, no implementation measures beyond continuing existing programs are recommended. RWQCB staff acknowledged that the approach to not recommend new implementation measures might be appropriate. Further consideration of this issue will be given once the draft SNMP is submitted for final review by RWQCB staff.

2. The voluntary Groundwater Management Program will be identified as a process that the SNMP will support, but programs and activities covered by the Groundwater Management Program will not be considered “implementation measures” for the SNMP. Other management measures that should continue but do not constitute “implementation measures” are recycled water permit requirement BMPs, agricultural BMPs, onsite wastewater treatment system (septic) BMPs and municipal wastewater treatment plant source control programs.

3. The Water Agency is also evaluating the feasibility of aquifer storage and recovery (ASR) utilizing wintertime Russian River drinking water. The recycled water, stormwater recharge and ASR programs and studies are being conducted as voluntary programs to help manage water supply reliability within the basin and are not considered implementation measures within this SNMP.

4. The future expansion of the recycled water application in Sonoma Valley is already covered under existing CEQA/NEPA documents, and any GMP programs resulting in infrastructure projects like groundwater banking or stormwater recharge would be covered under a separate environment compliance process.

2.5 Groundwater Monitoring Program

1. The recommended groundwater monitoring program consists of existing wells monitored by CDPH, DWR and SVGMP.

2. The Groundwater Monitoring Plan will be submitted as a stand-alone document that is an appendix of the SNMP so that if modification of the monitoring plan is required it can be done without a complete SNMP update.

3. SCWA recently obtained outside funding through an AB303 grant to install additional monitoring wells within the basin. There is a data gap area around the Baylands-Inland area transition and future funding will be pursued to expand the monitoring network.

4. The monitoring program reporting should be uploaded in the RWQCB’s Geotracker online data system. This will be completed on a three-year interval.

2.6 Basin Plan Amendment and CEQA Process

1. The Sonoma Valley team asked for direction for RWQCB approval of the final SNMP.

2. The Final SNMP will likely go the SCWA Board of Directors as an informational item only and not be submitted for formal approval or adoption. After this action has been completed, the Final SNMP (including an Executive Summary for the RWQCB's use in their BPA process) will be submitted to the RWQCB.

3. RWQCB staff is obtaining direction from the State Water Resources Control Board (SWRCB) on the Basin Plan Amendment process. The SWRCB is considering whether the scientific peer review of the SNMP and/or BPA would be needed.. It is not known at this time if the Sonoma Valley SNMP which has no new implementation measures recommended, would need to go through this peer review process. The peer review process could add four+ months to the schedule.

4. If a peer review is required for the Sonoma Valley SNMP, RWQCB staff will request help from the Sonoma Valley team in providing responses to peer review comments. If necessary, the SNMP may require revisions from peer review findings.

5. It has not been determined at this time if CEQA for the Sonoma Valley SNMP is required. RWQCB staff may need to develop a "Substitute CEQA Document" but it is not clear if that is necessary if the Sonoma Valley SNMP is approved as a "non-regulatory" Basin Plan Amendment. RWQCB staff concurred that moving forward as a "non-regulatory" document for inclusion in the Basin Plan Amendment is an option, and is reasonable since no new implementation measures are recommended and no discretionary items are incorporated in the SNMP that require CEQA documentation. More information about the CEQA process will be forth coming in the June, CEQA specific meeting to be hosted by the RWQCB for the region (see bullet # 2 under Next Steps). The Sonoma Valley team requested that the Sonoma Valley basin be considered as a special case that may not require the same Basin Plan Amendment and CEQA actions that other basins with poorer water quality, increasing quality trends, and implementation measures may be subject to.

6. If a CEQA process is determined to be needed for the Sonoma Valley SNMP the RWQCB staff have requested assistance in the following areas:

    a. Developing CEQA alternatives - likely alternatives will be the "no-project" alternative, and Scenario 1 describing future recycling project implementation

    b. Scoping meeting coordination, noticing, and presentation of findings

2.7 Next Steps

1. The Sonoma Valley SNMP is being funded through a Prop. 84 Planning Grant, and as part of that grant the team will develop SNMP template. The template will be available to other agencies within the region to use as a guide when preparing their own SNMP. The template is being drafted and will be discussed and reviewed by the Bay Area agencies at the June 3rd Integrated Regional Water Management Plan (IRWMP) Coordinating Committee Meeting. After comments are incorporated into the template, it will be submitted to the RWQCB for review.

2. RWQCB staff (BB) noted they are planning to convene an all-agency meeting to go through the CEQA process requirements for SNMPs, and asked input on the benefits of this proposed meeting. The Sonoma Valley team agreed this meeting would be useful. This meeting will likely be scheduled in mid June. RWQCB will send out a list of questions in advance of the meeting and allow each agency up to 15 minutes to provide an overview of their basin and response to the submitted questions.

3. RWQCB staff (BL) is planning on attending the July 17, 2013 Sonoma Valley stakeholder workshop presenting the Draft SNMP.

Appendix C - Guidance Document for SNMPs for the San Francisco Bay Region

Guidance Document for Salt and Nutrient Management Plans

San Francisco Bay Region

Prepared by: Sonoma Valley County Sanitation District

August 2013

Table of Contents

This Guidance Document was developed as a result of the Sonoma Valley Salt and Nutrient Management Plan (SNMP) preparation effort. Sonoma Valley County Sanitation District, along with the Zone 7 Water Agency and Santa Clara Valley Water District are developing SNMPs in three priority groundwater basins (as identified by the Regional Water Board) for the San Francisco Bay Region. The Sonoma Valley SNMP received funding through the Proposition 84 Planning Grant for SNMP preparation and development of a guidance document to assist other Bay Area agencies wanting to undergo a similar process in developing their SNMPs.

The California state-wide Recycled Water Policy, adopted by the State Water Resources Control Board in 2009, indicates that Salt and Nutrient Management Plans (SNMPs) are to be developed for groundwater basins in California, to address the potential for increased salt and nutrient loading from increased recycled water use and other sources. It is anticipated that SNMPs will contain the following components to be responsive to both the Recycled Water Policy requirements and the Basin Planning Amendment process undertaken by the Regional Water Board:

- General groundwater basin information and characteristics
- Beneficial use designation
- Goals for water recycling and stormwater recharge/use (as applicable);
- Salt and nutrient source identification;
- Water quality objectives (both narrative and numeric)
- Salt and nutrient source loading and assimilative capacity estimates;
- Implementation measures and management strategies;
- Antidegradation analysis, as needed;
- Development of a basin-wide monitoring plan; and
- A provision for monitoring Constituents of Emerging Concern (CECs) in recycled water used for groundwater recharge reuse.
- A statement regarding Plan limitations

The purpose of this document is to describe the common steps that may be undertaken by Bay Area groups in preparing an SNMP. The San Francisco Bay Regional Water Quality Control Board (Regional Water Board) is expected to consider the size, complexity, level of activity, and site-specific factors within a basin in reviewing the level of detail and the specific tasks required for each SNMP. It may be appropriate to meet with Regional Water Board staff early in the process of developing an SNMP, to ensure common expectations before resources are expended.

Step 1 Initial Basin Characterization

Task 1.1 Identify the Basin and Delineate the Study Area

- Delineate the study area for salt and nutrient management planning.

- Identify the areal extent of the groundwater basin, including if known, the watershed area tributary to the aquifer, known source loads or impacts within the watershed, the location of existing or proposed recycled water use areas, and/or jurisdictional boundaries.
    - In developing SNMPs, it is recognized that the SNMP may wish to address study areas using a sub-basin approach.
    - SNMPs interested in focusing on groundwater supply development may define the study area to encompass anticipated project sites other than recycled water, or source control needs such as control of pollutants from a dairy operation.

Task 1.2 Identify Stakeholders

- Develop a preliminary list of stakeholders (including potential interest, contact person, and contact information). Key stakeholders include local agencies involved in groundwater management, owners and operators of recharge facilities, water purveyors, water districts, wastewater agencies, known salt and nutrient contributing dischargers, and the general public.
- Perform outreach and obtain stakeholder feedback for planning process (now or near future).

Task 1.3 Establish Communication with the Regional Water Board

- Identify a point of contact at the Regional Water Board with whom to coordinate the preparation of your SNMP.

Task 1.4 Identify Beneficial Uses and Water Quality Objectives

- Identify designated beneficial uses of the groundwater basin (see 2011 Basin Plan, Table 2-2).
- Identify water quality objectives for groundwater basin (see 2011 Basin Plan, starting on page 2-8).

Task 1.5 Identify, Collect, and Review Existing Groundwater Studies and Data

- Collect and review readily available and applicable regional groundwater and salt/nutrient management studies and data. Studies with data on groundwater quality, use, supply development, and salt and nutrient loading may be useful. The types of studies and data that may be useful include the following:
    - Planning documents, including Urban Water Management Plans (UWMPs) and Groundwater Management Plans
    - Groundwater supply, storage, or conjunctive use studies;
    - Groundwater aquifer hydrogeologic investigations;
    - Groundwater quality studies or groundwater protection studies;
    - Groundwater models
    - Recycled water compliance, assimilative capacity, and Basin Plan studies;

  - Pollutant modeling and transport studies;
  - Watershed studies; and
  - Source assessment evaluations.
- Collect and review readily available and applicable well data and information, as follows:
  - Existing and planned municipal supply wells or projects within the basin.
  - Private groundwater wells or private well areas within the basin.
- Contact organizations engaged in ongoing groundwater monitoring to determine if the collected data can be made available for use in the SNMP.

Task 1.6 Perform Initial Groundwater Quality Characterization

- Review prior reference studies and data (collected as part of Task 1.5) and assess the reliability and specificity of the groundwater quality data, depth-to-water data, and estimates for hydrogeologic parameters, as applicable.

Potential Off-Ramp #1

Evaluate the potential feasibility of water uses for beneficial use consistent with land use within the region. If groundwater is not considered suitable for use as a municipal or domestic water supply by meeting an exception listed in State Board Resolution No. 88-63 - *The Sources of Drinking Water Policy*, then at a minimum, Best Management Practices can be documented along with the basin characterization and comprise the SNMP in lieu of the standard required elements listed in the Recycled Water Policy. Depending on stakeholder input, other elements, such as a simplified groundwater monitoring plan could also be included. If groundwater is used as a public water supply in the basin, proceed to next bullet.

- Identify the parameters of interest for the plan which should include salts and nutrients but could include other parameters of interest that adversely affect groundwater quality. These parameters should be based on collected groundwater quality information and stakeholder input.
- Identify whether readily available data and information is sufficient to complete a baseline analysis to determine if the groundwater basin is currently meeting water quality objectives. If not, develop a plan for collecting data, collect the data, and then return to next step.
- If data are sufficient, review data to determine whether (1) water quality objectives are being exceeded, and (2) any trends that show an increase in salt or nutrient management concentrations.
- Select and justify preliminary planning horizon to look into the future (such as 20 years – similar to a UWMP planning horizon), depending on expected changes in the future such

as growth, land use changes, water supply changes and increases in recycled water application.

- Evaluate historical trends and anticipated projects that would contribute salt or nutrients to the groundwater, and estimate whether an exceedance of water quality objectives is anticipated within the planning horizon (document the evaluation and results).

Potential Off-Ramp #2

If there is a sound basis that water quality objectives will not be exceeded, this basin is a No Threat basin. Document the basin characterization, evaluation and results, including Best Management Practices. This documentation will comprise the SNMP unless stakeholders determine collaboratively that other elements suggested by the Recycled Water Policy (i.e. a groundwater monitoring plan) should be included. If it is estimated that water quality objectives would be exceeded, or if there is uncertainty regarding whether water quality objectives would be exceeded, proceed to next section (Step 2).

Step 2 Recycled Water and Recharge Water

Task 2.1 Identify Recycled Water and Recharge Water/Use Quantities

- Collect available data and information about current and predicted recycled water and recharge water (including stormwater or imported water)/use. Urban Water Management Plans (UWMPs) can be used as an initial data source. Recycled water producers will also have information about recycled water and potential plans for future expanded use.

Task 2.2 Identify Recycled Water and Recharge Water Goals

- Identify the goals of the recycled water studies, and stormwater and other recharge water studies related to the basin. Goals should be consistent with the goals within the Recycled Water Policy to increase recycled water use and stormwater recharge. Gather data about the future quantitative goals for these projects.

Step 3 Comprehensive Review of Salt and Nutrient Sources

Task 3.1 Evaluate Sources within the Basin

- Identify general land uses within the basin.
- Identify known sources of salt/nutrient loads within the basin, to supplement work from Task 1.4. Sources may include:
    - Applied Water (groundwater)

- Applied Water (surface water)
- Recycled Water Application
- Artificial Recharge of Stormwater Runoff
- Artificial Recharge with Imported Water Supplies
- Atmospheric Deposition
- Biosolids Application
- Commercial, Industrial, and Institutional Facilities
- Creek Recharge
- Agriculture, including applied fertilizer and soil amendments
- Dairy Operations
- Mines
- Natural Geologic Sources
- Natural Soil Conditions
- Point Source Wastewater Discharges
- Rainfall
- Seawater Intrusion
- Septic Tank Discharges
- Storage Ponds
- Streamflow Infiltration
- Subsurface Inflow (including upstream inflow and seawater intrusion)
- Urban Runoff

- Identify the locations where source loads are impacting the basin.

Task 3.2 Quantify Basin Assimilative Capacity

- Using water quality data gathered under Task 1, establish the baseline water quality. Calculation of constituent concentrations can be performed with a spatial averaging approach.
- Compare these values to the Basin Plan water quality objectives, taking dilution into account if appropriate, to determine the assimilative capacity of the basin. The assimilative capacity is the difference between the water quality objectives and the existing water quality, taking into account dilution if appropriate. If the basin has either an existing or potential beneficial use of municipal and domestic supply (see 2011 Basin Plan, Table 2-2), compliance with the water quality objectives for municipal supply should be assessed (see Basin Plan, Table 3-5).

Task 3.3 Develop Source Load Assessment Tools

- Develop tools for assessing salt and nutrient loading, as well as fate and transport, of salts and nutrients. Examples of tools include geographical information system (GIS) relational models, groundwater flow/transport models (complex basins) or spreadsheet-based mass balance computations.

Task 3.4 Gather Fate and Transport Information

- Gather information about the fate and transport of salts and nutrients in the basin. Reviewing California's Groundwater Bulletin 118 can be a starting point for this process.
- Additional tasks that may be useful are as follows:

- On the basis of available hydrogeological, water quality, or geologic studies, determine fault lines, bedrock constrictions, or vertical stratification that may affect transport and groundwater quality.
- Identify known hydrogeologic parameters for the basin (e.g. hydraulic conductivity, storage coefficient, etc.) and the bases on which these parameters were estimated.
- Assess the geographic completeness of existing groundwater quality data, depth-to-water data, and hydrogeologic parameters and determine if any data gaps exist that prevent geographic, seasonal, or depth-dependent characterization of groundwater quality, occurrence or transport.
- Assess the geographic distribution of water quality concentrations for the salt/nutrient parameters of interest, and assess the depth-dependent distribution of water quality.

Step 4 Salt/Nutrient Loading and Implementation Measures

Task 4.1 Determine Planning Horizon

- Determine an appropriate planning horizon (the number of years to look into the future), and justify the selection. A longer timeframe may be useful, such as the one established in the region's UWMPs (e.g., 25 years), especially if the region expects limited growth. If the region expects significant land use changes or projects with expected impacts to salt and nutrient loadings (such as recharge projects with stormwater or recycled water), a shorter time frame (e.g., 10 years) is recommended.

Task 4.2 Estimate Future Salt/Nutrient Source Loads

- Prepare estimates for future recharge flow to the basin from surface and subsurface sources, discharge/withdrawal (flow) from the basin, and salt and nutrient loading from the sources identified in Task 3.1. Land use data may provide valuable information for estimating source loads.
- Building on the baseline calculations performed in Task 3.2, use the tool developed in Task 3.3 to compute predicted concentration estimates that are representative of the basin for the identified constituents of interest.

Task 4.3 Determine Future Water Quality

- Develop a mixing model on an annual time step for the selected planning horizon to mix the load concentrations developed within the basin. A spreadsheet model is typically adequate for the mixing analysis. Available data from other basin models (e.g. existing USGS or other models) such as hydrogeology characteristics (depth of mixing), water balance and water quality concentration information may be extracted and used within the mixing model. Comment on limitations and sensitivities within the mixing model (i.e. mixing depth, timing of future land use or land management changes, etc).
- Determine the degree to which the basin will be exceeding applicable water quality objectives for the identified salt and nutrient parameters within the planning horizon.

- Determine the impact of recycled water on the assimilative capacity of the basin.
- Assess the general level of effort for managing salts and nutrients in the basin. Consider the basin's characteristics and uses in this assessment.

Task 4.4 Identify Appropriate Implementation Measures and Management Strategies

- Identify the basin's existing implementation measures and strategies to manage salt and nutrient loading in the basin. If future water quality trends are flat, BPOs are not being exceeded or projected to be exceeded, and recycled water project utilize less than 10% assimilative capacity (or 20% for multiple projects); existing management measures may be sufficient for managing salts and nutrients within the basin.
- If salt and/or nutrient concentrations are increasing, additional implementation measures may be necessary. In a collaborative manner with Plan participants, develop (as applicable) a list of additional, appropriate implementation measures and management strategies (additional measures) to manage salt and nutrient loading in the basin on a sustainable basis. Examples of best management practices (BMPs) include:
    - Irrigation at agronomic rates
    - Configuration of irrigation and drainage facilities in land application fields to reasonably minimize runoff of applied animal waste
    - Fertilizer use workshops
    - Industrial discharge controls (local pretreatment limits, high strength surcharge for nutrients and/or salts)
    - Irrigation workshops
    - Land use policy modification
    - Recharge program adoption or modification (stormwater, recycled water, imported water)
    - Recycled water application limitations or quality guidelines
    - Septic system BMPs
    - Source load diversion/control

Task 4.5 Assess Load Reduction & Water Quality Improvement Associated with Additional Measures

- If additional measures are being considered, it may be of interest to evaluate the ability of the additional measures to achieve load reduction or groundwater quality improvement. Use the tool developed in Task 3.3 to assess the ranges of potential load reduction and water quality improvement effects associated with additional measures, if appropriate.
- Evaluate and compare the additional implementation measures and select the preferred measure(s) for implementation. It may be appropriate to consult among stakeholders to inform the process of making decisions about implementation measures.

Step 5 Antidegradation Analysis

- Conduct an antidegradation analysis to demonstrate that implementation measures, including identified projects, included within the SNMP will collectively comply with the requirements of Resolution No. 68-16.

Step 6 Basin/Sub-basin Wide Monitoring Plan

- Identify existing monitoring wells and select appropriately located wells to determine water quality throughout the most critical areas of the basin. Focus on water quality near water supply wells, but also consider wells near large water recycling projects and groundwater recharge projects. Consider a range of well depths to monitor shallow or deep zones, as appropriate.
- Propose additional (new) monitoring wells if appropriate.
- Determine appropriate salt and nutrient parameters and monitoring frequencies that are reasonable and cost-effective that may help determine whether the Basin Plan water quality objectives for salts and nutrients are being, or are threatening to be, exceeded. Monitoring data should be evaluated to understand the effectiveness of the BMPs developed as part of Task 4.4. Refer to the amended Recycled Water Policy (April 2013) for guidance on CEC monitoring requirements.
- Identify stakeholders responsible for maintaining, assessing, and storing the monitoring data.

Step 7 Plan Documents and Regional Water Board Coordination

- Compile analyses in a Plan document.
- Coordinate with the Regional Water Board on next steps regarding Plan submittal and support of their Basin Plan Amendment and California Environmental Quality Act compliance process.

Appendix D - Salt and Nutrient Source Identification and Loading Technical Memorandum

Technical Memorandum

Sonoma Valley Salt and Nutrient Management Plan

Subject: **Salt and Nutrient Source Identification and Loading**

Prepared For: Marcus Trotta, SVCSD

Prepared by: Chris van Lienden, RMC

Reviewed by: Christy Kennedy, RMC, John Dickey, PlanTierra

Date: 28 June 2013

Reference: 0047-008

1 Introduction

An analysis of salt and nutrient loading occurring due to surface activities is presented to identify sources of salt and nutrients, evaluate their linkage with the groundwater system, and estimate the mass of salts and nutrients loaded to the Sonoma Valley groundwater subbasin associated with those sources.

Salt and nutrient loading from surface activities to the Sonoma Valley groundwater basin are due to various sources, including:

- Irrigation water (potable water, surface water, groundwater, and recycled water)
- Agricultural inputs (fertilizer, soil amendments, and applied water)
- Residential inputs (septic systems, fertilizer, soil amendments, and applied water)
- Animal waste (dairy manure land application)

Most of these sources, or "inputs", are associated with rural and agricultural areas. Urban area salt and nutrient loads (e.g. due to indoor water use) are assumed to be primarily routed to the municipal wastewater system for recycling or discharge rather than to groundwater, except for landscape irrigation. Other surface inputs of salts and nutrients, such as atmospheric loading, are not considered a significant net contributing source of salts and nutrients and are not captured in the loading analysis. In addition to surface salinity inputs, potential subsurface inputs of high salinity waters from San Pablo Bay, thermal water upwelling and connate groundwater exists within the basin. These potential subsurface inputs are discussed in this Technical Memorandum (TM) and are further described along with other subsurface inputs in the Existing and Future Groundwater Quality TM.

The purpose of this TM is to document the inputs of salts and nutrients in the Sonoma Valley, along with the methodology used to estimate the effect of those inputs on water quality in the groundwater basin.

2 Methodology

To support the Sonoma Valley Salt and Nutrient Management Plan (SNMP) and to better understand the significance of various loading factors, a GIS-based loading model was developed. The loading model is a simple, spatially based mass balance tool that represents total dissolved solids (TDS) and nitrogen loading on an annual-average basis. Calibration of the model was limited to focusing on comparing recent historical trends to changes in concentrations estimated through incorporating the loading model results into the mixing model. In addition to the limited calibration activities, extensive stakeholder coordination was performed to refine the parameters in the loading model, including land use, applied water, TDS and N application (in applied water, as fertilizers and amendments, and in land applied manure), irrigation water source quality, and sewer service areas (to determine septic loads). Given these activities, the model is considered suitable for this analysis of basin conditions.

Primary inputs to the model are land use, irrigation water source and quality, recycled water storage pond locations and percolation, septic system areas and loading, and soil characteristics. These datasets are described in the following sections. The general process used to arrive at the salt and nutrient loads was:

- Identify the analysis units to be used in the model. In the case of Sonoma Valley, parcels from the Sonoma County Assessor's Office are the analysis units.
- Categorize land use categories into discrete groups. These land use groups represent land uses that have similar water demand as well as salt and nutrient loading and uptake characteristics.
- Apply the land use group characteristics to the analysis units.
- Apply the irrigation water source to the analysis units. Each water source is assigned concentrations of TDS and nitrogen.
- Apply the septic system assumption to the analysis units.
- Apply the soil texture characteristics to the analysis units.
- Estimate the water demand for the parcel based on the irrigated area of the parcel and the land use group.
- Estimate the TDS load applied to each parcel based on the land use practices, irrigation water source and quantity, septic load, and infrastructure load. The loading model makes the conservative assumption that no salt is removed from the system once it enters the system. Other transport mechanisms (such as runoff draining to creeks exiting the basin) likely reduce the total quantity of salt in the basin.
- Estimate the nitrogen load applied to each parcel based on the land use practices, irrigation water source and quantity, septic load, and infrastructure (e.g. wastewater ponds) load. The loading model assumes that a portion of the applied nitrogen is taken up by plants and (in some cases) removed from the system (through harvest of plant material). Additional nitrogen is converted to gaseous forms and lost to the atmosphere. Remaining nitrogen is assumed to convert to nitrate and to be subject to leaching. Soil texture is used to estimate and account for mobility of leaching water and the efficiency of nitrate transport through the root zone.

3 Data Inputs

Data inputs to the model include the spatial distribution of land uses (with associated loading factors), irrigation water sources (with associated water quality), septic inputs, wastewater infrastructure loads, and soil textures. These inputs are discussed below.

3.1 Land Use

Land use data are obtained from the 2012 Sonoma County Assessor's Office parcel dataset. This dataset contains several hundred discrete land use categories. These categories are consolidated into the following land use groups for the Sonoma Valley basin area:

- Flowers and nursery
- Pasture
- Vines
- Other row crops
- Dairies
- Other confined animal feeding operations
- Non-irrigated vines
- Non-irrigated field crops
- Non-irrigated orchard
- Shrub/Scrub
- Grassland/ Herbaceous
- Barren land
- Farmsteads
- Urban commercial and industrial
- Urban commercial and industrial, low impervious surface (e.g. maintenance yards, schools)
- Urban landscape
- Urban residential
- Paved areas (roads and parking lots)

Local stakeholders and Plan partners confirmed that the land use is substantially unchanged since the 2012 dataset, within the accuracy requirements of this type of analysis. The spatial distribution of land uses is shown in Figure 3-1. Upon review of the land use dataset, stakeholders provided updates to the dairies and grassland/herbaceous categories in the October 10, 2012 SNMP Workshop with the Sonoma Valley Groundwater Management Program's (SVGMP's) Technical Advisory Committee (TAC). Because there are so many distinct categories, a discrete color for each type could not be assigned. Therefore, land use categories with similar characteristics (i.e. urban categories, non- irrigated agriculture categories, irrigated agriculture categories) are shown combined into a color category.

Each land use group is assigned characteristics including:

- Applied water
- Percent irrigated
- Applied nitrogen
- Used nitrogen
- Leachable nitrogen
- Applied TDS

Leachable nitrogen is assumed to be the applied nitrogen less 10 percent of the applied nitrogen for gaseous loss, less nitrogen removal in harvested plant material. Table 3-1 consists of a matrix of values for the land use categories and characteristics. These values were also presented to the stakeholder group and refined based on their input. Refinements included adjustments to vineyards, farmsteads/rural residential, and non-irrigated field crops. For vineyards, coordination with stakeholders included modification to applied TDS and irrigation volume to reflect practices in the area. For farmsteads/rural residential, modifications were made to applied TDS, applied N, and irrigation volume based on improved understanding of land uses on these diverse parcels. Finally, non-irrigated field crops were given the non-irrigated designation based on stakeholder input on the farming practices of what are generally small-grain hay crops in the southern portion of the basin.

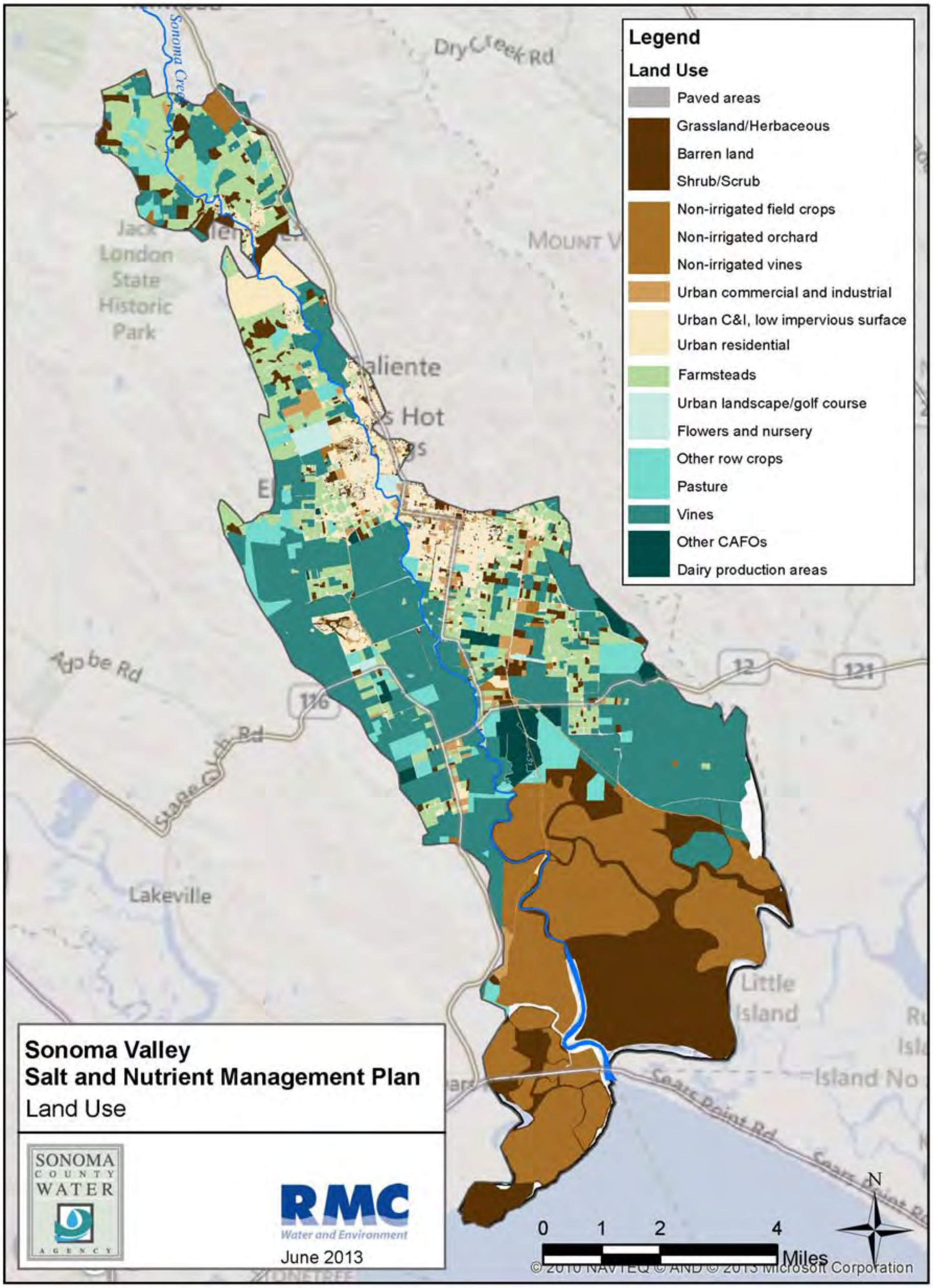


Figure 3-1: Land Use

Table 3-1: Land Use Related Loading Factors

Land Use Group	Total Area (acres)	Percent Cultivated[1]	Applied Water[2] (in/yr)	Applied Nitrogen[3] (lbs/acre-year)	Nitrogen Uptake[4] (lbs/acre-year)	Leachable Nitrogen[5] (lbs/acre-year)	Applied TDS[6] (lbs/acre-year)
Paved Areas	28	0%	0	0	0	0	0
Grasslands/Barren/ Herbaceous	7,212	0%	0	0	0	0	0
Non-irrigated vines	284	80%	0	18	16	0	84
Non-irrigated Orchard	41	80%	0	75	60	8	292
Non-irrigated field crops (hay)	8,489	80%	0	34	22	8	170
Urban Commercial and Industrial	1,018	5%	48.5	92	60	23	657
Urban C&I, Low Impervious Surface	807	30%	48.5	92	60	23	438
Farmsteads/Rural-Residential[7]	5,608	10%	28.7	60	42	13	303
Urban Residential	2,238	15%	51.1	92	60	23	438
Urban Landscape/Golf Course	327	75%	48.5	92	60	23	584
Pasture	2,266	40%	51.1	110	90	14	584
Vines[8]	13,075	100%	6.3	29	23	3	168
Other CAFOs	102	10%	0.0	84	-	75	730
Dairy[9]	769	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

1 Percent of land area assumed to be cultivated within each class is estimated is based review of aerial photography and agricultural scientist professional judgment of a reasonable, broad average for each class.

2 Applied water values and other climatic data are taken from Department of Water Resources (DWR) land and water use data (http://www.water.ca.gov/landwateruse/anlwuest.cfm). On this website, four years of data are available. Climatic data averages, based on these four years of data, was compared to the 21-year average of available CIMIS climatic data for the Sonoma Valley area. As the two data sets correspond well, the average DWR applied water values were used, with some adjustment using crop coefficients for the Sonoma Valley area to fit the study land use classes.

3 Applied nitrogen estimates are based on literature review for individual land cover classes and professional judgment. Applied nitrogen was then calculated for total acreage and checked against fertilizer sales records for Sonoma County (available from the California Department of Food and Agriculture). Application rates were then scaled to match sales records, and adjusted if appropriate based on discussions with growers in the region.

4 Uptake of nitrogen was estimated from available literature by multiplying reported yield figures by reported nitrogen concentrations for harvested plant parts. Balances between uptake and application were checked to ensure that nitrogen use efficiencies were in the reported ranges, adjusted for professional knowledge of irrigation and fertilization practice in each land cover class.

5 Maximum nitrogen leaching calculations for each land cover unit were calculated based on the balance between application, gaseous loss (volatilization and denitrification), and uptake. The maximum was then reduced based on soil conditions mapped for the area.

6 Applied TDS estimates are based on literature review for individual land cover classes and professional judgment. Applied TDS was then calculated for total acreage and checked against amendment sales records for Sonoma County (available from the California Department of Food and Agriculture). Application rates were then scaled to match sales records. Amendment application rates were adjusted if appropriate based on discussions with growers in the region.Farmstead irrigated areas are assumed to be a mix of turf grasses and vineyards.

7 Assumes that irrigated vines have a larger percent cultivation due to increased production efficiency from irrigation and a conservative value of 100% cultivation was used. An additional assumption for vines is that vines irrigated with recycled water utilize the same fertilizer and amendment application rates as those irrigated with groundwater (conservative estimate).

8 See discussion on dairy parcels below.

Due to the importance of dairies, some additional consideration is applied to dairy parcels. To better reflect land use practices, the applied, used, and leachable nitrogen characteristics and the applied TDS characteristic are further subdivided into production areas, ponds, and land application areas. Leachable nitrogen is calculated the same way as for the other land use groups except that gaseous loss is assumed to be 20 percent, as opposed to the 10 percent assumed loss for other land use groups, mainly due to the regular timing and highly organic nature of applied nitrigen. Table 3-2 summarizes the assumed dairy characteristics.

Table 3-2: Assumed Characteristic Dairy Values for the Loading Model

Dairy Subdivision Designation	Percent of Total Parcel Area Used Per Designation	Applied Nitrogen **(lbs/acre-year)**	Used Nitrogen **(lbs/acre-year)**	Leachable Nitrogen **(lbs/acre-year)**	Applied TDS **(lbs/acre-year)**
Production Area	6%	20	0	8	82
Ponds	1%	141	0	113	933
Land Application Area	93%	367	352	30	1,280

3.2 Irrigation Water Source

The irrigation water source data input is the result of a compilation of several different data sets. Potable water service areas were used as the initial layer. Those areas not served by a potable municipal water source are then assumed to obtain irrigation water from local groundwater wells. The spatial extent of these water sources is determined by city water service limits, recycled water studies, local knowledge, and stakeholder input. Stakeholder input was specifically utilized to refine irrigation and frost protection volumes for vineyards; water supply sources for the Temelec area; irrigation volumes on pasture, grazing land, field crops, and farmsteads; and the percentage of irrigated land at the Sonoma Developmental Center. Parcels in a recycled water service area are assumed to use recycled water for irrigation. Based on recycled water use rates and estimated demands, it has been assumed that vineyards were receiving recycled water blended with groundwater (~60% recycled water) to irrigate. Based on imagery of the area receiving recycled water, it has also been assumed that pastures receiving recycled water only irrigate 10% of their total area.

For irrigation water source from Valley of the Moon Water District and the City of Sonoma, TDS and nitrogen concentrations were obtained from annual water quality reports. The values assumed for groundwater are based on a basin-wide average calculated from groundwater samples collected from various public supply wells between the years 2000 to 2012 (the baseline period for the SNMP). More information on the existing groundwater quality can be found in the Existing and Future Water Quality TM. The values assumed for recycled water were estimated from effluent sampling conducted in 2012.

Table 3-3 summarizes the water quality inputs used for each irrigation water source. The spatial distribution of water sources is shown in Figure 3-2.

Table 3-3: Water Quality Parameters for Loading Model Water Sources

Source	TDS (mg/L)	Nitrate (as N) (mg/L)
Valley of the Moon Water District	162	0.2
City of Sonoma	172	0.4
Groundwater	372	0.1
Recycled Water	440	5.2

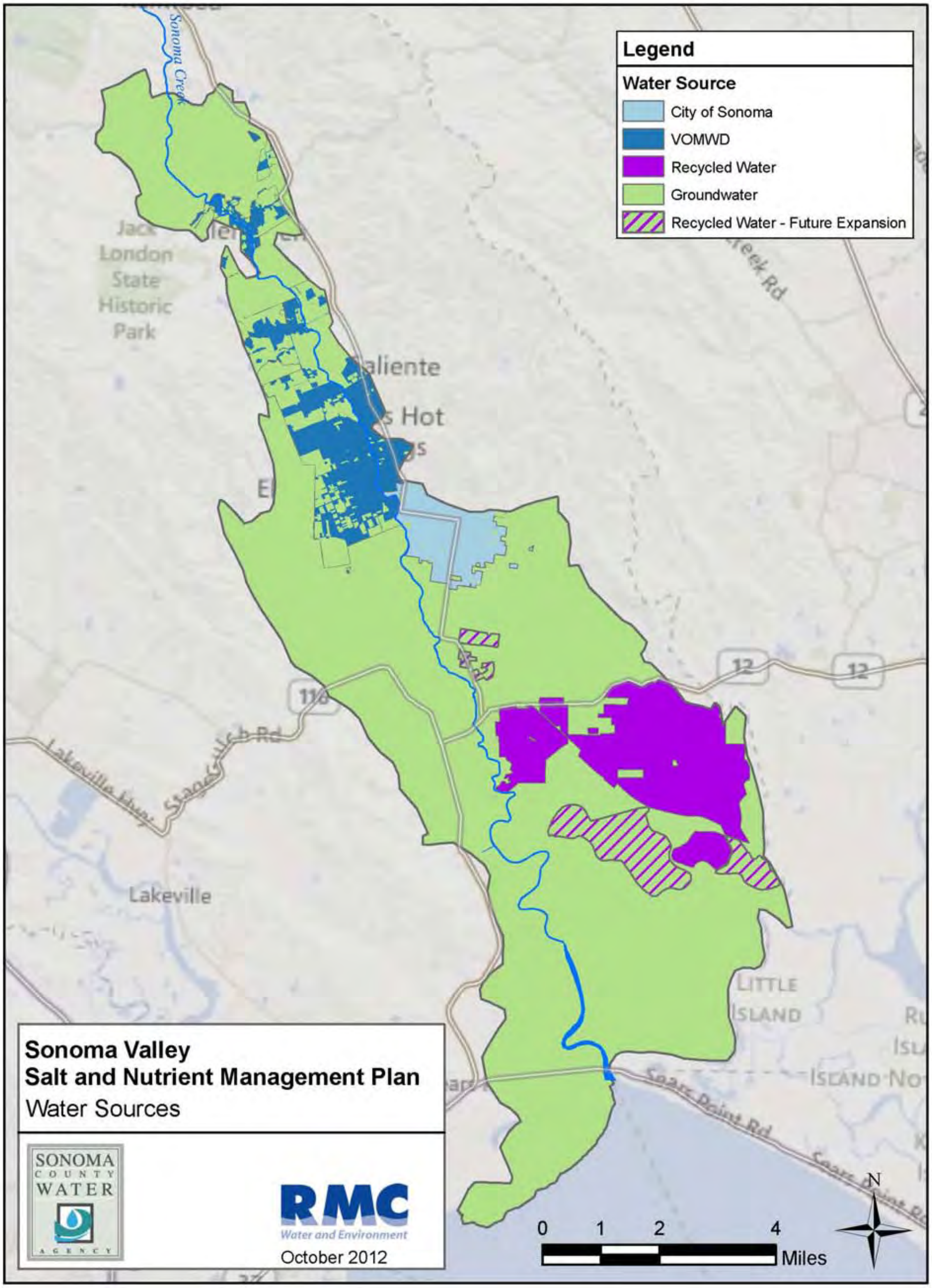


Figure 3-2: Water Sources

3.3 Septic Systems

A dataset documenting which parcels have septic systems was not available. It has been assumed that parcels outside of the Sonoma Valley County Sanitation District Service Area use a septic system. Of those parcels, septic systems are assumed where a residence is identified in the land use dataset. Each parcel with a septic system is assumed to produce 263 gallons per day (gpd), based on 75 gpd/person with 3.5 people per system. The 75 gpd/person estimate is based domestic use quantity estimates per California Code of Regulations, Title 23, Section 697. An estimate of 3.5 persons per household is a conservative estimate which assumes that household size for homes with septic is larger than that that of homes within the City (per the census bureau, persons per household for 2007-2011 is 2.54 in Sonoma County, with the City at only 2.07 people per household, therefore the outlying areas must be greater than 2.54 persons per household). The septic waste is assumed to have TDS concentrations of 572 mg/L, based on typical groundwater concentrations plus an assumed household contribution of 200 mg/L (Metcalf & Eddy, 2003). N concentrations were assumed to be 30 mg/L, based on typical wastewater concentrations for medium strength wastewater (Metcalf & Eddy, 2003) of 40 mg/L minus an assumed volatization rate of 25 percent within the septic system. The areas within the basin that could potentially have septic systems are shown in Figure 3-3.

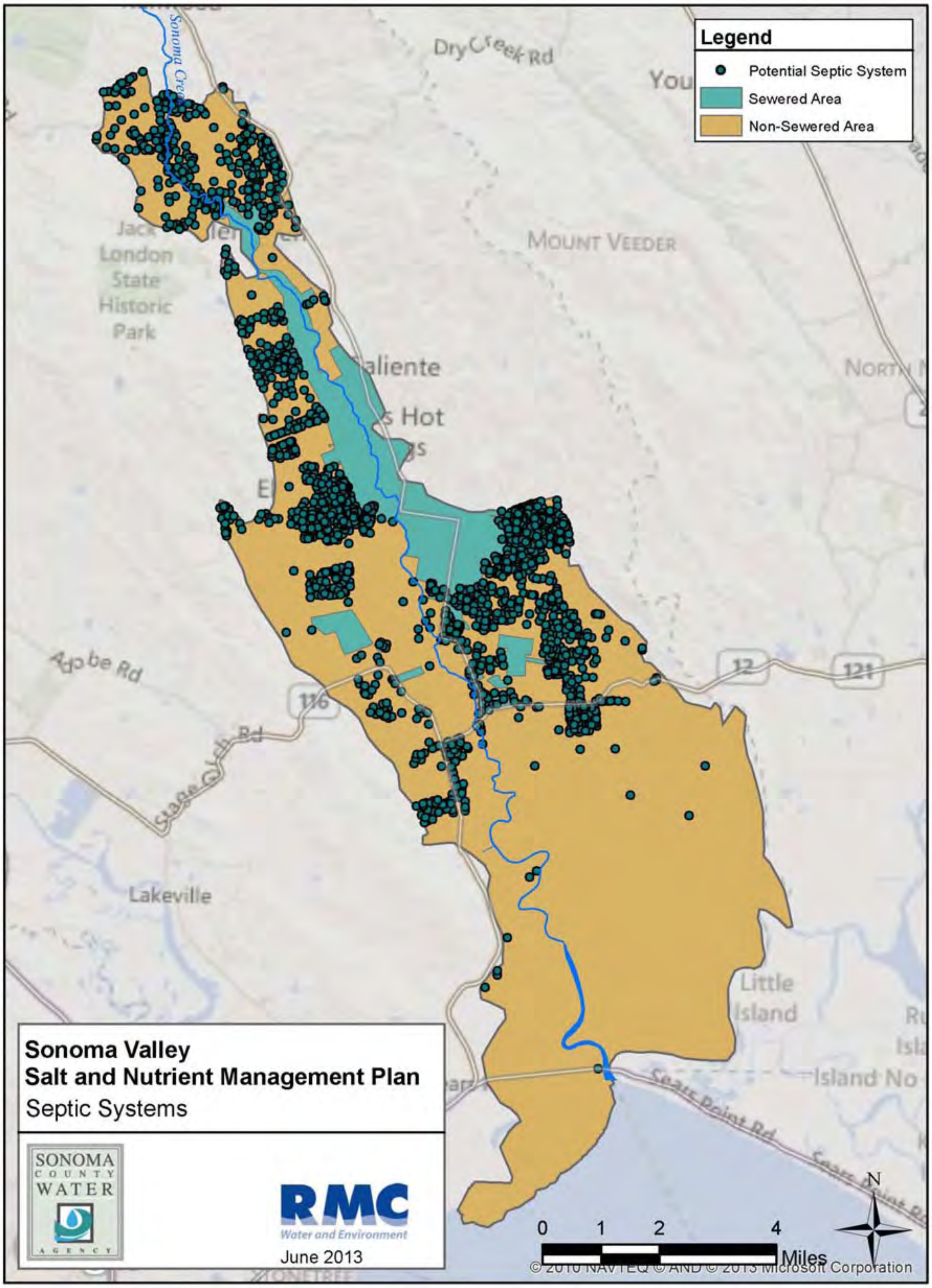


Figure 3-3: Septic Systems

3.4 Wastewater/Recycled Water Infrastructure

Sonoma Valley County Sanitation District operates five recycled water ponds within the groundwater basin; these are indicated in Attachment 1. Two of the ponds use clay liners, while the other three ponds use plastic liners. Due to the liners, it is assumed that no significant loading occurs at pond locations. It is also assumed that leakage from wastewater (sanitary sewer) and recycled water pipelines is not likely to be a significant source of salt and nutrient loading.

An effort was also undertaken to quantify potential salt and nutrient loading from winery wastewater ponds. These ponds are often lined with plastic or clay and contain rinsewater with salt and TDS concentrations similar to the source water (likely groundwater) because no additional salts and nutrients are added in the winemaking process. This effort showed that salt and nutrient loading from these ponds were likely negligible, with biological oxygen demand (BOD) the primary concern. These loads were not included in the model, beyond the loads already included through irrigation of the vineyards.

3.5 Soil Textures

Soil textures (NRCS, 2013) were obtained from the the Soil Survey of Sonoma County (SCS, 1972). Soil textures were assigned a hydraulic conductivity (NRCS, 1993). Hydraulic conductivity was used to develop an adjustment factor through linearly scaling the estimated conductivities from 0.1 (lowest) to 1.00 (highest). The adjustment factor is used to represent the proportion of nitrate that will migrate to the aquifer, relative to the other textural classes. Where conductivity is slower, it is reasoned (and observed) that nitrogen resides longer in the soil, increasing the proportion that is either taken up or lost through conversion to gaseous species.

Similar logic is not applied to TDS as salts are mostly not subject to conversion to gaseous forms, and rapidly saturate soil capacity to adsorb and retain them. Table 3-4 summarizes soil textures within the basin boundaries and how those textures are represented in the loading model. The spatial distribution of textures is shown in Figure 3-4.

Table 3-4: Loading Parameters for Surface Textures

Surface SoilTexture	Textural Class of Soil Matrix	Saturated Hydraulic Conductivity **(in/hr)**	Adjustment Factor[1]
Unweathered bedrock	-	0	0
Clay	Clay	0.03	0.1
Clay loam	Clay loam	0.18	0.13
Cobbly clay loam	Clay loam	0.18	0.13
Gravelly clay loam	Clay loam	0.18	0.13
Silty clay loam	Silty clay loam	0.23	0.14
Variable	Variable	0.48	0.19
Gravelly silt loam	Silty loam	0.48	0.19
Silt loam	Silty loam	0.48	0.19
Gravelly loam	Loam	0.73	0.24
Loam	Loam	0.73	0.24
Very gravelly loam	Loam	0.73	0.24
Fine sandy loam	Sandy loam	1.98	0.49
Gravelly sandy loam	Sandy loam	1.98	0.49
Sandy loam	Sandy loam	1.98	0.49
Very gravelly sandy loam	Sandy loam	1.98	0.49
Gravelly sand	Sand	4.49	1
Very gravelly sand	Sand	4.49	1

Notes:

1 Adjustment factors are based on hydraulic conductivity. The factor linearly scales estimated conductivity from 0.1 (lowest) to 1.00 (highest). The adjustment factor is used to represent how likely the nitrogen is to migrate to the aquifer, relative to the other textural classes.

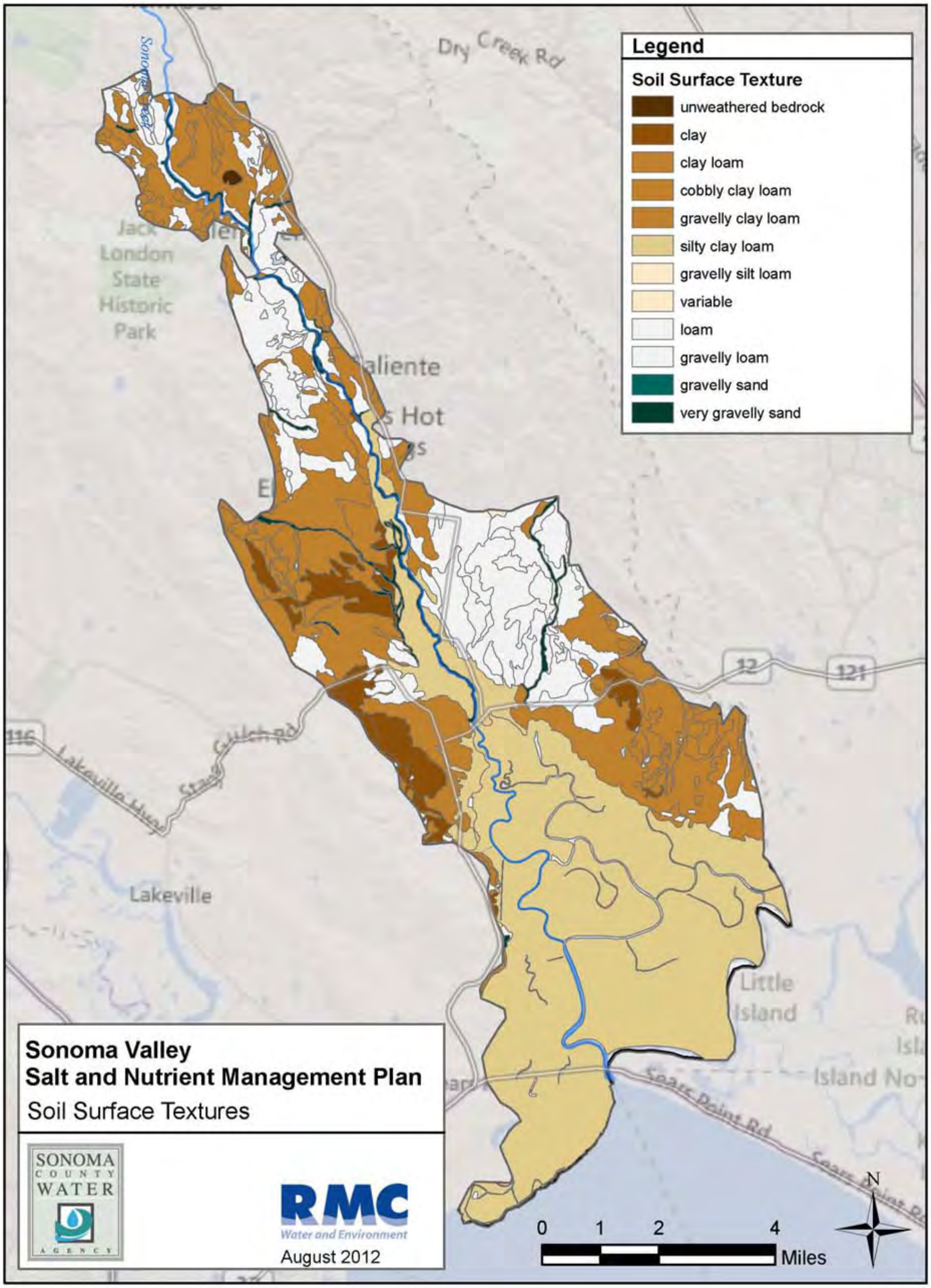


Figure 3-4: Soil Surface Textures

4 Loading Model Results

Based on the loading parameters and methodology described above, the loading model is used to develop TDS and nitrogen loading rates across the basin. Table 4-1 summarizes the overall contribution of each land use group to total TDS and nitrogen loading. The spatial distribution of TDS and nitrogen loading rates are shown in Figure 4-1 and Figure 4-2, respectively. The loading analysis estimates somewhat higher loading of TDS in the rural and agricultural areas of the basin, while nitrate loading is higher in the urban areas largely due to the low nitrogen application rates on vineyards. These results areutilized in the Existing and Future Water Quality TM.

Table 4-1: TDS and Nitrate Loading Results

Land Use Group	Total Area **(acres)**	Percent of Total Area	Percentage of Total TDS Loading	Percentage of Nitrogen Loading
Paved Areas	28	0%	0%	0%
Grasslands/Barren/ Herbaceous	7,212	17%	0%	0%
Non-irrigated vines	284	1%	0%	0%
Non-irrigated Orchard	41	0%	0%	0%
Non-irrigated field crops (hay)	8,489	20%	5%	6%
Urban Commercial and Industrial	1,018	2%	1%	8%
Urban C&I, Low Impervious Surface	807	2%	5%	7%
Farmsteads/Rural-Residential	5,608	13%	11%	37%
Urban Residential	2,238	5%	6%	22%
Urban Landscape/Golf Course	327	1%	5%	1%
Pasture	2,266	5%	17%	10%
Vines	13,075	31%	42%	3%
Other CAFOs	102	0%	0%	0%
Dairy	769	2%	7%	5%

The relative proportion of the land uses by area, nitrogen loading, and TDS loading are shown in Figure 4-3, Figure 4-4, and Figure 4-5, respectively.

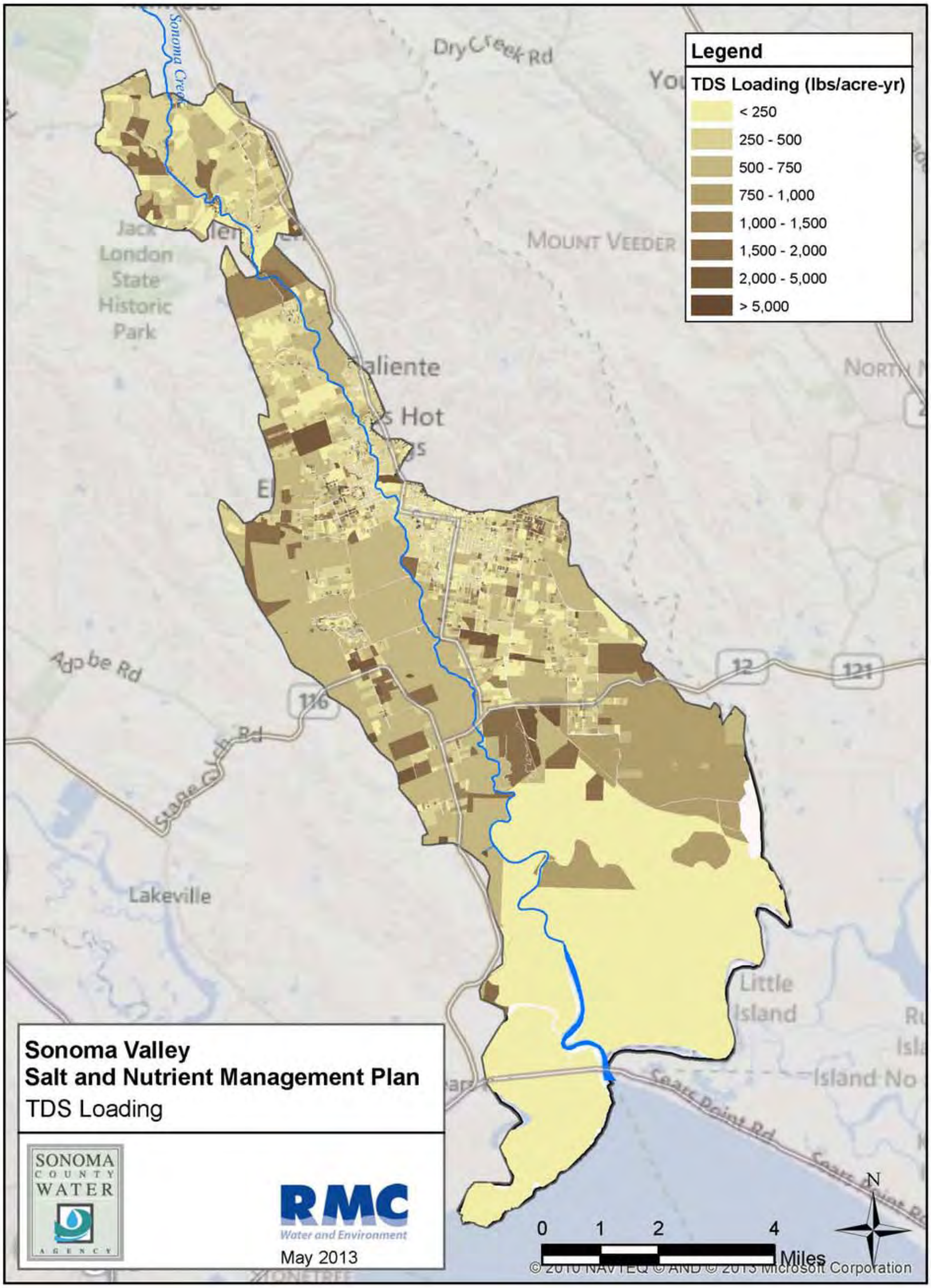


Figure 4-1: Estimated TDS Loading

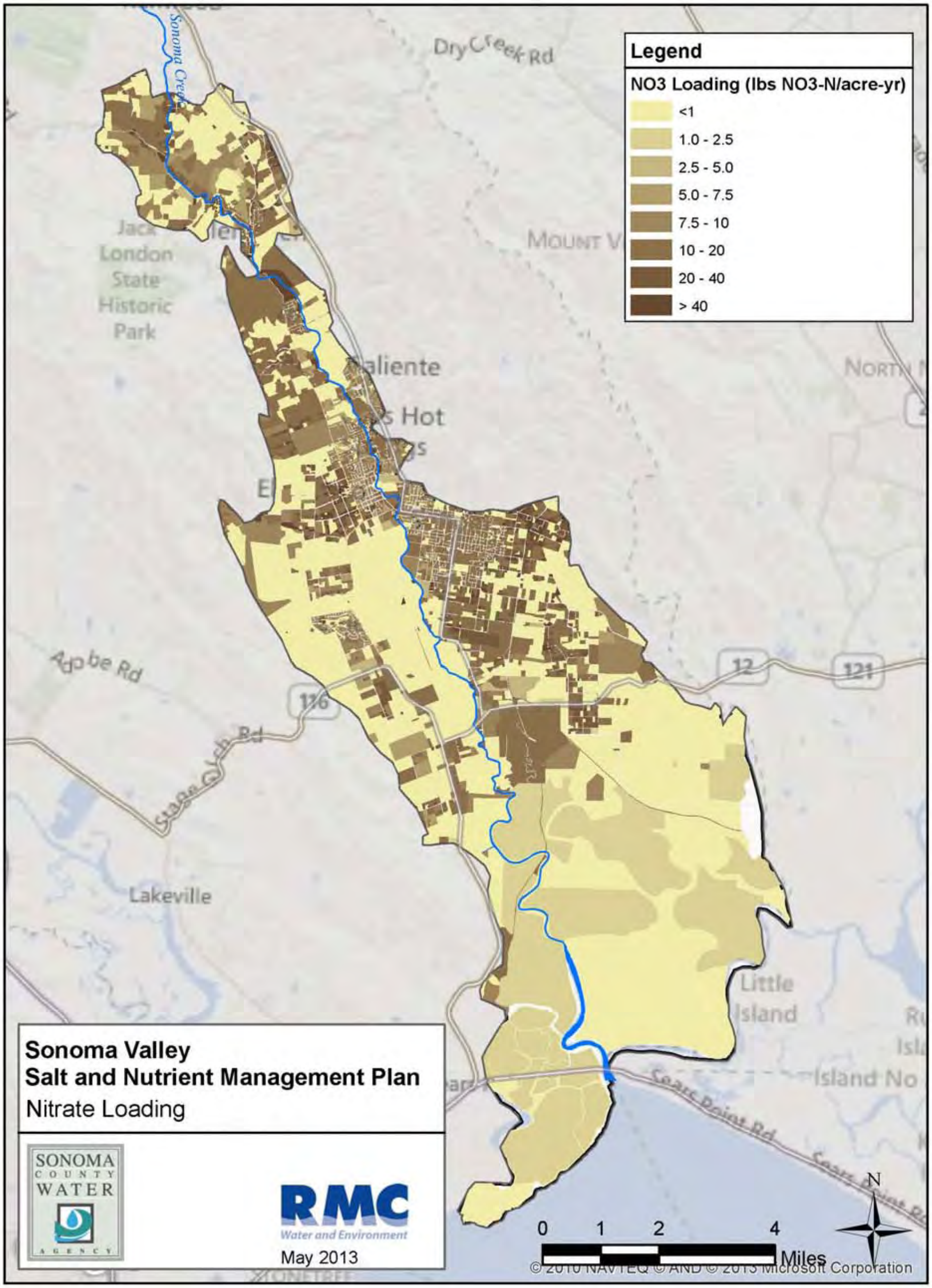
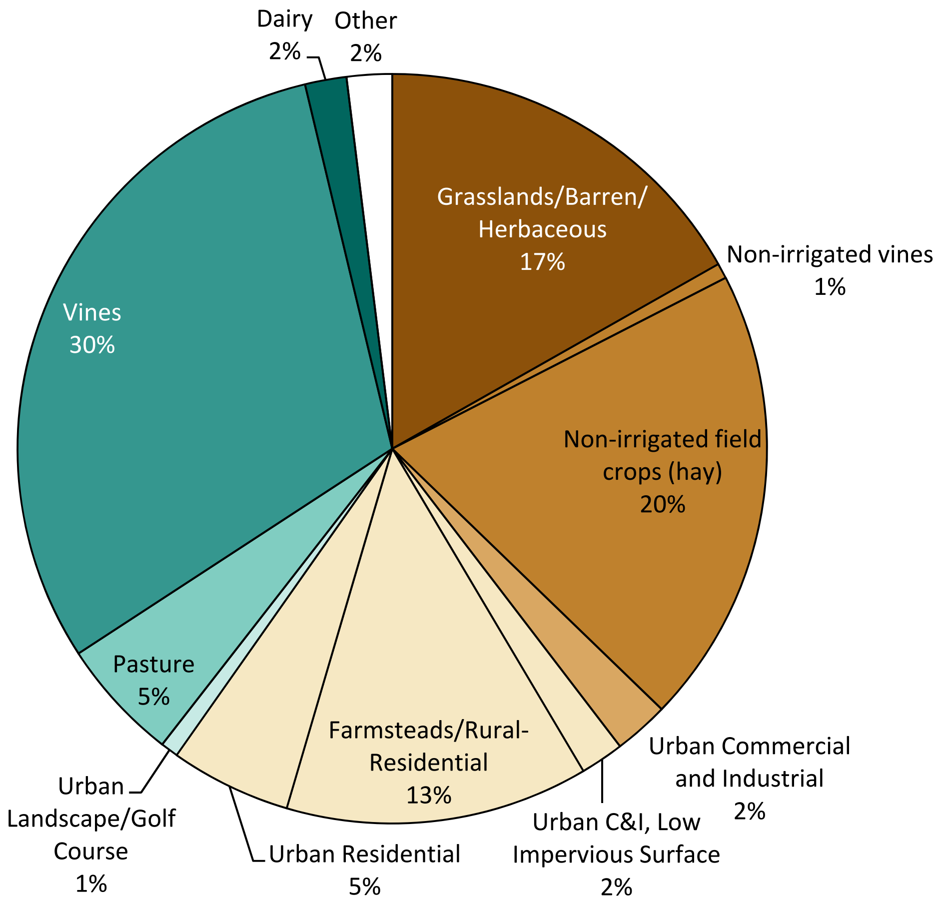
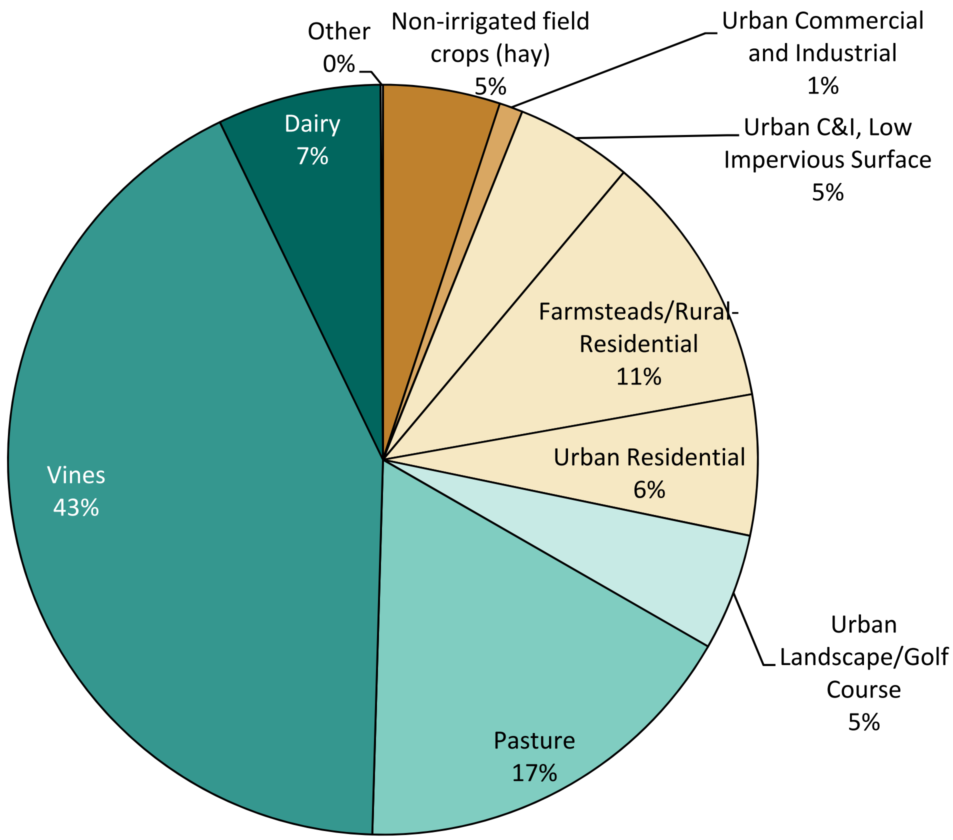


Figure 4-2: Estimated Nitrate Loading



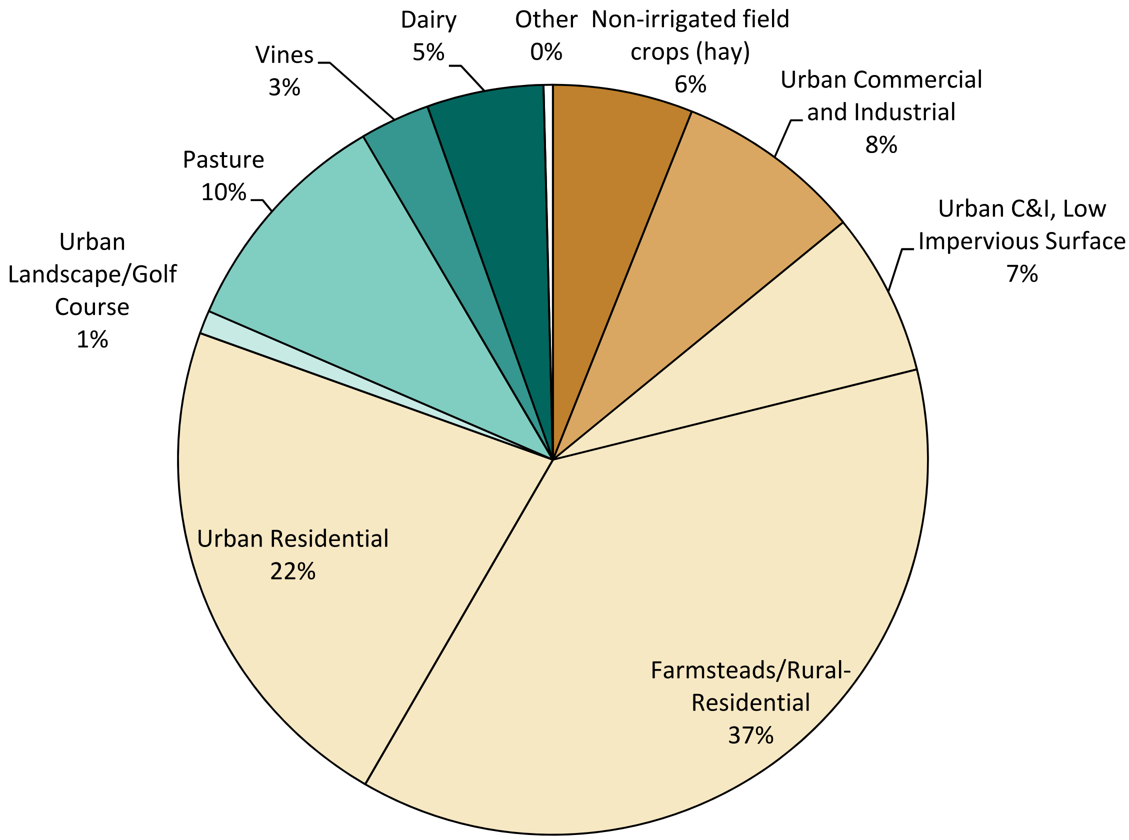
Other: Categories contributing less than 1% of land area: paved areas, non-irrigated orchards, other CAFOs

Figure 4-3 Percentage of Land Use in Study Area



Other: Categories contributing less than 1% of TDS loading: paved areas, grasslands/barren/shrubs, non-irrigated vines, non-irrigated orchards, other CAFOs

Figure 4-4 Percentage of TDS Loading in Study Area, by Land Use



Other: Categories contributing less than 1% of nitrogen loading: paved areas, grasslands/barren/shrubs, non-irrigated vines, non-irrigated orchards, other CAFOs

Figure 4-5 Percentage of Nitrogen Loading in Study Area, by Land Use

5 Brackish Groundwater

Kunkel and Upson (1960) originally identified an area of historical brackish groundwater (conductivity greater than 1,000 uS/cm) located primarily beneath the marshlands south of Highway 12/121. In 2006, The U.S. Geological Survey (USGS) developed new estimates of the extent of brackish water using conductivity measurements from 44 wells (USGS, 2006). The report found that intrusion had advanced as much as one mile north of Highway 121 in one area, and indicated the advancement may be attributed to increased groundwater pumping southeast of the City of Sonoma. In other areas (e.g., west of Highway 12), salinity levels diminished. Other potential subsurface inputs of salinity to the groundwater basin include upwelling of high-TDS thermal groundwater along fault zones and inflow connate groundwater.

The occurrence and trends related to brackish groundwater in southern Sonoma Valley are further discussed in the Existing and Future Groundwater Quality TM (Todd, 2013).

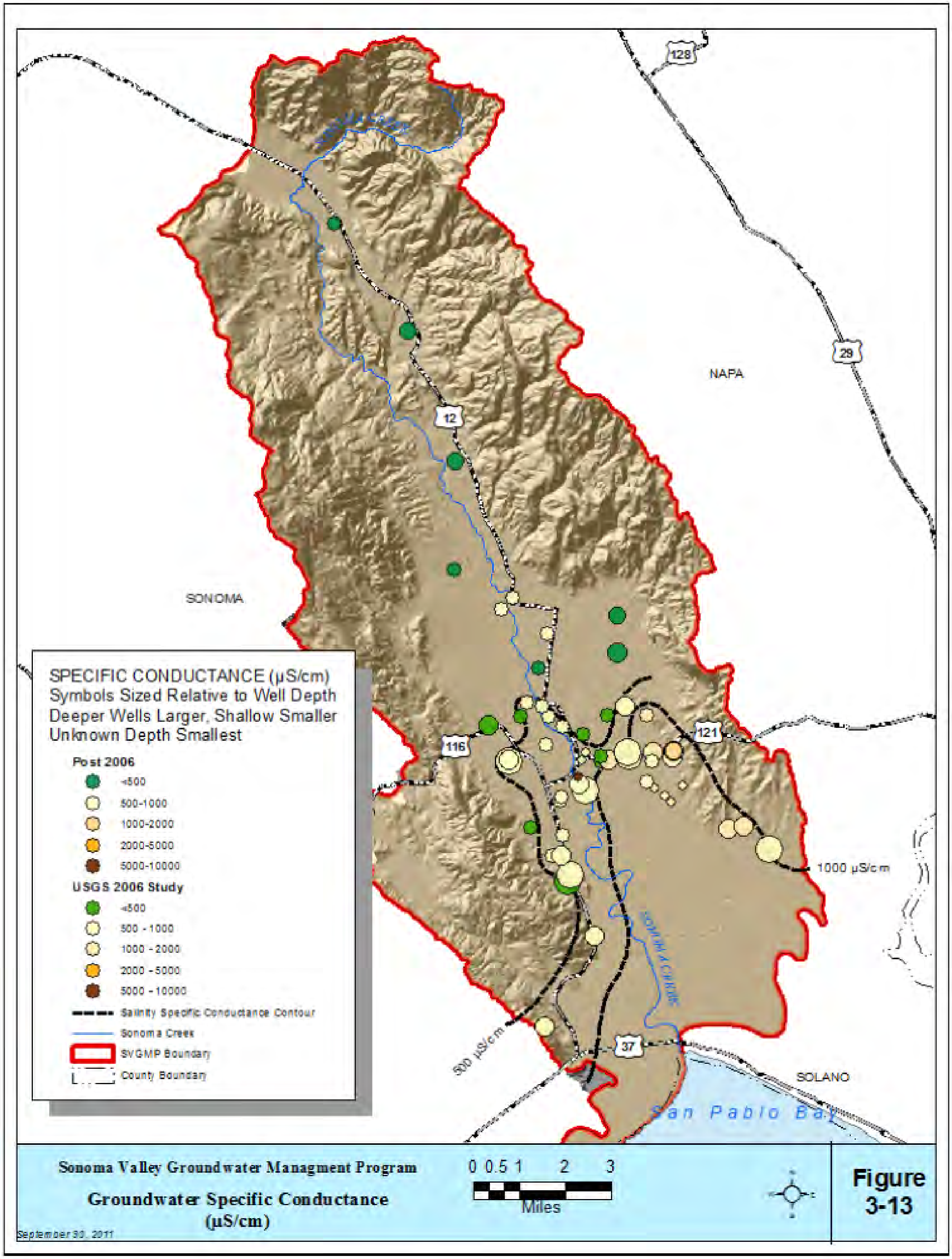


Figure 5-1: Groundwater Specific Conductance (SCWA, 2010)

6 References

California Code of Regulations, Title 23, Section 697

Census Data, 2007-2011; Sonoma County and City of Sonoma

City of Sonoma, 2011, “Annual Water Quality Report”

Kunkel, F. and J.E. Upson, 1960. Geology and ground water in Napa and Sonoma Valleys, Napa and Sonoma Counties, California. USGS Water Supply Paper: 1495

Metcalf & Eddy. (2003). *Wastewater Engineering: Treatment and Reuse*. New York: McGraw-Hill

Natural Resource Conservation Service of the US Department of Agriculture (NRCS). 1993. Soil Survey Manual - Chapter Three; Guidelines for Ksat Class Placement. http://soils.usda.gov/technical/manual/contents/chapter3.html

NRCS. 2013. Soil texture calculator. 20http://soils.usda.gov/technical/aids/investigations/texture/

SCWA, 2011, “Sonoma Valley Groundwater Management Program: 2010 Annual Report”

Soil Conservation Service (SCS; now NRCS). 1972. Soil Survey of Sonoma County, California, as contained in the Soil Survey Geographic (SSURGO) Database.

USGS, 2006, “Geohydrological Characterization, Water-Chemistry, and Ground-Water Flow Simulation Model of the Sonoma Valley Area, Sonoma County, California”

Valley of the Moon Water District, 2011, “Annual Water Quality Report”

Attachment 1 – Current and Future Recycled Water Users

SVCSD Recycled Water Users and Parcels

Sonoma County, California

DISCLAIMER

This map document and associated data are distributed for informational purposes only "AS-IS" at the published scale and provided without warranty of any kind expressed or implied. The positional accuracy of the data is approximate and not intended to represent survey map accuracy. The Sonoma County Water Agency assumes no responsibility arising from use of this information.

Appendix E - SNMP Groundwater Monitoring Plan

Technical Memorandum

Todd Engineers

Sonoma Valley Salt and Nutrient Management Plan

Subject:	**Salt and Nutrient Management Plan Groundwater Quality Monitoring Program**
Prepared For:	Marcus Trotta, Sonoma Valley County Sanitation District
Prepared by:	Sally McCraven, Todd Engineers
Reviewed by:	Christy Kennedy, RMC Water and Environment
Date:	August 26, 2013

1 Introduction

This technical memorandum (TM) describes a proposed Salt and Nutrient Management Plan (SNMP) Groundwater Quality Monitoring Plan for the Sonoma Valley. In February 2009, the State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-0011, which established a statewide Recycled Water Policy. Draft amendments to the Recycled Water Policy were released in May 2012, September 2012, October 2012 (SWRCB hearing change sheets), and January 2013. The Recycled Water Policy Amendment was adopted by the SWRCB on January 22, 2013.

With respect to monitoring, the Recycled Water Policy states that the SNMP should include a monitoring program that consists of a network of monitoring locations ". . . adequate to provide a reasonable, cost-effective means of determining whether the concentrations of salts, nutrients, and other constituents of concern as identified in the salt and nutrient plans are consistent with applicable water quality objectives." Additionally, the SNMP ". . . must focus on basin water quality near water supply wells and areas proximate to large water recycling projects, particularly groundwater recharge projects. Also, monitoring locations shall, where appropriate, target groundwater and surface waters where groundwater has connectivity with the adjacent surface waters." The preferred approach is to ". . . collect samples from existing wells if feasible as long as the existing wells are located appropriately to determine water quality throughout the most critical areas of the basin. The monitoring plan shall identify those stakeholders responsible for conducting, sampling, and reporting the monitoring data. The data shall be reported to the Regional Water Board at least every three years." With regards to constituents of emerging concern (CECs), the Recycled Water Policy Attachment A states that "Monitoring of health-based CECs or performance indicator CECs is not required for recycled water used for landscape irrigation due to the low risk for ingestion of the water." While the policy does not discuss agricultural irrigation application uses, the conclusion of low risk for ingestion of the water applies to agricultural irrigation uses as well.

In 2006, the Sonoma County Water Agency (Water Agency) coordinated development of a voluntary, non-regulatory Sonoma Valley Groundwater Management Plan (GMP) in compliance with the 1992 Assembly Bill 3030 (AB3030) and the 2002 Senate Bill 1938 (SB1938) with the participation and collaboration of a broad range of local stakeholders who served as a Basin Advisory Panel. As part of the GMP, the Water Agency and stakeholders have identified implementation of a long-term water quality monitoring program as a funding-dependent component of the GMP (SCWA, 2007). The SNMP monitoring program incorporates the GMP monitoring program. Data gaps in the existing monitoring program are identified.

The purpose of this TM is to describe the SNMP Groundwater Quality Monitoring Program for Sonoma Valley including groundwater sampling locations, sampling frequency, constituents monitored, sampling protocols and associated quality assurance and quality control (QA/QC) procedures, data analysis and evaluation criteria, and reporting. The entities responsible for monitoring and reporting will also be described.

2 SNMP Groundwater Quality Monitoring Program

2.1 Monitored Parameters

Total dissolved solids (TDS) and nitrate are the indicator salts and nutrients (S/Ns) selected for the Sonoma Valley SNMP. Total salinity is commonly expressed in terms of TDS in milligrams per liter (mg/L). TDS (and electrical [EC] conductivity data that can be converted to TDS) are available for source waters (both inflows and outflows) in the valley. While TDS can be an indicator of anthropogenic impacts such as infiltration of runoff, soil leaching, and land use, there is also a natural background TDS concentration in groundwater. The background TDS concentration in groundwater can vary considerably based on purity and crystal size of the formation minerals, rock texture and porosity, the regional structure, origin of sediments, the age of the groundwater, and many other factors (Hem, 1989).

Nitrate is a widespread contaminant in California groundwater. High levels of nitrate in groundwater are associated with agricultural activities, septic systems, confined animal facilities, landscape fertilization, and wastewater treatment facility discharges. Nitrate is the primary form of nitrogen detected in groundwater. Nitrate data are available for source waters (both inflows and outflows) in the valley. Natural nitrate levels in groundwater are generally very low (typically less than 2 mg/L for nitrate as nitrogen (nitrate-N). Nitrate is commonly reported as either nitrate-NO_3 or nitrate-N; and one can be converted to the other. Nitrate-N is the form of nitrate selected for assessment for this SNMP.

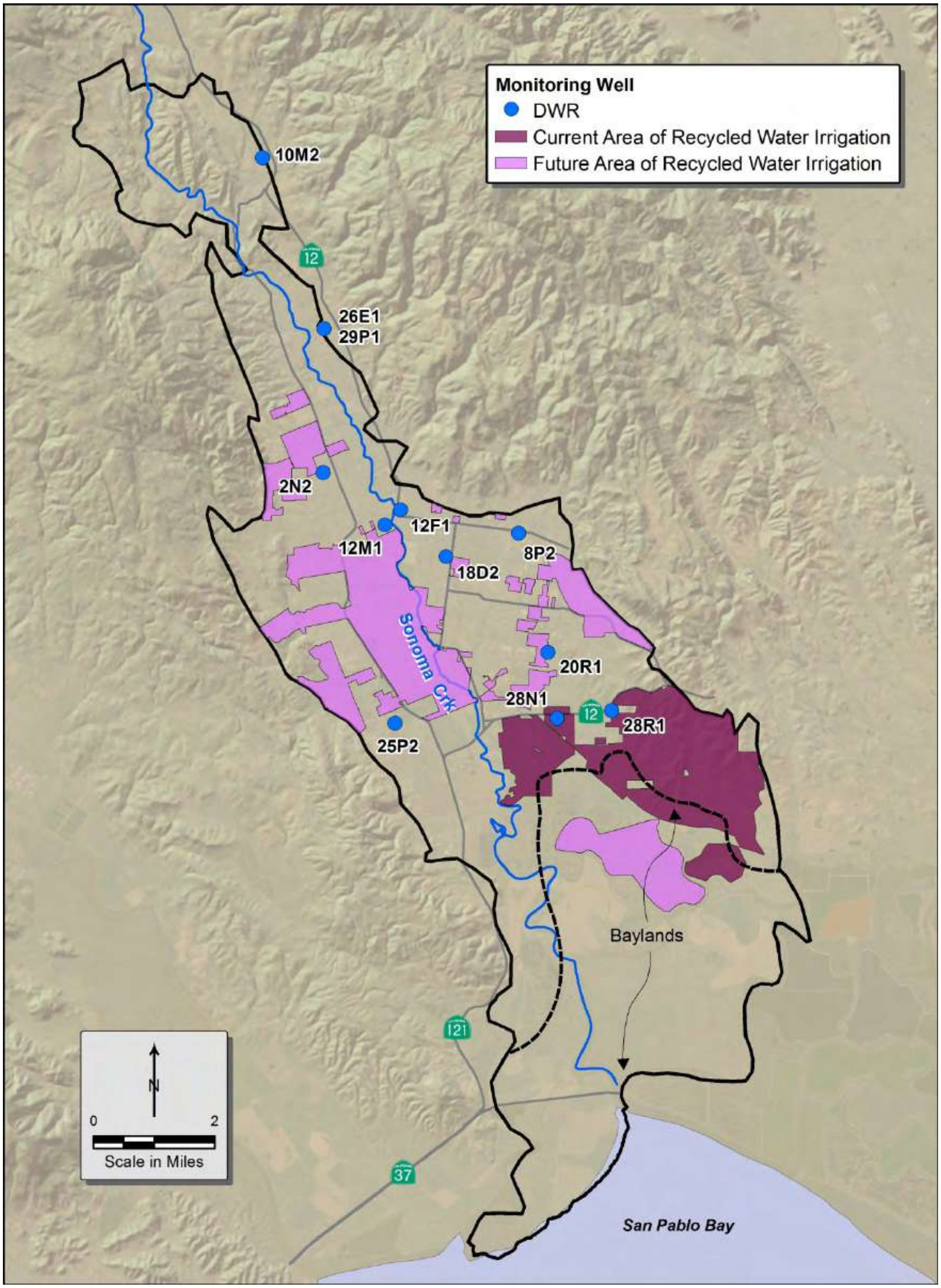
The SNMP monitoring program focused on TDS, nitrate, and EC as S/N indicator chemicals.

2.2 Basin Groundwater Quality and S/N Loading

As discussed in Chapter 5 of the SNMP, generally, relatively low TDS and nitrate concentrations are observed throughout most of the Inland Area of the subbasin and water quality concentration trends over time are flat or stable. The subbasin was divided into Inland and Baylands areas as shown in **Figure 2-1**. The Baylands Area is an area of historically elevated TDS concentrations due to proximity to San Pablo Bay. Due to the elevated salt in this area, groundwater pumping is limited, and the area is unlikely to be developed for groundwater supply in the future. Average TDS and nitrate as nitrogen (nitrate-N) groundwater quality were calculated for the Inland Area, Baylands Area, and combined Inland/Baylands area. The average TDS concentrations of the Inland, Baylands, and combined areas are 372, 1,220, and 635 mg/L respectively. The average nitrate-N concentrations of the Inland, Baylands, and combined areas are 0.06, 0.07, and 0.06 mg/L, respectively.

As discussed in Appendix A of the SNMP, TDS and nitrate loading to the subbasin is a function of the volume of water recharged and the concentration of that water. The largest TDS load to the subbasin is from deep percolation of aerial precipitation and mountain front recharge, which are the represent the largest volumes of recharge. These two sources represents 57% of the overall TDS loading to the subbasin. However, the TDS concentration of recharge from these source waters is low; 250 mg/L for both precipitation infiltration and mountain front recharge. So while these two sources add TDS load, they act to improve overall groundwater quality with respect to TDS because their TDS concentration is lower than the ambient average groundwater quality (372 mg/L in the Inland Area. Agricultural (groundwater source water) return flow is the second largest TDS load (28% of total loading).

Figure 2-1: DWR Monitoring Wells



The TDS concentration of agricultural return flow is high (4,347 mg/L). As such, agricultural return flows add mass and reduce TDS groundwater quality. Sonoma Creek leakage (6% of total loading at a concentration of 21 mg/L) and municipal return (6% of total loading at a concentration of 1,182 mg/L) contribute the next highest mass of TDS to the subbasin. Septic system return flows (572 mg/L), agricultural (recycled water) return flow (4,344 mg/L), and subsurface inflow from the Baylands Area (1,220 mg/L) combined represent less than 2% of the TDS loading to the subbasin.

The largest nitrate load is agricultural (groundwater source water) return flow (at a concentration of 24 mg/L), which represents approximately 43% of the total nitrate loading to the subbasin. Municipal return flow (20 mg/L) is the second largest nitrate load (28% of total loading), followed by septic system return flow (20% at a concentration of 26 mg/L), deep percolation of aerial precipitation and mountain front recharge (4% at a concentration of 0.06 mg/) and agricultural (recycled water source water) return flow (3% at 24 mg/L). Sonoma Creek leakage (0.2 mg/L) and subsurface inflow from the Baylands Area (0.07 mg/L) represent minor nitrate loading factors in the subbasin.

2.3 Monitoring Programs

Groundwater quality in the Sonoma Valley has been monitored since 1949. Most data represent one-time samples for short-term studies or individual well-specific assessments. The GMP monitoring program and the proposed SNMP monitoring program rely on three existing ongoing programs:

- California Department of Water Resources (DWR) Monitoring
- California Department of Public Health (DPH) Required Monitoring
- Sonoma County Water Agency (Water Agency) Monitoring

The SNMP monitoring program will also collect and consider data from any other special studies conducted in the subbasin, such as studies conducted through the GMP to evaluate salinity sources in southern Sonoma Valley and studies conducted under the California Groundwater Ambient Monitoring and Assessment (GAMA) Program. Each program is described in the following sections.

2.4 DWR Monitoring

Beginning in the 1950s, DWR initiated the longest sustained water quality monitoring effort in the Sonoma Valley. Since the late 1950s the DWR has sampled and analyzed groundwater for major ions (calcium, magnesium, potassium, sodium, chloride and sulfate), boron, nitrate, TDS, total alkalinity, specific conductance or electrical conductance, pH, and water temperature. DWR has monitored 12 private volunteer water supply wells in Sonoma Valley on a regular basis since 2004. Figure 2-1 shows the locations of the current DWR monitoring wells. **Table 2-1** lists the wells and provides approximate location; construction information (if available); and the period of data available for EC, TDS, and nitrate. Total well depths are available for all wells and screened interval information is available for seven of the 12 wells.

Table 2-1: Current Wells Monitored by DWR

Well No.	DPH Well No.	Latitude	Longitude	Depth Drilled (feet)	Depth Cased (feet)	Depth of Top Perf. (feet)	Depth of Bottom of Perf. (feet)	Land Surface Elevation (ft-msl)	Period of Data		
									EC	TDS	Nitrate
5N/5W-8P2		38.2896	-122.4387	250	245	170	240	100	1974–2002	1974–2002	1974–2010
5N/5W-18D2		38.2839	-122.4608	75	75	—	—	—	1958–2004	1958–2004	1958–2010
5N/5W-20R1		38.2611	-122.4297	504	449	—	—	32	1969–2010	1958 - 2010	1958 - 2010
5N/5W-28N1		38.2453	-122.4268	130	110	—	—	11	1951–2002	1951–2002	1951–2010
5N/5W-28R1		38.2472	-122.4103	280	280	80	270	70	1971–2004	1971–2004	1971–2010
5N/6W-2N2		38.3038	-122.4983	171	171	150	167	135	1972–2010	1972–2010	1972–2010
5N/6W-12F1		38.2950	-122.4747	113	113	—	—	80	1958–2004	1958–2004	1958–2010
5N/6W-12M1		38.2914	-122.4794	60	58	49	57	80	1972 - 2010	1972 - 2010	1972 - 2010
5N/6W-25P2		38.2440	-122.4760	640	640	175	640	37	1968–2003	1970 - 2002	1970 - 2010
6N/6W-10M2		38.3791	-122.5172	228	224	84	224	320	1975–2004	1985 - 2004	1975–2010
6N/6W-26E1		38.3382	-122.4982	304	241	—	—	180	1958 -2010	1958 - 2010	1958 - 2010
7N/6W-29P1		38.3381	-122.4981	112	112	—	63	70	1957 - 2010	1957 - 2010	1957 - 2007

EC - electrical conductivity
TDS - total dissolved solids
Perf. - perforation

One half of the wells are typically sampled in odd numbered years and the remaining half in even numbered years, so that wells are sampled once every two years. DWR has confirmed that funding is available to continue this regular monitoring program (Nordberg, 2013). Currently analyzed water quality parameters are listed in **Table 2-2**. Indicator S/Ns to be included in the SNMP monitoring program are highlighted in orange.

Water quality data collected by DWR are provided to the Agency and incorporated into the GMP water quality database. Selected water quality data are analyzed and periodically reported in the GMP annual report (SCWA, 2011). The GMP reports are available online at the Agency website.

Table 2-2: Constituents Monitored by DWR

List of Constituents Monitored by DWR	
• pH • Specific conductance or electrical conductivity (EC) (field & lab) • Temperature • Hardness • Calcium • Magnesium • Potassium • Sodium • Alkalinity • Bicarbonate • Nitrate	• Total dissolved solids (TDS) • Chloride • Sulfate • Boron • Bromide • Barium • Iron • Manganese • Arsenic • Stable Isotopes of Oxygen and Hydrogen

2.5 DPH Monitoring

The DPH regulates public drinking water systems. A public drinking water system means a system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year. Private domestic wells and irrigation wells are not regulated by the DPH. The DPH regulates all public water systems in the State to ensure the delivery of safe drinking water from these systems.

The DPH establishes the monitoring requirements for drinking water wells and all the data collected must be reported to DPH by the well owner. Production wells that supply drinking water are regulated under Title 22 of the California Code of Regulations. Title 22 also establishes the regulatory limits for volatile organic compounds, non-volatile synthetic organic compounds, inorganic chemicals, radionuclides, disinfection byproducts, and other general physical constituents.

Public groundwater purveyors are obligated to collect groundwater samples to determine compliance with maximum contaminant levels (MCLs) in accordance with monitoring schedules developed by DPH based on the size of the water system. Purveyors are required to submit data directly to DPH via electronic transfer. The constituents monitored and the frequency of monitoring varies based on the well, size of the water system, and history of water quality monitoring results. DPH provides drinking water quality monitoring notification documents to water systems that identify upcoming required contaminant testing. These are updated periodically and vary for each water system. Sonoma's (District 18) monitoring schedule for small water systems can be found at:
http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Monitoringschedule/DistrictReports-Monitoring%20Page/SonomaDistrict18.pdf

There are currently 26 wells with recent data (2000 to 2012) for at least one of the S/Ns; EC, TDS, and nitrate. The well data reported to the DPH may change in the future as wells are put on standby or abandoned and as new wells are drilled and operated. Accordingly, the DPH data included in the SNMP may change over time. However, the general geographic distribution and sampling frequency is not anticipated to vary significantly. **Figure 2-2** shows the approximate locations of wells in the DPH monitoring network. **Table 2-3** provides information on the wells. The table lists 39 wells including several City of Sonoma and Valley of the Moon Water District wells that have not been sampled recently for EC, TDS, or nitrate. Well depth and screened interval information is available for 12 of the 39 wells.

Water quality data reported to the DPH is incorporated by the Agency into the GMP water quality database. Selected water quality data are analyzed and periodically reported in the GMP annual report (SCWA, 2011). The GMP reports are posted on the Agency website.

2.6 SCWA Monitoring

In 2011, the Agency and GMP stakeholders installed two nested monitoring wells with drilling and construction funded through a Local Groundwater Assistance (LGA) grant. **Figure 2-3** shows the locations of the wells. Well depth and screened interval information is available for all the wells (**Table 2-4)**. At SVMW-1, four target zones were selected and a nested groundwater monitoring well was constructed comprising four individual nested 3-inch diameter polyvinyl chloride (PVC) well casings within a single borehole. At SVMW-2, five target zones were selected and a nested groundwater monitoring well was constructed comprising four individual nested 3-inch diameter PVC well casings within a single borehole and a separate shallow-zone groundwater monitoring well was constructed within a separate borehole adjacent to the nested well. Parameters analyzed by the Agency are shown in **Table 2-5**. Indicator S/Ns to be monitored for the SNMP monitoring program are highlighted in orange.

The wells have been sampled twice since their installation in November 2011 and September 2012. The Agency and GMP stakeholders intend to sample the wells a minimum of once per year. The water quality data will be analyzed and periodically reported in the GMP annual report and the report will be posted on the Agency website.

2.7 Special Studies

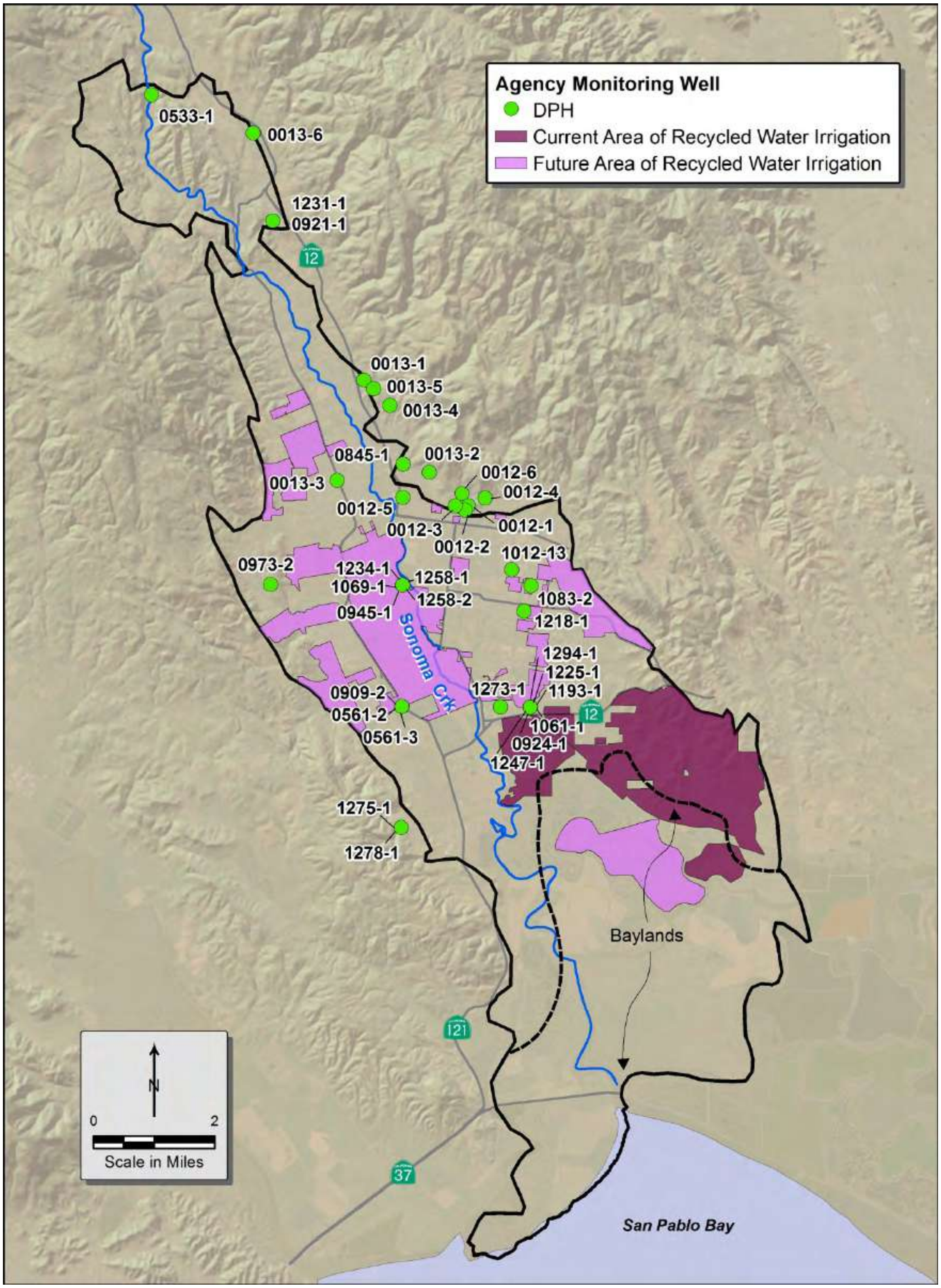
The United States Geological Survey (USGS) has also sampled and analyzed both surface and groundwater in Sonoma Valley for special studies. In 2002, 2003, and 2004, wells were sampled by USGS for the “Geohydrological Characterization, Water-Chemistry, and Ground-Water Flow Simulation Model of the Sonoma Valley Area, Sonoma County, California” (USGS, 2006). That report also incorporated sampling conducted under the (GAMA) Program for the North San Francisco Bay Hydrologic Region (USGS, 2004). Special studies associated with the GAMA program have also been conducted in Sonoma Valley, including “Interpretation of Isotopic Data in Sonoma Valley, California” (Moran, et al., 2010 and a Shallow Aquifer Assessment Program (USGS, in preparation).

Data from these special studies have been incorporated into the GMP water quality database. These and any future special studies that conduct S/N monitoring will be incorporated and reported through the SNMP monitoring program.

2.8 Monitoring Locations and Frequency

Figure 2-4 shows the monitoring locations that will be included in the SNMP monitoring program. The sampling points, frequency, and monitored parameters are described in **Table 2-6**. As mentioned previously, the DPH required monitoring frequency and constituents monitored are variable based on the well and DPH requirements. All available DPH S/N data will be incorporated in the SNMP monitoring program and described in monitoring reports.

Figure 2-2: DPH Monitoring Wells



Note: Well locations are approximate

Table 2-3: Wells Monitored for DPH

State Well No.	DPH Well No.	Latitude	Longitude	Depth Drilled (feet)	Depth Cased (feet)	Depth of Top Perf. (feet)	Depth of Bottom of Perf. (feet)	Land Surface Elevation (ft-msl)	Period of Data		
									EC	TDS	Nitrate
6N/6W-36M2	4910013-003	38.3020	-122.4940	214?	214?	140	214?	230	1989 - 2011	1989 - 2011	1989 - 2011
5N/6W-8B1	4900973-002	38.2770	-122.5140	380	380	90	380	968	1998 - 2012	1998 - 2012	1998 - 2012
5N/6W-12C1	4910012-005	38.2980	-122.4740	730	730	530	730	95	1982 - 2011	1982 - 2011	1982 - 2011
	4910012-001	38.2960	-122.4540	405	395	100	395	98		1988 - 2002	
5N/5W-7G1	4910012-002	38.2950	-122.4550	221	75	-	-	95		2008	
5N/5W-7F1	4910012-003	38.2960	-122.4580	263	165	-	-	95		2008	
5N/5W-7A2	4910012-004	38.2980	-122.4490	500	210	-	-	140		2008	
5N/5W-7C2	4910012-006	38.2990	-122.4560	250	266	140	236	120		2008	
5N/5W-17E1	4910012-013	38.2808	122.4409	861	666	473	646	69		2008	
6N/6W-35A1	4910013-001	38.3260	-122.4860	-	-	-	-	-		2008	
5N/6W-1J3	4910013-002	38.3040	-122.4660	460	440	140	440	125		2008	
5N/6W-2P2	4910013-004	38.3200	-122.4780	425	360	60	350	118		2008	
	4910013-005	38.3240	-122.4830	-	-	-	-	-		2008	
6N/6W-9A1	4910013-006	38.3850	-122.5200	265	258	41	258	320	1979 - 2001	1979 - 2001	1979 - 2001
	4910013-019	38.3850	-122.5200	-	-	-	-	-		2009	
	4900533-001	38.3940	-122.5510	-	-	-	-	-	2000 - 2009	2000 - 2009	2000 - 2011
	4900561-002	38.2480	-122.4740	-	-	-	-	-	1994 - 2011	1994 - 2011	1994 - 2011
	4900561-003	38.2480	-122.4740	-	-	-	-	-	1994 - 2011	1994 - 2011	1994 - 2011
	4900845-001	38.3060	-122.4740	-	-	-	-	-	1994 - 2009	1994 - 2009	1994 - 2009
	4900909-002	38.2480	-122.4740	-	-	-	-	-		2010 -2010	2000 - 2011
	4900918-001	38.3060	-122.4740	-	-	-	-	-	1992 - 2010	1992 - 2010	1992 - 2010
	4900921-001	38.3640	-122.5140	-	-	-	-	-			1997 - 2011
	4900924-001	38.2480	-122.4350	-	-	-	-	-			1997 - 2011
	4900945-001	38.2770	-122.4740	-	-	-	-	-			2001 - 2010
	4901061-001	38.2480	-122.4350	-	-	-	-	-	2010 - 2011	2010 -2010	2003 - 2011
	4901069-001	38.2770	-122.4740	-	-	-	-	-			1997 - 2012
	4901083-002	38.2770	-122.4350	-	-	-	-	-			2000 - 2011
	4901193-001	38.2480	-122.4350	-	-	-	-	-			2000 - 2010
	4901218-001	38.2710	-122.4370	-	-	-	-	-	2000 - 2000	2000 - 2000	2000 - 2012
	4901225-001	38.2480	-122.4350	-	-	-	-	-	1998 - 1998	1998 - 1998	1998 - 2010
	4901231-001	38.3640	-122.5140	-	-	-	-	-	1996 - 1996	1996 - 1996	1996 - 2012
	4901234-001	38.2770	-122.4740	-	-	-	-	-	1998 - 1998	1998 - 1998	1998 - 2011
	4901247-001	38.2480	-122.4350	-	-	-	-	-	2010 - 2011	2010 - 2010	1999 - 2011
	4901258-001	38.2770	-122.4740	-	-	-	-	-	2000 - 2000	2000 - 2000	2000 - 2011
	4901258-002	38.2770	-122.4740	-	-	-	-	-	2000 - 2000	2000 - 2000	2000 - 2011
	4901273-001	38.2480	-122.4440	-	-	-	-	-	2002 - 2002	2002 - 2002	2002 - 2011
	4901275-001	38.2190	-122.4740	-	-	-	-	-			2004 - 2011
	4901278-001	38.2190	-122.4740	-	-	-	-	-	2010 - 2010	2010 - 2010	2010 - 2012
	4901294-001	38.2480	-122.4350	-	-	-	-	-	2008 - 2011	2009 - 2011	2004 - 2012

EC - electrical conductivity

TDS - total dissolved solids

Perf. - perforation

Figure 2-3: Agency Monitoring Wells

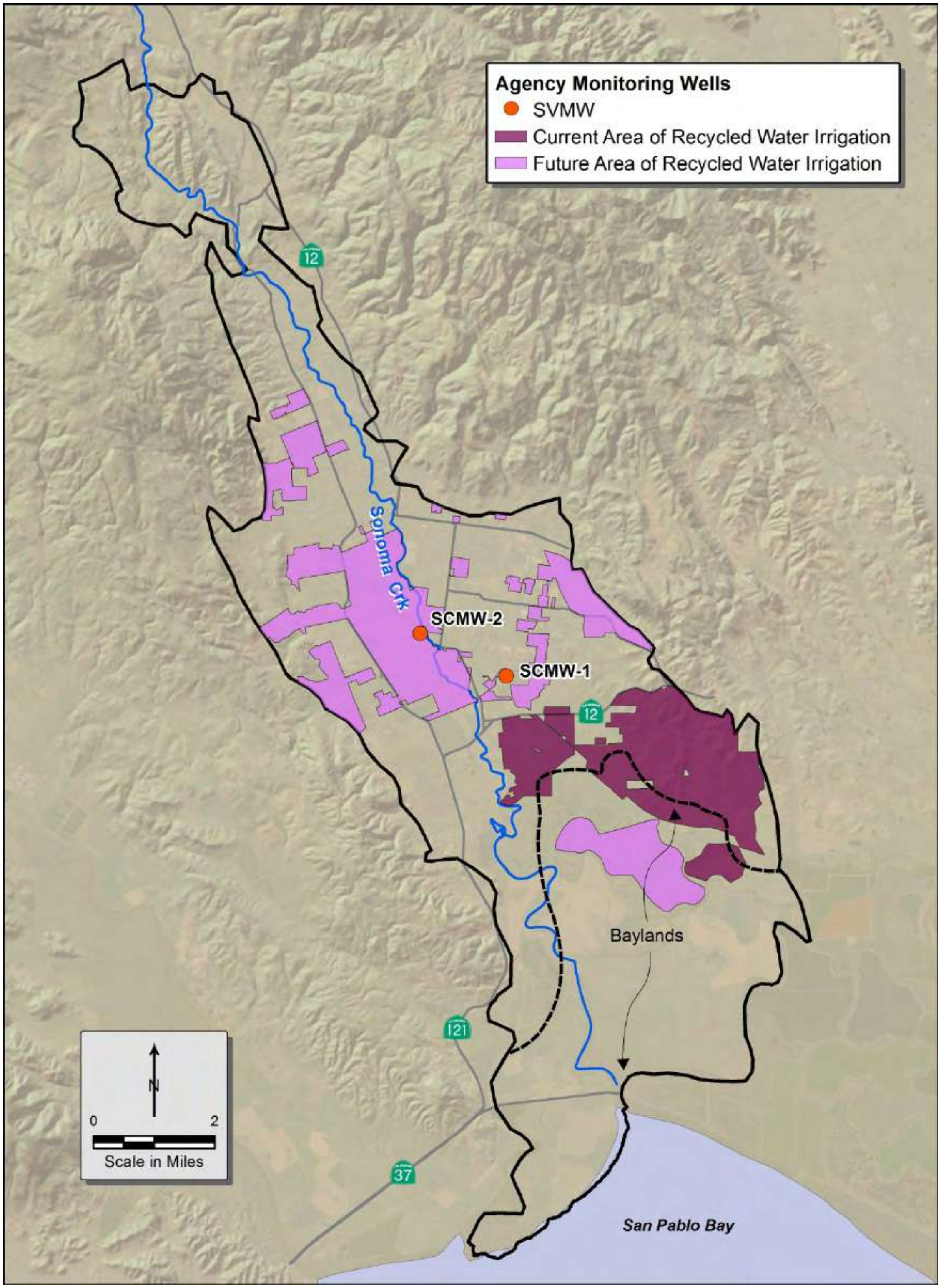


Table 2-4: Wells Monitored by the Agency

Well No.	DPH Well No.	Latitude	Longitude	Depth Drilled (feet)	Depth Cased (feet)	Depth of Top Perf. (feet)	Depth of Bottom of Perf. (feet)	Land Surface Elevation (ft-msl)	Period of Data			Owner	Well Name
									EC	TDS	Nitrate		
SVMW-1-95		38.2554	-122.4422	470	105	85	95	2.87 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-1
SVMW1-233		38.2554	-122.4422	470	243	223	233	22.83 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-1
SVMW1-365		38.2554	-122.4422	470	374	355	365	22.85 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-1
SVMW1-455		38.2554	-122.4422	470	465	440	455	22.83 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-1
SVMW2-52		38.2655	-122.4685	485		32	52	45.2 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-2
SVMW2-100		38.2655	-122.4685	485	110	80	100	45.43 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-2
SVMW2-220		38.2655	-122.4685	485	230	200	220	45.42 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-2
SVMW2-409		38.2655	-122.4685	485	419	374	384	45.42 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-2
SVMW2-480		38.2655	-122.4685	485	490	460	480	45.42 [1]	2011 - 2012	2011 - 2012	2011 - 2012	SCWA	MW-2

EC - electrical conductivity

TDS - total dissolved solids

Perf. - perforation

1 - Top of casing elevation

Table 2-5: Constituents Monitored by Agency

List of Constituents Monitored by Agency

- Temperature (field)
- pH (field and lab)
- Electrical conductivity (field and lab)
- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Boron
- Bromide
- Cadmium
- Calcium
- Chloride
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Magnesium
- Manganese
- Mercury
- Molybdenum
- Nickel
- Potassium
- Selenium
- Silver
- Sodium
- Strontium
- Sulfate
- Titanium
- Vanadium
- Zinc Bicarbonate
- Carbonate
- Hardness
- Total Alkalinity
- Total Dissolved Solids
- Hydroxide
- Iodide
- Nitrate

Figure 2-4: SNMP Monitoring Program

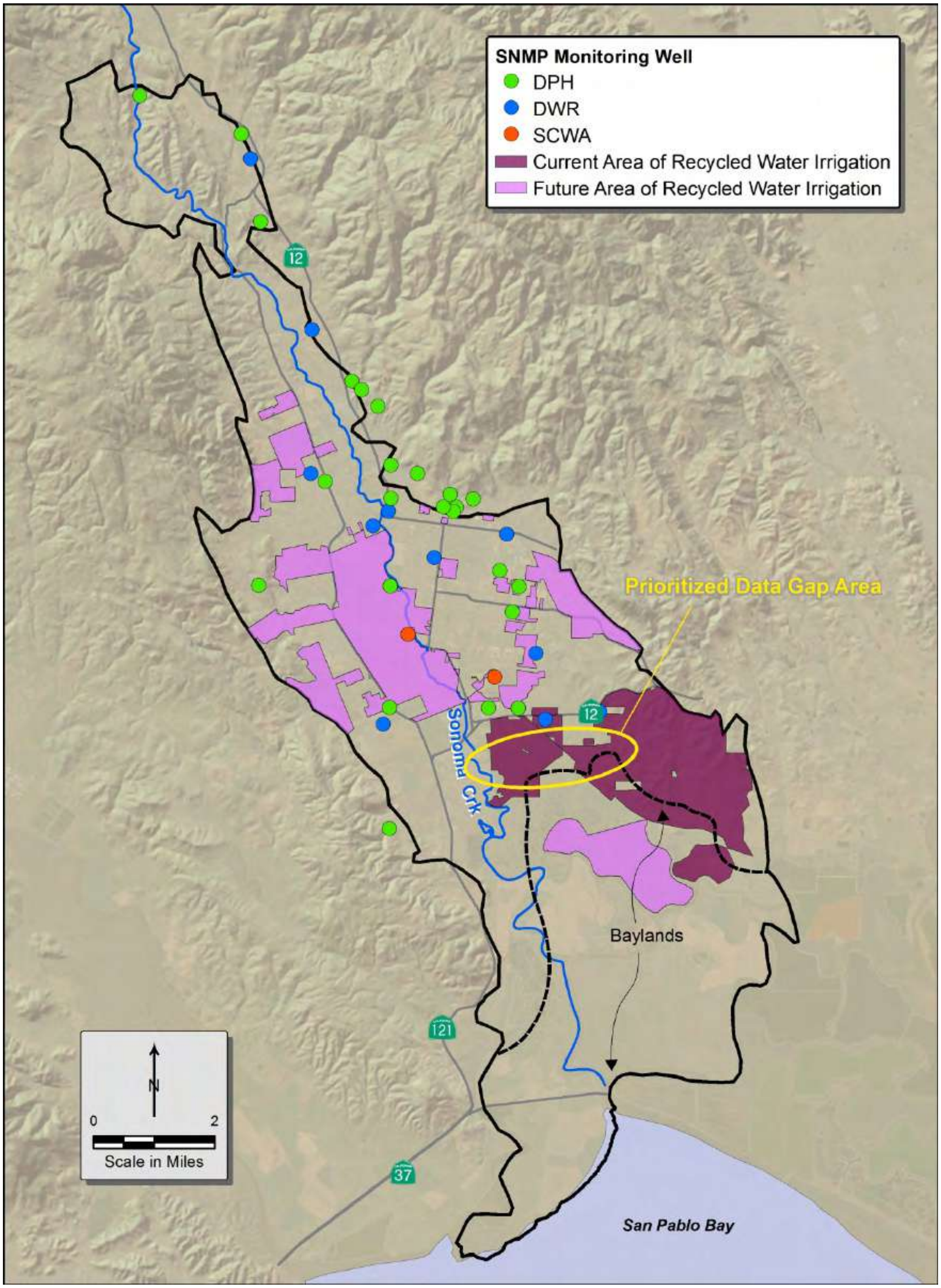


Table 2-6: SNMP Monitoring Program

Program	No. of Wells	Monitoring Frequency	Constituents
DWR	12	Every 2 years	EC, TDS, and nitrate
DPH	26 [1]	Typically every 3 years	EC, TDS, or nitrate
Agency	9	Once per year	EC, TDS, and nitrate

DWR – California Department of Water Resources
DPH – California Department of Public Health
Agency – Sonoma County Water Agency
EC – Electrical Conductivity
TDS – total dissolved solids
1 – Number of wells sampled may vary

2.9 Adequacy of Proposed Monitoring Program and Recommendations for Additional Data

In general, the proposed SNMP monitoring program described above is deemed adequate to monitor the spatial variability and transient change in S/N groundwater quality as required by the Recycled Water Policy. Specifically, the proposed monitoring program focuses on monitoring "basin water quality near water supply wells" and a number of wells are located within or proximate to areas of recycled water use. Additionally, shallow wells 5N/6W-12F1, 5N/6W-12M1 and SVMW2-52 are located in areas with connectivity with adjacent surface waters (i.e., Sonoma Creek). Nonetheless, three areas where additional data would benefit the SNMP monitoring program have been identified. These include:

- Characterization of well completions for wells in the monitoring program
- Additional monitoring well(s) immediately north of the Baylands Area
- Collection of TDS, EC, and nitrate from all DPH monitored wells

Well completion information for some wells is not available as shown in Tables 2-1, 2-3, and 2-4. More well completion information would allow better characterization of the vertical distribution of S/Ns in the subbasin. If a funding mechanism were available, the following is recommended for wells without well completion information:

- Contact the DPH and well owners to ask for available well completion information
- Review available DWR well logs for completion information on wells in the monitoring network

Figure 2-4 shows an area just north of the Baylands Area where additional monitoring would be desirable to monitor potential changes in the area of saline intrusion, if a funding mechanism was available. The additional monitoring point or points could include existing production wells, ideally with completion information, or new nested monitoring wells.

TDS, EC, and nitrate data are not available for all DPH monitored wells. It would be helpful if both TDS and nitrate were collected for all wells. The well owners could be asked to voluntarily provide both analyses to DPH, if not currently doing so.

2.10 Data Analysis and Reporting

Responsible Party

The monitoring data described above will be collected by the Water Agency. The data will be analyzed and reported to the RWQCB every three years by the SVCSD. The SNMP report will include the following:

- Discussion of TDS and EC water quality including
  - Water quality summary tables (TDS and specific conductance)
  - Water quality concentration maps (TDS and specific conductance)
  - Time-concentration plots (specific conductance) to assess trends
  - Comparison of detections with BPOs
- Status of recycled water use and stormwater capture projects and implementation measures

The SNMP monitoring program will be reviewed every three years as part of the triennial SNMP reporting.

Nitrate

As discussed in the *Salt and Nutrient Management Plan,* nitrate concentrations are typically low and well below the basin plan objective (BPO) and time-concentration plots indicate generally stable trends. Only one well (28N1) in the monitoring program shows an increasing nitrate trend. Accordingly, nitrate has not been a focus of analysis for the triennial GMP water quality report. For future SNMP reporting it is recommended that nitrate data be presented in summary tables, any concentrations approaching the BPO or increasing trends should be noted, and a time-concentration plot for 28N1 should be included to track future trends in this well. Water quality concentration maps are not recommended unless increasing nitrate concentrations are observed in the future.

Specific Conductance and TDS

It is recommended that the TDS and specific conductance maps and specific conductance time-concentration plots continue to be presented in the future SNMP report. TDS and specific conductance are equivalent and it is not necessary to present time concentrations plots for both. In addition, specific conductance is more frequently monitored. It is recommended that the BPO be plotted for reference on the time-concentration charts.

Evaluation Criteria

The criteria or performance measures to evaluate groundwater quality are the TDS/specific conductance and nitrate trends and concentrations. The BPOs are the primary evaluation criteria used to evaluate S/N groundwater quality. Accordingly, the monitoring report should discuss whether S/N concentration trends are generally consistent with the patterns described and predicted in SNMP. TDS, specific conductance, and nitrate groundwater quality should be compared with BPOs to determine if overall basins groundwater quality meets basin plan objectives and will continue to meet BPOs in the future.

Other

The monitoring reports should also discuss the status of recycled water and stormwater recharge projects and S/N implementation measures.

3 Sampling Protocols and QA/QC

Groundwater sampling is conducted by trained professionals from the Agency, DWR, USGS, and water providers (for DPH required monitoring). The DWR, USGS, DPH, and Agency sampling follows established industry standards. A formal sampling protocol and QA/QC program for the recently installed Agency nested monitoring wells has not yet been established. Accordingly, this TM describes the recommended sampling protocol and QA/QC program for the Agency nested well sampling. Sampling protocols and QA/QC procedures for each of these four programs are described below.

3.1 DWR Sampling Procedures

The DWR does not have formalized sampling procedures, but follows standard industry protocols (Nordberg, 2013). DWR typically samples a well from an outside water hose tap. Water is allowed to run through a flow-through cell until field parameters including pH, temperature, dissolved oxygen (DO), oxidation-reduction potential (ORP), and TDS stabilize. Then, the sample is collected in prepared bottles provided by the laboratory. Samples are placed in coolers with ice packs and transported to an in-house laboratory called Bryte Labs following standard chain-of-custody procedures.

Bryte Labs QA/QC procedures follow United States Environmental Protection Agency (USEPA) policy guidelines outlined in the *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, QAMS-005/80 and also meet the DPH, Environmental Laboratory Accreditation Program. QA/QC may include equipment, field, and trip blanks for field sampling; and duplicates, method and instrument blanks for laboratory checks. These blanks and duplicates monitor:

- contamination from the collection, transport, and storage of the samples
- contamination that originates in the lab or exists in the analytical procedure
- repeatability or precision of the analytical method.

The types of blanks and duplicates collected depend upon the constituents being analyzed. Trip blanks are typically only needed if volatile organic compounds are being analyzed.

3.2 DPH Sampling Procedures

The DPH (formally California Department of Health Services (DHS)) has established formal sampling procedures *Water Sampling Manual* (DHS, 2006). Water suppliers are to send samples to State-certified laboratories and follow the sampling and QA/QC requirements of those laboratories. Samples are to be taken before the check valve on the wellhead and collected after the well has been pumped sufficiently to ensure that the sample represents the groundwater source (DPH, 2013).

Laboratories are to meet various requirements available on DPH's website:
http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Labinfo.aspx

QA/QC may include the analysis of duplicates and equipment, field, trip, method, and instrument blanks.

3.3 SCWA Sampling Procedures

The two nested monitoring wells will be sampled by the Water Agency. Purging and sampling of each of the nine intervals (four in SVMW-1 and five in SVMW-2) will follow standard monitoring well sampling guidelines such as those presented in the *National Field Manual for the Collection of Water-Quality Data* (USGS, 2010) http://water.usgs.gov/owq/FieldManual/chapter4/html/Ch4_contents.html.
These procedures are described in the following sections.

3.3.1 Purging and Sampling

Generally, the nested wells may be purged prior to sample collection. Purging is conducted until field instruments indicate that water quality parameters (pH, ORP, specific conductance, and temperature) have stabilized and turbidity measurements are below five Nephelometric Turbidity Unit (NTUs). Industry-accepted purge methods include purging a standard three casing volumes as well as no-purge and low-flow purge methods. Any of these methods, as well as new industry- and regulatory-accepted sampling technologies, may be used. The method used will demonstrate that the sample collected is representative of formation water and not stagnant water in the well casing or well filter pack.

All groundwater samples are collected in laboratory supplied pre-labeled containers and include prescribed preservatives.

3.3.2 Record Keeping and Sample Transport

All field measurements will be recorded in a field logbook or worksheets and the sample containers will be labeled correctly and recorded on the chain-of-custody form. The applicable chain-of-custody sections will be completed and forwarded with the samples to the laboratory. Upon receipt of the samples at the laboratory, laboratory personnel will complete the chain-of-custody. Samples will be shipped to the laboratory in sealed insulated shipping containers (ice chests) to maintain the samples at approximately 4°C.

3.3.3 QA/QC

Field QA/QC

QA/QC assessment of field sampling will include field blanks and duplicates as described below.

Field Blank - Field blanks identify sample contamination that is associated with the field environment and sample handling. These samples will be prepared in the field by filling the appropriate sample containers with the distilled water used for cleaning and decontamination of all field equipment. One field blank per sampling will be collected.

Duplicates - Duplicates document the precision of the sampling and analytical process. A duplicate is a second sample collected concurrently with the primary sample using the exact same method and analysis. Duplicates will not be identified as to their primary sample source to the laboratory. One duplicate per sampling will be collected.

Laboratory QA/QC

Samples will be sent to a State-certified laboratory that has in place a documented analytical QA/QC program that includes procedures to reduce variability and errors, identify and correct measurement problems, and provide a statistical measure of data quality. The laboratory will conduct all QA/QC procedures in accordance with its QA/QC program. All QA/QC data shall be reported in the laboratory analytical report, including: the method, equipment, and analytical detection limits, the recovery rates, an explanation for any recovery rate that is less than 80 percent, the results of equipment and method blanks, the results of spiked and surrogate samples, the frequency of quality control analysis, and the name of the person(s) performing the analyses. Sample results shall be reported unadjusted for blank results or spike recovery.

3.4 USGS Special Studies

USGS sampling is conducted in compliance with standard monitoring well sampling guidelines presented in the *National Field Manual for the Collection of Water-Quality Data* (USGS, 2010) http://water.usgs.gov/owq/FieldManual/.

4 References

California Department of Health Services (DHS) Drinking Water and Environmental Management Division, Sanitation and Radiation Laboratories Branch, Microbial Disease Laboratory Branch, January 06, 2006, "Water Sampling Manual"

California Department of Public Health (DPH) Sonoma and Mendocino Field Office, April 24, 2013, "Personal Communication"

California Department of Water Resources (CDWR), April 2012, "Bryte Chemical Laboratory Quality Assurance Manual, Quality Assurance Technical Document 8"

Nordberg, Mark, California Department of Water Resources (DWR), April 2013, "Verbal communications"

Sonoma County Water Agency (SCWA), December 2007, "Sonoma Valley Groundwater Management Plan"

Sonoma County Water Agency (SCWA), December 30, 2011, "Sonoma Valley Groundwater Management Plan 2010 annual Report"

Sonoma County Water Agency (SCWA), July 2012, "Well Completion Technical Memorandum for Nested Groundwater Monitoring Wells SVMW-1 & SVMW-2, Sonoma Valley"

State Water Resources Control Board (SWRCB), May 2009, "Draft Recycled Water Policy", amended September 2012, October 2012, and January 2013, approved January 2013

United States Environmental Protection Agency (USEPA), Revised January 19, 2012, "Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells"

United States Geological Survey, 2004, "Ground-Water Quality Data in the North San Francisco Bay Hydrologic Provinces, California, 2004: results from the California Ground-Water Ambient Monitoring and Assessment (GAMA) Program", Data Series 167

United States Geological Survey, 2006, "Geohydrologic Characterization, Water-Chemistry, and Ground-Water Flow Simulation Model of the Sonoma Valley Area, Sonoma County, California", Scientific Investigation Report 2006-5092

United States Geological Survey (USGS), (variously dated) Compiled 2012, "National Field Manual for the Collection of Water-Quality Data, Techniques of Water-Resources Investigations, Book 9 Chaps. A1-A9", http://pubs.water.usgs.gov/twri9A

Appendix F - Regional Water Quality Control Board Basin Planning Template

DRAFT

Attachment A to Resolution No. __________

[NO THREAT BASIN EXAMPLE]
Amendment to the Water Quality Control Plan – [*Region*] to Incorporate the Groundwater Quality Management Plan for the [*Basin(s)*]

Adopted by the California Regional Water Quality Control Board, [*Region*] on [*Date*].

This groundwater quality management plan satisfies the Recycled Water Policy requirement for salt/nutrient management plans. This groundwater quality management plan applies to groundwater basin(s) considered a low threat for impairment of groundwater quality.

Amendments:

Table of Contents

List of Figures, Tables and Inserts

Chapter X. Groundwater Quality Management Plan
[*Basin(s)*] Groundwater Quality Management Plan

This [*Basin(s)*] Groundwater Management Plan was adopted by: The Regional Water Quality Control Board on [*Date*].
This [*Basin(s)*] Groundwater Management Plan was approved by: The State Water Resources Control Board on [*Date*].
This [*Basin(s)*] Groundwater Management Plan was approved by: The Office of Administrative Law on [*Date*].
This [*Basin(s)*] Groundwater Management Plan was approved by: U.S. Environmental Protection Agency on [*Date*].
This [*Basin(s)*] Groundwater Management Plan is effective on [*Date*].

The following tables include the elements of this Groundwater Quality Management Plan.

DRAFT

Attachment A to Resolution No. __________

Table X-X.1. [*Basin*] Groundwater Quality Management Plan and Related Effects: Elements

Element	Key Findings and Regulatory Provisions
Purpose Statement	***Is the groundwater basin impaired or threatened to be impaired by [nutrients, salts, and other constituents]?*** Overall, water quality in the Sonoma Valley Subbasin is very good and the subbasin is not impaired. Generally, TDS is less than Basin Plan Objectives (BPOs) of 500 milligrams per liter (mg/L) through most of the basin, with concentrations reaching above 500 mg/L in the southeastern portion of the basin that borders San Pablo Bay due to brackish water intrusion. These elevated concentrations are consistent with historical brackish groundwater reported in that area of the basin. This southeastern portion of the basin (delineated as “Baylands Area” in the Salt and Nutrient Management Plan [SNMP]) is impaired (brackish), and further brackish water intrusion is a concern in the basin. Nitrate levels are generally very low with a basin average of roughly 0.06 mg/L, well below the BPO of 10 mg/L, therefore the basin is not impaired or threatened to be impaired by nutrients. ***What are the effects of increased levels of [nutrients, salts, and other constituents] on the beneficial uses of groundwater and surface water? What detrimental effects are attributed to [nutrients, salts, and other constituents]? Concerns involving taste and odor, toxicity, human health, crop yields, etc.*** Increased TDS levels from brackish water intrusion affect the municipal and agricultural beneficial uses of the groundwater subbasin in the Baylands Area. Highly saline water becomes non-potable (due to taste), and from an agricultural perspective, there exists the potential for crop damage and stunted plant growth. While TDS levels within the subbasin are not high enough to warrant a health threat to humans, levels above 1,000 mg/L may have an objectionable taste and odor. Increased levels of nutrients could also affect the beneficial uses of the groundwater subbasin; however, basin-wide average nitrate levels are far below the BPO and nitrate contamination is not a concern. ***Are surface water and/or groundwater affected by [nutrients, salts, and other constituents]?*** Groundwater is affected by brackish water intrusion in the southeastern portion of the subbasin, which borders San Pablo Bay, but is not affected by salts and nutrients in the Inland Area due to the few sources and high amount of flushing from precipitation and mountain front recharge. Surface water is affected by excess sediment,

Element	Key Findings and Regulatory Provisions
	pathogens and nutrients and there are existing total maximum daily load (TMDL) programs in place for these constituents. ***Is groundwater quality affected by [nutrients, salts, and other constituents] in surface water; and vise versa?*** Because both groundwater and surface water quality (for TDS and nitrate) are good and below BPOs, water quality impacts from one on the other are minimal. A small percentage of inflow (11% or about 6,400 acre-feet per year [AFY]) into the groundwater subbasin is from surface waters, which have a low estimated average TDS concentration of 210 mg/L and average nitrate concentration of 0.19 mg/L. Average Inland Area (excluding the Baylands Area) groundwater quality is 372 mg/L for TDS and 0.07 mg/L for nitrate. Therefore, surface water leakage to groundwater adds TDS and nitrate load, but improves TDS groundwater quality (i.e., average TDS in surface water is lower than in groundwater) and degrades nitrate groundwater quality very slightly (i.e., average nitrate in surface water is higher than in groundwater). Groundwater discharge to surface water is about 51,000 AFY. Groundwater discharge to surface water adds TDS and nitrate load; degrades TDS surface water quality slightly (i.e., average TDS in groundwater is higher than in surface water) and improves nitrate surface water quality slightly (i.e., average nitrate in groundwater is lower than in surface water). ***What are the beneficial uses (i.e., MUN, AGR, IND, FRSH, AQUA, etc.) of groundwater in the [Basin(s)]?*** The Sonoma Valley Subbasin has both MUN and AGR as existing beneficial uses. IND and PROC are listed as potential beneficial uses. ***What regulatory provisions are there to protect beneficial uses related to impacts by [nutrients, salts, and other constituents]; such as, Resolution No. 68-16 (Antidegradation Policy), etc.?*** Resolution No. 68-16 protects the beneficial uses of water bodies related to impacts associated with increased nutrients, salts, and other constituents. The Sonoma Valley County Sanitation District provides recycled water to the area under a Recycled Water Permit (Order 92-067), which includes stringent guidelines to ensure proper application to minimize runoff. The SNMP finds that the use of recycled water can be increased while still protecting groundwater quality.
Narrative and Numeric Water Quality Objectives *(Interpretation of the narrative and numeric water*	***What are the bases for narrative and numeric Water Quality Objectives (WQOs) for the Groundwater Quality Management Plan?*** The Water Quality Objective (WQO) for TDS is based on the California Department of Public Health's

Element	Key Findings and Regulatory Provisions
quality objective, used to calculate the load allocations)	(CDPHs) adoption of a secondary maximum contaminant level (SMCL) for TDS. SMCLs address aesthetic concerns like odor, taste, and color and are not related to health concerns. The BPO for TDS is 500 mg/L, following the SMCL adopted by the CDPH. The objective for TDS allows an upper limit of 1,000 mg/L with a short-term limit of 1,500 mg/L. For nitrates, the BPO is set at the maximum contaminant level (MCL) of 10 mg/L. ***What are the narrative and numeric WQOs?*** Narrative: Bacteria, Organic and Inorganic Chemical Constituents, Radioactivity, and Taste and Odor Relevant numeric WQOs for Municipal and Agricultural Supply: TDS = 500 mg/L (municipal), 10,000 mg/L (agricultural) Nitrate-N = 10 mg/L (municipal), 22.22 mg/L (agricultural)
Source Analysis	***Point sources and non-point sources: <Explain and identify sources and loads from sources. Sources should be inventoried.>*** Most of the constituent sources are associated with point sources from agricultural and rural areas. These sources include irrigation water, agricultural inputs, residential inputs, and animal waste. 1. Irrigation water. This includes potable water, surface water, groundwater, and recycled water. 2. Agricultural inputs. This includes fertilizer, soil amendments, and applied water. 3. Residential, commercial and industrial inputs. This includes septic systems, fertilizer, soil amendments, and applied water. 4. Animal waste. This includes dairy manure land application. Urban loads are assumed to be routed to municipal wastewater systems for recycling or discharge rather than to the groundwater, with the exception of landscape irrigation. Non-point sources, like atmospheric deposition, are not considered to be a main source of the constituents of concern. Potential subsurface inputs of high salinity include San Pablo Bay, thermal water upwelling, and existing connate groundwater within the basin. ***Explain factors that contribute to the basin not being impaired or threatened to be impaired (e.g., high precipitation, few and low-volume sources, etc.).*** The findings from the technical analysis completed for the SNMP indicate that overall groundwater quality in the basin is stable with low salinity and nutrient values resulting from a combination

Element	Key Findings and Regulatory Provisions
	of factors including the high percentage of mountain front and precipitation recharge with very low TDS and nitrate concentrations, the low amount of loading from the few sources identified, and the low volume and high quality of recycled water used for irrigation.
Basin Water Quality	***Is groundwater quality being maintained? What is the mass balance of constituents within the basin?*** Current groundwater quality within the basin is being maintained. Both TDS and nitrate have relatively stable concentrations from the period of record, which are predicted into the future through 2035. ***What is the basin-wide average concentration for constituents?*** TDS: Inland Area = 372 mg/L; Baylands Area = 1,220 mg/L Nitrate-N: Inland Area = 0.06 mg/L; Baylands Area = 0.07 mg/L ***Provide maps showing basin characteristics: locations of wells, water quality, contour maps of TDS, nitrogen and other contaminants*****.** Groundwater subbasin, drainages, recycled water use areas: Figure 2-1 Groundwater elevation map: Figure 2-2 Location of wells: Figures 5-3, 5-5, 9-1 Water quality: Figures 5-3 (TDS), 5-5 (Nitrate) Contour map of TDS: Figure 5-2 Contour map of nitrate: Figure 5-4 Land use: Figure 6-1
Potential for Impairment	***Acknowledge types of activities or land uses that have the potential to degrade groundwater (fertilizer use, manure spreading, recycled water application etc.).*** Land uses that have the most potential to degrade groundwater quality are vineyards, pasture land, urban residential areas, and farmsteads or rural-residential areas. Other land uses which contribute to the TDS and nitrate loading of the basin are dairy operations, urban landscape or golfing areas, non-irrigated field crops, and urban commercial and industrial areas. Each of these land uses was a designated loading factor for nitrogen and TDS, as well as applied water and percent irrigated.
Recycled Water Projects	***List recycled water projects/uses*****.** As discussed in Chapter 4 of the SNMP, planned future recycled water projects include expanding agricultural irrigation within the Valley; serving irrigation water to large, urban landscape areas (i.e. Sonoma Valley High School, The Plaza, Sonoma Mission Inn Golf Course, etc); and environmental enhancement through the Napa-Sonoma Salt Marsh Restoration Project. ***Provide general information, categories and/or specific***

Element	Key Findings and Regulatory Provisions
	discharges. The volume of recycled water currently used within the Sonoma Valley Subbasin is approximately 1,110 AFY; and is expected to increase to around 4,100 AFY by 2035. The majority of recycled water application is for irrigation and therefore, it is most typically applied in the summer and fall months. Recycled water application follows stringent guidelines within the Recycled Water Permit (Order 92-067). These guidelines include irrigating at agronomic rates and other best management practices (BMPs) which target minimizing irrigation runoff.
Limitations	***Describe limitations and uncertainties associated with the development of the Plan.*** Spatially, while historical information from the Baylands brackish area was available, no known wells currently exist in the Baylands Area and therefore no current groundwater quality information was available. Vertically within the aquifer, many wells lack well construction information rendering the depth of many wells unknown. Without sufficient depth-specific well screen information, water quality for shallow and deep zones could not be distinguished. Therefore, the simplicity of the mixing model is a limitation, because it simulates two big "buckets" (Inland and Baylands areas with movement between) and mixing is instantaneous. Additionally, verification of assumptions/estimates for individual anthropogenic loading sources during the calibration process was limited by the sensitivity of groundwater quality to and dominance of natural inflows (precipitation and stream recharge) in Sonoma Valley. Data collected as part of the SNMP Groundwater Monitoring Program will help to determine if relatively flat trends predicted by the SNMP are verified in the future. Information used to derive future conditions was obtained from planning documents such as Urban Water Management Plans; however, this information is projected on a 20-year planning horizon and can change. For instance recycled water expansion is planned to serve additional agricultural irrigation customers and the urban area of the City of Sonoma; however, exact sites and demands may shift as projects are implemented in the future. To address this, the SNMP Groundwater Monitoring Plan will assess changes in recycled water use on a triennial basis.
Monitoring Plan	***Monitoring Plan:*** ***What are the types of monitoring is required (i.e., ambient, site specific, groundwater, surface water, discharges, recycled water, effectiveness of the Implementation Plan, etc.)? What is the goal or need of the monitoring program(s)?*** The Plan requires groundwater monitoring, with the ultimate goal of determining if the salt and nutrient concentrations remain below BPOs and future trends are consistent with those outlined in the SNMP. ***Who is responsible for implementing the monitoring***

Element	Key Findings and Regulatory Provisions
	program(s)? Because the SNMP monitoring program relies on three existing programs, those responsible for implementing the existing programs will also be responsible for implementing the SNMP monitoring program. Those entities are the California Department of Water Resources (DWR), the California Department of Public Health (CDPH), and the Sonoma Valley Groundwater Management Program (SVGMP). ***What shall be analyzed and the frequency?*** Electrical conductivity (EC), total dissolved solids (TDS), and nitrate are analyzed. Because the monitoring plan relies on the current monitoring conducted by DWR, CDPH, and SVGMP, the frequency will follow those monitoring schedules. Namely, DWR wells will be monitored every 2 years, CDPH wells will be monitored between one and three years, and SVGMP wells will be monitored annually. ***Where are the monitoring locations?*** The 47 monitoring locations are spread throughout Sonoma Valley, with the majority clustered in the northern portion of the subbasin. ***What are the reporting requirements?*** Monitoring results will be reported through the Geotracker database system to the Regional Water Board every three years and will include an SNMP Groundwater Monitoring Report. ***Review period and reopener: The basin monitoring plan will be reviewed on a _3_ year basis. Implementation Schedule, Table X-X.2***
Implementation Plan	***Describe any actions resulting from the plan.*** There are no new implementation measures resulting from the SNMP, the SNMP only endorses current groundwater supply and quality management measures underway within the subbasin and these are not considered actions resulting from the Plan. ***Special Studies (What special studies are needed and why? The schedule for the special studies [Implementation Schedule, Table X-X.2]?*** No special studies are recommended to be undertaken as part of this SNMP. ***Include goals and objectives for recycled water and stormwater recharge/use.*** The overall goal for both recycled water and stormwater recharge/use is to increase water supplies and supply reliability within the groundwater subbasin, and decrease the amount of pumping and strain on groundwater supplies. For the SNMP, recycled water goals and objectives are based on information provided in 2010 UWMPs and 2012 recycled water usage data. Recycled water goals were set based on 2010 UWMP recycled water use projections. No quantitative goals were set for stormwater recharge/use in this SNMP because planning efforts and specific projects for

Element	Key Findings and Regulatory Provisions
	stormwater recharge in the basin are now underway which would establish these objectives.

Environmental Considerations

Because the Salt and Nutrient Management Plan does not recommend or require any new implementation measures, it does not fit the definition of a "project" under CEQA, and thus does not require the completion of a CEQA document. According to Section 21065 of CEQA:

"Project" means an activity which may cause either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment

As described in further detail in the table on the following pages, the SNMP does not include implementation of any new actions that would have potential to affect any environmental resources.

Resource Categories	Potential Impacts	Significance
Aesthetics	None. The SNMP does not recommend new implementation measures; therefore, no aesthetic impacts are anticipated as part of Plan approval.	No impact
Agriculture and Forest Resources	None. The SNMP does not recommend new implementation measures; therefore, no agriculture and forest resources impacts are anticipated as part of Plan approval.	No impact
Air Quality	None. The SNMP does not recommend new implementation measures; therefore, no air quality impacts are anticipated as part of Plan approval.	No impact
Biological Resources	None. The SNMP does not recommend new implementation measures; therefore, no biological resource impacts are anticipated as part of Plan approval.	No impact
Cultural Resources	None. The SNMP does not recommend new implementation measures; therefore, no cultural resource impacts are anticipated as part of Plan approval.	No impact
Geology and Soils	None. The SNMP does not recommend new implementation measures; therefore, no geology and soil impacts are anticipated as part of Plan approval.	No impact
Greenhouse Gas Emissions	None. The SNMP does not recommend new implementation measures; therefore, no greenhouse gas emissions are anticipated as part of Plan approval.	No impact
Hazards and Hazardous Materials	None. The SNMP does not recommend new implementation measures; therefore, no hazard and hazardous material impacts are anticipated as part of Plan approval.	No impact
Hydrology and Water Quality	No negative impacts. The SNMP does not recommend new implementation measures; therefore, no negative hydrology and water quality impacts are anticipated as part of Plan approval. Plan approval does result in beneficial water quality outcomes by formalizing a groundwater monitoring program and through a number of projects in which the Plan promotes.	No negative impact/ Beneficial impact
Land Use and Planning	None. The SNMP does not recommend new implementation measures; therefore, no negative land use and planning impacts are anticipated as part of Plan approval.	No impact
Mineral Resources	None. The SNMP does not recommend new implementation measures; therefore, no negative mineral resource impacts are anticipated as part of Plan approval.	No impact

Resource Categories	Potential Impacts	Significance
Noise	None. The SNMP does not recommend new implementation measures; therefore, no noise impacts are anticipated as part of Plan approval.	No impact
Population and Housing	None. The SNMP does not recommend new implementation measures; therefore, no population and housing impacts are anticipated as part of Plan approval.	No impact
Public Services	None. The SNMP does not recommend new implementation measures; therefore, no public service impacts are anticipated as part of Plan approval.	No impact
Recreation	None. The SNMP does not recommend new implementation measures; therefore, no recreation impacts are anticipated as part of Plan approval.	No impact
Transportation/Traffic	None. The SNMP does not recommend new implementation measures; therefore, no transportation/traffic impacts are anticipated as part of Plan approval.	No impact
Utilities and Service Systems	None. The SNMP does not recommend new implementation measures; therefore, no utilities and service system impacts are anticipated as part of Plan approval.	No impact
Mandatory Findings of Significance	While the SNMP does not recommend new implementation measures, the projects and activities it endorses provide a net benefit to the region.	Beneficial impact

Sonoma Valley Salt and Nutrient Management Plan

Prepared for the Sonoma Valley County Sanitation District

SONOMA COUNTY WATER AGENCY

September 2013

Sonoma Valley Salt and Nutrient Management Plan
Final Report

Prepared by:

RMC Water and Environment

In Association with:

Todd Engineers

PlanTierra, Inc.

Prepared for the Sonoma Valley County Sanitation District

September 2013

Table of Contents

List of Tables

List of Figures

Appendices

List of Acronyms

AF	Acre-Feet
AFY	Acre-Feet per Year
BAP	Basin Advisory Panel
BMPs	Best Management Practices
BOD	Biological Oxygen Demand
BPO	Basin Plan Objective
CDPH	California Department of Public Health
CEC	Constituents of Emerging Concern
DWR	Department of Water Resources
EC	Electrical Conductivity
GMP	Groundwater Management Plan
IRWM	Integrated Regional Water Management
LID	Low Impact Development

MCL	Maximum Contaminant Level
OWTS	Onsite Wastewater Treatment System
SCWA	Sonoma County Water Agency
SMCL	Secondary Maximum Contaminant Level
SNMP	Salt and Nutrient Management Plan
SVCSD	Sonoma Valley County Sanitation District
SVGMP	Sonoma Valley Groundwater Management Program
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TDS	Total Dissolved Solids
USGS	United States Geological Survey
UWMPs	Urban Water Management Plans
VOMWD	Valley of the Moon Water District

Executive Summary

ES-1 Recycled Water Policy Background and Salt and Nutrient Plan Requirement

In February 2009, the State Water Resources Control Board established a statewide Recycled Water Policy to encourage the use of recycled water and local stormwater capture. The Recycled Water Policy also required local water and wastewater entities, together with local salt and nutrient contributing stakeholders to develop a Salt and Nutrient Management Plan (SNMP) for each groundwater basin or subbasin in California. In addition to promoting reliance on local, sustainable water sources such as recycled water and stormwater, the SNMP's purpose is to manage salts and nutrients from all sources to ensure water quality objectives are met and sustained, and beneficial uses of the groundwater basin are protected. The information in this SNMP is limited to the available data for the subbasin.

ES-2 Conceptual Model of the Sonoma Valley Subbasin

This SNMP was developed for the Sonoma Valley Subbasin, defined as basin number 2-2.02 in the California Department of Water Resources (DWR) Bulletin 118-4 (DWR, 2003). The Sonoma Valley Subbasin encompasses an area of approximately 70 square miles and is located within the larger 166 square mile Sonoma Creek Watershed. Due to an area of historical brackish groundwater located adjacent to and northwest of San Pablo Bay, the Sonoma Valley Subbasin was divided into a Baylands Area (containing the historical brackish groundwater) and an Inland Area for the analyses within this SNMP.

There are distinct shallow and deeper groundwater zones with the subbasin, and two groundwater pumping depressions are apparent in the deep zone southeast of the City of Sonoma (City) and in the El Verano area. Groundwater serves approximately 25% of the Sonoma Valley population and is the primary source of drinking water supply for rural domestic and other unincorporated areas not being served by urban suppliers. More than half of the water demand in 2000 was met with groundwater and the remaining demand was met with imported water (36%), recycled water (7%), and local surface water (<1%).

The Sonoma County Water Agency (SCWA) manages and operates the wastewater treatment facility owned by the Sonoma Valley County Sanitation District (SVCSD). During dry weather months from May through October, the SVCSD provides 1,000 to 1,200 acre-feet per year (AFY) of recycled water for vineyards, dairies, and pasturelands in the southern part of Sonoma Valley.

In 2006, a collaborative group of over twenty stakeholders began development of a non-regulatory Groundwater Management Plan (GMP). The Sonoma Valley Groundwater Management Program (SVGMP) arising from the GMP locally manages groundwater resources for all beneficial uses.

ES-3 Developing a Plan Collaboratively

The SNMP was coordinated through the efforts of the SVGMP's existing stakeholder groups, the Basin Advisory Panel (BAP) and the Technical Advisory Committee (TAC). Development of the SNMP was a collaborative effort that utilized a series of six workshops at key milestones in the plan development and technical analysis. The San Francisco Bay Regional Water Quality Control Board (Regional Water Board), has also been heavily involved in the Plan development and progress through two inter-regional regulatory meetings, and three Sonoma Valley SNMP-specific meetings. These meetings were held to share findings and obtain concurrence on critical elements of the technical analysis and the development approach for the SNMP.

The Sonoma Valley SNMP received partial funding through the Proposition 84 Planning Grant for the SNMP preparation and development of a guidance document to assist other Bay Area agencies wanting to undergo a similar process in developing their SNMPs. The *Guidance Document for Salt and Nutrient Management Plans for the San Francisco Bay Region* was developed as a result, and is included as Appendix B.

ES-4 Recycled Water and Stormwater Goals

The goals for use of recycled water and stormwater recharge in the subasin were developed based on stakeholder input and on the information contained in UWMPs and other planning documents. Currently, approximately 1,100 AFY of recycled water is utilized within the subbasin for agricultural irrigation. Future planned use, and hence the recycled water goal for the subbasin is 4,100 AFY for irrigation of urban areas and agricultural, and environmental enhancement.

Agencies and stakeholders in the Sonoma Valley Subbasin are actively working to increase the ability to put stormwater to beneficial use. However, the benefit of recharging stormwater (which is likely to be low in TDS) is not included in the groundwater quality analyses in this Plan due to uncertainties in the projected quantity and volumes of stormwater recharge at this time.

ES-5 Existing Groundwater Quality

TDS and nitrate were utilized as indicator parameters within this SNMP. A period of 2000-2012 was utilized to establish baseline groundwater quality conditions. Generally, relatively low TDS concentrations (less than 500 mg/L) are observed throughout most of the subbasin. A few wells with elevated concentrations (above 750 mg/L) are seen in the southeastern portion of the subbasin in an area of historical brackish groundwater (Baylands Area).

This Baylands Area has been recognized for decades as an area of historical brackish groundwater (Kunkel and Upson, 1960; USGS, 2006). Due to the elevated salt in this area and land cover which is primarily tidal marshlands, groundwater pumping is limited, and the area is unlikely to be developed for groundwater supply in the future. Accordingly, this area is considered separately from the remainder of the subbasin referred to as the Inland Area to assess average groundwater quality. Average groundwater quality in the subbasin is characterized for the Inland Area, the Baylands Area, and the combined Inland and Baylands areas as one aquifer.

The average TDS concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in Table ES-1. The average Inland Area TDS concentration is 372 mg/L, well below the BPO of 500 mg/L, resulting in available assimilative capacity of 128 mg/L.

Table ES-1: Average TDS Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	635	372	1,220
BPO	500	500	500
Available Assimilative Capacity	**-135**	**128**	**-720**

TDS – total dissolved solids
mg/L – milligrams per liter

Generally low nitrate concentrations are observed throughout most of the subbasin. The average nitrate concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in Table ES-2.

Table ES-2: Average Nitrate-N Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	0.06	0.06	0.07
BPO	10.00	10.00	10.00
Available Assimilative Capacity	**9.94**	**9.94**	**9.93**

TDS – total dissolved solids
mg/L – milligrams per liter

ES-6 Source Identification and Loading

Salt and nutrient loading from surface activities to the Sonoma Valley Subbasin are due to various sources, including:

- Irrigation water (potable water, surface water, groundwater, and recycled water)
- Agricultural inputs (fertilizer, soil amendments, and applied water)
- Residential inputs (septic systems, fertilizer, soil amendments, and applied water)
- Animal waste (dairy manure land application)

To better understand the significance of various loading factors for the SNMP analysis, a GIS-based loading model was developed. Data inputs to the model include the spatial distribution of land uses (with associated loading factors), irrigation water sources (with associated water quality), septic inputs, wastewater infrastructure loads, and soil textures. The loading analysis found somewhat higher loading of TDS in the rural and agricultural areas of the subbasin, while nitrate loading was higher in the urban areas largely due to the low nitrogen application rates on vineyards. Loading model outputs were utilized to determine future water quality conditions.

ES-7 Future Groundwater Quality

A mixing model was used to predict future water quality, water quality trends, and the percentage of the existing available assimilative capacity used by recycled water projects in the subbasin during the future planning period (through 2035).

Three future scenarios were simulated:

- Future Scenario 0 (No-Project): Assumes average baseline water balance conditions and no additional enhanced stormwater capture and recharge is applied.
- Future Scenario 1: Assumes 2035 planned recycled water use of 4,100 AFY (applied consistently from WY 2013-14 through WY 2034-35)
- Future Scenario 2: Assumes 2035 planned recycled water use plus an additional 5,000 AFY of recycled water (applied consistently from WY 2013-14 through WY 2034-35).

For all three scenarios, recycled water projects use less than 10% of the available assimilative capacity for both TDS and nitrate, and projected concentrations remain well below the BPO of 500 mg/L for TDS and 10 mg/L for nitrate.

ES-8 Implementation Measures

The findings from the technical analysis completed for the SNMP indicate that overall groundwater quality in the basin is stable with low salinity and nutrient values, well below the Regional Water Board's BPOs. Analysis of future water quality (through 2035) indicates good water quality and stable trends. Therefore, no new implementation measures or BMPs as part of the SNMP process are recommended at this time; however, it is recommended that existing measures or practices to manage groundwater quality in the basin continue.

ES-9 Groundwater Monitoring Program

A Groundwater Monitoring Plan is a required element of all SNMPs. For the SNMP Groundwater Monitoring Program, 47 wells that are currently monitored by DWR, CDPH, and SVGMP will be included in the monitoring program. Wells will be monitored on the same schedule as their current monitoring, and results will be reported through the Geotracker database system to the Regional Water Board every three years in an SNMP Groundwater Monitoring Report. Parameters to be monitored include EC, TDS and nitrate.

ES-10 Antidegradation Analysis

Recycled water project(s) in the Sonoma Valley include existing (agricultural irrigation) and projected increased use of recycled water for irrigation and environmental enhancement through the end of the future planning period in 2035. Irrigation with recycled water contributes only very minor salt and nutrient loading to the subbasin and recycled water projects do not use more that 10 % of the available assimilative capacity.

In addition to the minimal negative water quality impacts associated with recycled water irrigation project(s) in the Subbasin, the Recycled Water Policy and other state-wide planning documents recognize the tremendous need for and benefits of increased recycled water use in California. The SNMP analysis finds that recycled water use can be increased while still protecting and improving groundwater quality for beneficial uses.

ES-11 Plan Finalization Process

Following the presentation of the Draft SNMP at the July 18, 2013 public workshop, public comments on the Draft SNMP Report were considered and incorporated into this Final SNMP Report. This SNMP is being submitted to the Regional Water Board (in September 2013) for their review and incorporation to their Basin Planning process and subsequent environmental documentation process. The Final SNMP Report has been posted online at the following web address: www.scwa.ca.gov/svgroundwater/

ES-12 Conclusion

The findings from the technical analysis completed for the SNMP indicate that overall groundwater quality in the basin is stable with low salinity and nutrient values (well below the Regional Water Board's BPOs), resulting from a combination of factors including the high percentage of mountain front recharge with very low TDS and nitrate concentrations, the low amount of loading from the few sources identified, and the low volume and high quality of recycled water used. Analysis of future water quality (through 2035) also indicates good water quality and stable trends.

In conclusion, no new implementation measures or BMPs as part of the SNMP process are recommended at this time.

Chapter 1 Introduction and Background

In February 2009, the State Water Resources Control Board (SWRCB) adopted Resolution No. 2009-0011, which established a statewide Recycled Water Policy. The policy encourages increased use of recycled water and local stormwater capture. It also requires local water and wastewater entities, together with local salt and nutrient contributing stakeholders to develop a Salt and Nutrient Management Plan (SNMP) for each groundwater basin or subbasin in California. The Sonoma Valley SNMP was developed through a collaborative process over an 18-month period starting in January 2012.

This SNMP was prepared for the Sonoma Valley Groundwater Subbasin in Sonoma County, California. The community overlying the groundwater subbasin includes urban areas as well as a significant amount of rural and agricultural land. Groundwater is an important resource to the area. Recycled water is currently used for agricultural irrigation and there are plans for expanded use of recycled water to augment or offset existing water supplies. As the primary local distributor of recycled water, the Sonoma Valley County Sanitation District (SVCSD) is leading the development of this SNMP.

1.1 Plan Purpose

The purpose of this SNMP is to:

- Promote reliance on local sustainable water sources such as recycled water and stormwater
- Manage salts and nutrients from all sources on a sustainable basis to ensure attainment of water quality objectives and protection of beneficial uses

1.2 Plan Organization

This SNMP is a comprehensive summary document of both the technical and planning work that went into development of the SNMP. The body of the report provides a high-level overview of the work completed in developing of the SNMP. The detailed technical analysis and assumptions for the groundwater quality trend and assimilative capacity analysis, loading and antidegradation analysis, and groundwater monitoring plan are contained within a series of technical memoranda attached as appendices to this SNMP.

This document first describes the groundwater basin characteristics and existing conditions, the collaborative process undertaken to develop this SNMP, existing groundwater quality, salt and nutrient loading analysis, future groundwater quality, goals, implementation measures, groundwater monitoring plan, and how this plan will be used.

Table 1-1: Document Organization and Chapter Summary

Chapter No.	Chapter Title	Chapter Overview
1	Introduction and Background	Plan purpose, recycled water policy requirement overview, and summary of document organization
2	Conceptual Model of the Sonoma Valley Subbasin	Groundwater subbasin characterization, water uses, groundwater levels, and water budget
3	Collaborative Plan Development Approach	Description of the collaborative process undertaken to develop the SNMP including stakeholders, meetings, and regulatory coordination
4	Goals	Documentation of recycled water and stormwater recharge goals within the Sonoma Valley Subbasin
5	Existing Groundwater Quality Analysis	Approach, methodology, and existing groundwater quality
6	Source Identification and Loading Analysis	Characterization of salt and nutrient sources, methodology for loading analysis, and findings
7	Future Groundwater Quality Analysis	Approach, methodology, and future groundwater quality
8	Implementation Measures	Documentation of groundwater management measures and volunteer efforts underway within the groundwater subbasin
9	Groundwater Monitoring Plan	Overview of SNMP groundwater monitoring plan and reporting
10	Antidegradation Assessment	Description of the antidegradation assessment
11	Plan Approval Process	Plan approval process and future updating criteria
12	Conclusion	A summary of findings from the SNMP process

1.3 Plan Limitations

Limitations and uncertainties associated with the development of this SNMP are mainly data related. Spatially, while historical information from the Baylands brackish area was available, no known wells currently exist in the Baylands and therefore no current groundwater quality information was available. Vertically within the aquifer, many well locations were lacking well construction detail information rendering the depth of the well unknown. Without depth-specific well screen information, water quality for shallow and deep zones was unable to be distinguished. Therefore the simplicity of the mixing model is a limitation because it simulates two big “buckets” (Inland and Baylands with movement between) and mixing is instantaneous. Additionally, verification of assumptions/estimates for individual anthropogenic loading sources during the calibration process was limited by the sensitivity of groundwater quality to and dominance of natural inflows (precipitation and stream recharge) in Sonoma Valley. Data collected as part of the SNMP Groundwater Monitoring Program will help in determining if flat trends predicted by the SNMP are verified.

Information used to derive future conditions was obtained from planning documents such as Urban Water Management Plans (UWMPs); however this information is projected on a 20-year planning horizon and can change. For instance recycled water expansion is planned to serve additional agricultural irrigation customers and the urban area of the City of Sonoma however exact sites and demands may shift as projects are implemented in the future. To address this, the SNMP Groundwater Monitoring Plan will assess changes in recycled water use on a triennial basis.

Chapter 2 Conceptual Model of the Sonoma Valley Subbasin

This chapter provides an overview of the hydrogeologic conceptual model of the Sonoma Valley Groundwater Subbasin located in Sonoma County, the subbasin for which this SNMP was developed.

2.1 Study Area

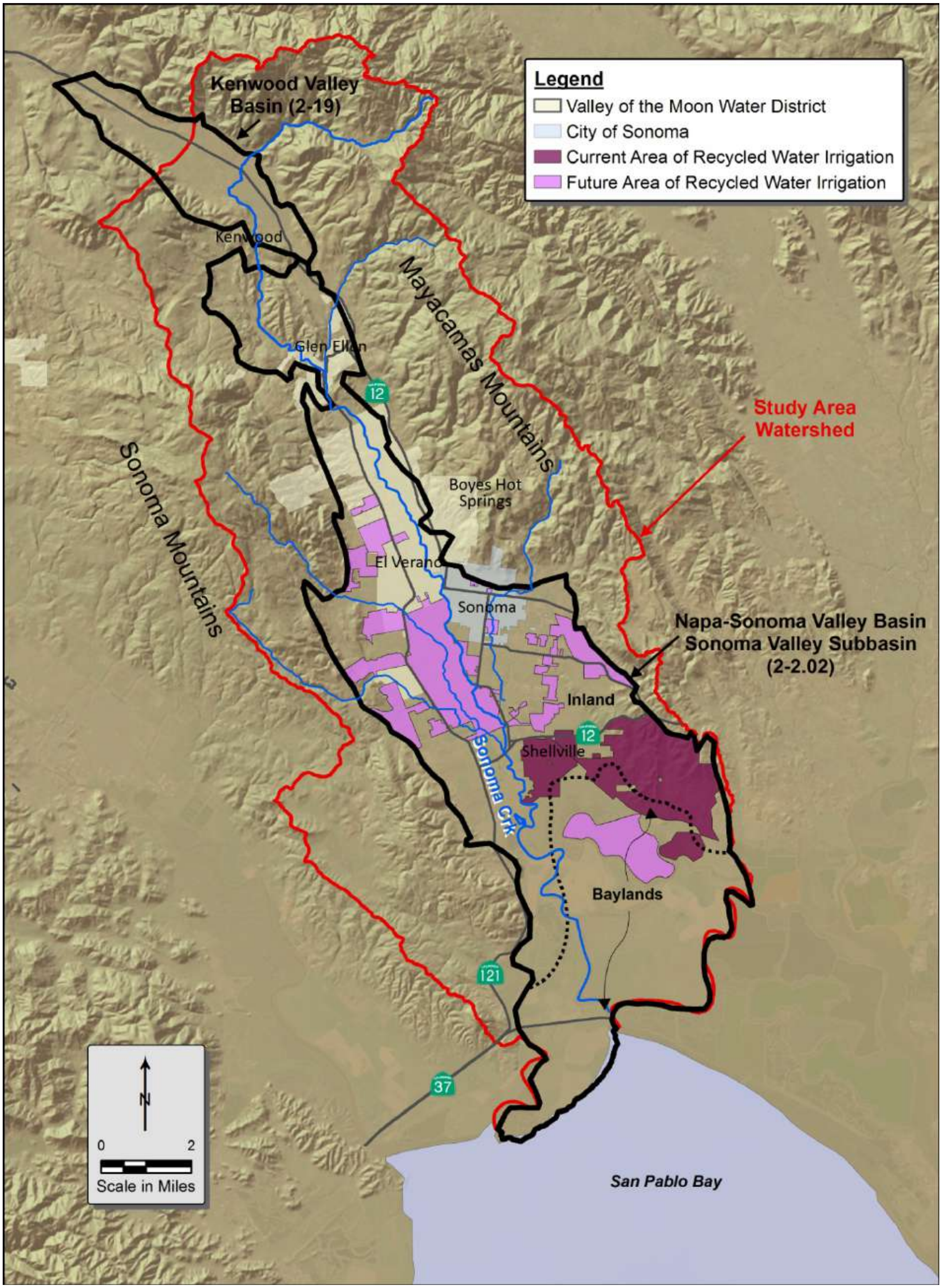
Per the Policy, SNMPs are to be developed for all groundwater basins in California. This SNMP was developed for the Sonoma Valley Subbasin, defined as basin number 2-2.02 in the California Department of Water Resources (DWR) Bulletin 118-4 (DWR, 2003). The Sonoma Valley Subbasin encompasses an area of approximately 70 square miles and is located within the larger 166 square mile Sonoma Creek Watershed, which also includes part of the Kenwood Valley Groundwater Basin, located northwest of the Sonoma Valley Subbasin. Due to an area of historical brackish groundwater located adjacent to and northwest of San Pablo Bay, the Sonoma Valley Subbasin was divided into a Baylands Area (containing the historical brackish groundwater) and an Inland Area as shown in Figure 2-1 for this SNMP. The Baylands Area is defined for this study as the area beneath the tidal sloughs adjacent to San Pablo Bay generally containing groundwater with greater than 750 milligrams per liter (mg/L) total dissolved solids (TDS).

The Sonoma Valley is a northwest trending, elongated depression. Geologic units generally dipping toward the center of the valley are bound on the southwest by the Sonoma Mountains and on the northeast by the Mayacamas Mountains (Figure 2-1). The uppermost part of the valley is relatively flat and stretches from Kenwood to near Glen Ellen. The middle part of the valley is narrower than the upper part and has a hilly topography. This portion is sometimes referred to as the Valley of the Moon and extends southward to near Boyes Hot Springs and includes the Glen Ellen area. The remainder of the valley slopes gently southward to San Pablo Bay, has flat topography, and extends to a maximum width of about 5 miles.

Sonoma Creek is the main surface water feature draining the valley. The creek originates in the Mayacamas Mountains in the northeastern area of the watershed. The creek flows into the Kenwood Valley Basin before flowing south into the Sonoma Valley Subbasin and ultimately discharging into San Pablo Bay. Other smaller tributary creeks flow into Sonoma Creek from the east and west.

The watershed area comprises large tracks of native vegetation, as well as lands used for agriculture, primarily vineyards. Urban, residential, commercial, and industrial development constitutes a relatively small percentage of the watershed area and is primarily located in the valley areas. Sonoma is the largest city in the Study Area. Other cities and unincorporated areas in the Sonoma Valley Subbasin include Glen Ellen, Boyes Hot Springs, El Verano, and Schellville (Figure 2-1).

Figure 2-1: Study Area



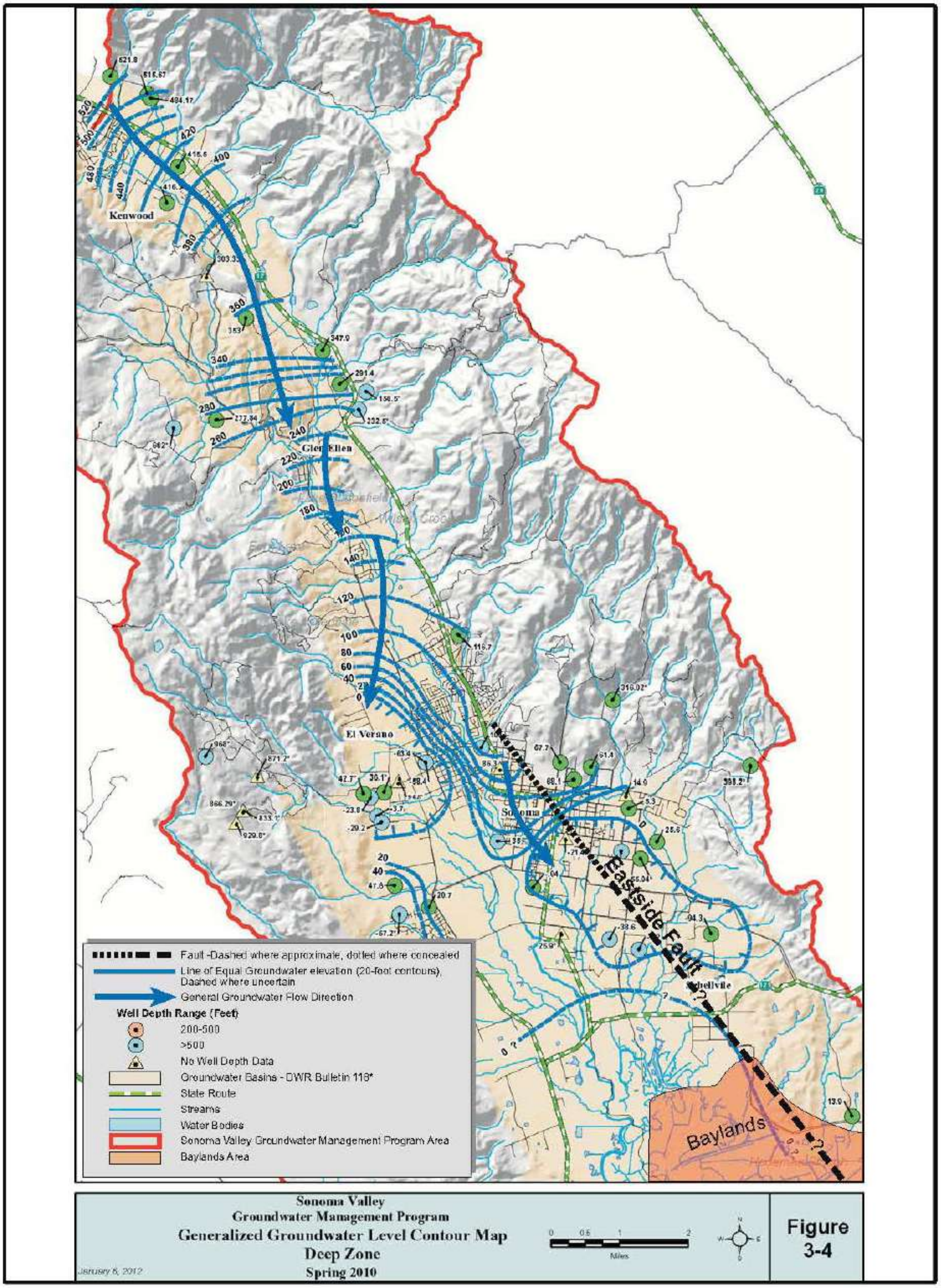
2.2 Groundwater Levels and Flow

Groundwater levels in the Sonoma Valley are monitored and reported as part of the Sonoma Valley Groundwater Management Plan (GMP) (SCWA, 2011). There is a groundwater divide within the Kenwood Valley Basin, with groundwater in the northern half of the Kenwood Basin flowing in a northwestward direction toward Santa Rosa and groundwater in the southern half of the Kenwood Basin flowing in a southeasterly direction toward the Sonoma Valley Subbasin in both the shallow and deep zones

Comparison of the shallow and deeper groundwater elevation contour maps (see Appendix A) indicates that groundwater elevations in the deep zone 1) are similar to groundwater elevations in the shallow zone in northern Sonoma Valley, and 2) are up to 100 feet lower than groundwater elevations in the shallow zone in southern Sonoma Valley, indicating a downward vertical gradient in southern Sonoma Valley.

As shown in Figure 2-2, two groundwater pumping depressions are apparent in the deep zone groundwater elevation contour map southeast of the City of Sonoma (City) and in the El Verano area. The pumping depression southeast of the City of Sonoma has the potential to induce intrusion of brackish water from the Baylands Area. This potential brackish water intrusion is being addressed through replacement of pumped groundwater with recycled water for irrigation in and north of the Baylands Area. Continued monitoring and assessment of groundwater levels and groundwater quality will be conducted to assess inland movement of the brackish water. This monitoring and assessment will be included in the triennial SNMP Groundwater Monitoring Report.

Figure 2-2: Generalized Groundwater Elevation Contour Map, Deep Zone, Spring 2010

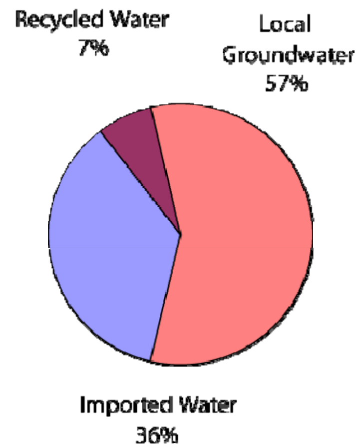


2.2.1 Surface Water – Groundwater Interaction

Sonoma Valley is drained by Sonoma Creek, which discharges to San Pablo Bay. Seepage testing conducted by the United States Geological Survey (USGS) in 2003 showed Sonoma Creek to be a gaining (groundwater discharging to the creek) creek through most of the valley with the exception of a short reach in the northern part of the watershed where the creek enters the Kenwood Valley Basin from the Mayacamas Mountains crossing the alluvial fan between the mountain front and Highway 12 (USGS, 2006).

2.3 Water Use

The Sonoma Valley relies on groundwater, imported surface water, and recycled water to meet domestic, agricultural and urban demands. Based on the USGS study (2006), more than half of the water demand in 2000 was met with groundwater and the remaining demand was met with imported water (36%), recycled water (7%), and local surface water (<1%).



The largest use of groundwater in the Sonoma Valley in 2000 was irrigation (72%), followed by rural domestic use (19%), and urban demand (9%). In 2000, total water use in the Sonoma Valley (including groundwater and imported surface water) was estimated at 14,018 acre-feet (AF), of which 48% was used for irrigation, 41% for urban use, and the remaining 11% for rural domestic use.

2.3.1 Groundwater

Groundwater serves approximately 25% of the Sonoma Valley population and is the primary source of drinking water supply for rural domestic and other unincorporated areas not being served by urban suppliers. Rural domestic demand is predominantly met by groundwater through privately owned and operated water wells. There are also mutual water companies in the Sonoma Valley that supply multiple households predominantly with groundwater although some companies also provide imported water. Agricultural water demands are largely met by groundwater supplies. It was estimated that as of 2000 the Sonoma Creek Watershed contained approximately 2,000 domestic, agricultural, and public supply wells (USGS, 2006).

2.3.2 Imported Surface Water

Imported surface water represents the primary source of drinking water to meet urban demands, which serves approximately 75% of the Sonoma Valley population. These imported water supplies are sourced from the Russian River and are provided via aqueduct by the Sonoma County Water Agency (SCWA) to the Valley of the Moon Water District (VOMWD) and the City who, in turn, provide water directly to their urban customers. The imported water is supplemented with local groundwater from the City and VOMWD public supply wells. The City and VOMWD boundaries are shown in Figure 2-1.

2.3.3 Recycled Water

SCWA manages and operates the wastewater treatment facility owned by the SVCSD. During dry weather months from May through October, the SVCSD provides 1,000 to 1,200 acre-feet per year (AFY) of recycled water for vineyards, dairies, and pasturelands in the southern part of Sonoma Valley. As of 2007, recycled water accounted for approximately 7% of the total estimated water use in Sonoma Valley (SCWA, December 2007). The current and future areas of recycled water use for irrigation exist in both the Inland and Baylands Areas and are shown in Figure 2-1.

2.4 Groundwater Management Program

In recognition of the increasing demands and challenges facing the Sonoma Valley groundwater subbasin, a collaborative group of over twenty stakeholders began development of a non-regulatory Groundwater Management Plan in 2006. This group, called the Basin Advisory Panel (BAP) represents varied groundwater interests including local agriculture, dairies, government, local water purveyors, business, and environmental interests. The BAP, assisted by a Technical Advisory Committee (TAC), developed the non-regulatory Groundwater Management Plan, which was adopted by SCWA, the City, VOMWD, and SVCSD in late 2007.

The Sonoma Valley Groundwater Management Program (SVGMP) identifies a range of voluntary management actions to maintain the health of the groundwater basin including increasing recycled water use and enhancing groundwater recharge. The SVGMP goal is to locally manage, protect, and enhance groundwater resources for all beneficial uses, in a sustainable, environmentally sound, economical, and equitable manner for generations to come.

Chapter 3 Collaborative Plan Development Approach

The SNMP was developed in a collaborative setting with input from a wide array of stakeholders and interested parties. The SNMP was able to utilize the existing stakeholder infrastructure set up by the SVGMP to hold meetings and obtain input on technical analysis and direction of the Plan. The stakeholder group make-up, workshop process and regulatory coordination elements of the process are outlined below.

3.1 Stakeholder Group

The SNMP was coordinated through the efforts of the SVGMP's existing stakeholder groups, the BAP and the TAC. Stakeholders that also participated in the SNMP process include:

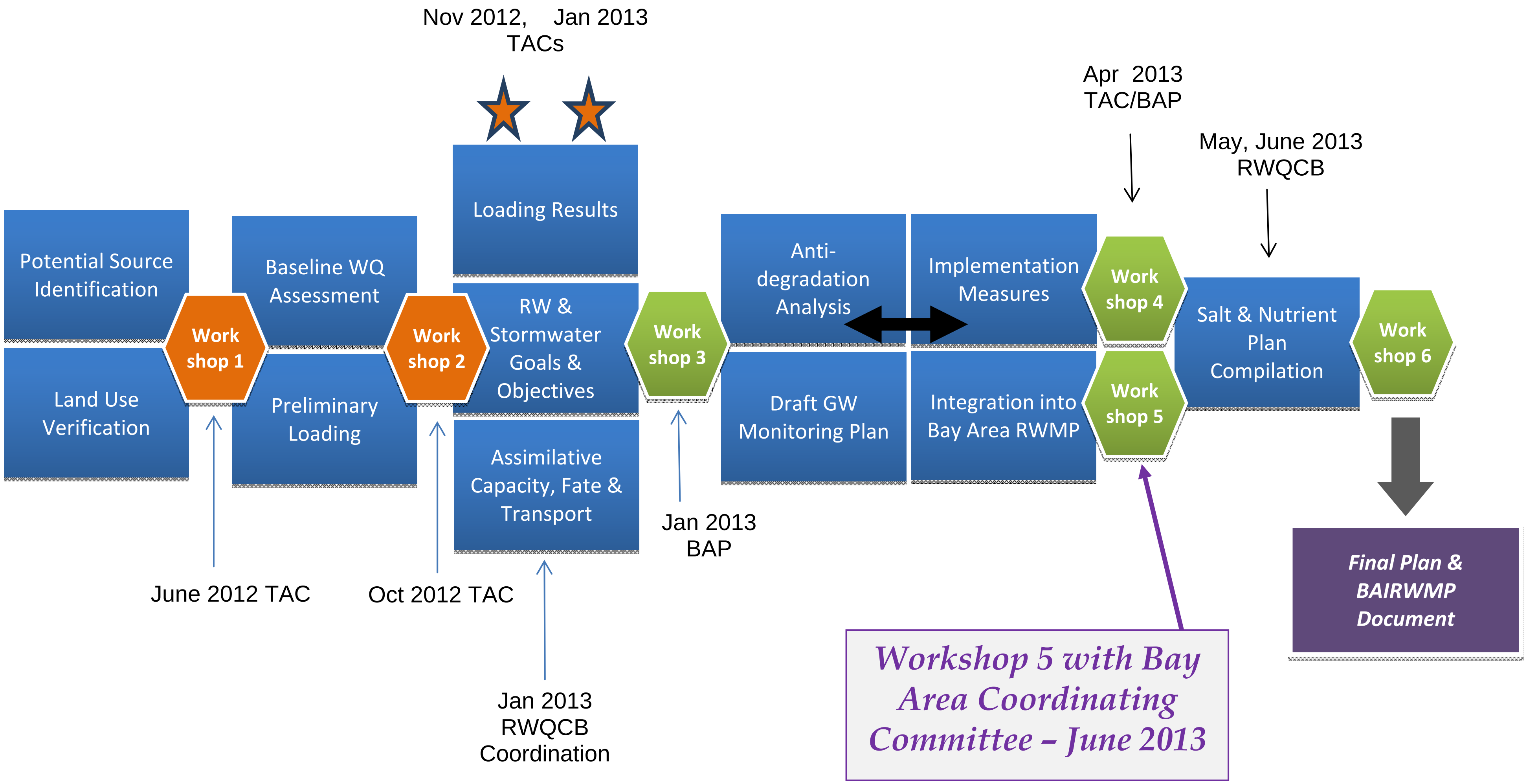
- Municipal agencies: SCWA, SVCSD, VOMWD, the City
- Resource groups: Sonoma Resource Conservation District
- Agricultural interests: members of the North Bay Agricultural Alliance and Sonoma Valley Vintners & Growers Alliance, Sonoma County Winegrape Commission, Mulas Dairy, and individual vineyard owners
- Others: Sonoma Ecology Center, private well owners
- Regulatory/Government Agencies: San Francisco Bay Regional Water Quality (Regional Water Board), California Department of Public Health (CDPH), DWR, USGS

3.2 Workshop Process

Development of the SNMP was a collaborative effort that utilized workshops at key milestones. As the technical analysis progressed, additional meetings were held with the TAC and other specific stakeholders to help develop and refine land use practices, water use information and loading parameter input. A total of six workshops were held through-out the 18-month SNMP development process. In addition to the six workshops, as part of data collection and regional coordination, the following meetings were held:

- Four meetings were held with the TAC (2012: November; 2013: January, April, July)
- Two conference calls were held with the Sonoma County Winegrape Commission (November 2013, January 2013)
- Four meetings were held with the Regional Water Board (2012: January; 2013: January, May, June)
- One meeting was held with the Bay Area Integrated Regional Water Management (IRWM) Coordinating Committee (April 22, 2013)

Figure 3-1: Collaborative Plan Development Process



Workshops were structured to present the technical analysis methodology and findings, and to obtain input and direction on assumptions and key elements of the plan moving forward. Each of the six workshops along with the major topics of discussion and outcomes are shown below.

Workshop 1 - June 13, 2012 (held with TAC)

- **Discussion Topics**
    - Recycled Water Policy Requirements
    - Sonoma Valley Planned Approach
    - Input on Land Cover Changes
    - Constituents to Address in the Plan
    - Schedule
- **Meeting Outcomes**
    - Stakeholder agreement on SNMP Plan development process
    - Refinements to land use and land cover (updated dairy areas, future recycled water areas)
    - Agreement on constituents to address in SNMP

Workshop 2 - October 10, 2012 (held with TAC)

- **Discussion Topics**
    - Existing Groundwater Water Quality Analysis and Findings
    - Salt and Nutrient Loading Model and Mixing Model Approach
    - Recycled Water and Stormwater Goals
- **Meeting Outcomes**
    - Stakeholder understanding of existing water quality
    - Confirmation of recycled water and stormwater recharge goals for the basin

Workshop 3 - January 17, 2013 (held as a public workshop following the BAP meeting)

- **Discussion Topics**
    - Background Recycled Water Policy and SNMP Requirements
    - Existing Groundwater Water Quality and Assimilative Capacity
    - Salt and Nutrient Loading Analysis and Findings
    - Recycled Water and Stormwater Goals
    - Mixing Model Approach
    - Bay Area IRWM Guidance Document Development
- **Meeting Outcomes**
    - Stakeholder understanding of existing water quality and assimilative capacity

  - Confirmation of technical approach
  - Input on land management practices for dairy operations

<u>Workshop 4</u> - **April 18, 2013** (held with BAP)

- **Discussion Topics**
  - Future Water Quality and Assimilative Capacity
  - Existing Implementation Measures
  - SNMP Groundwater Monitoring Program
  - Next Steps for SNMP Finalization
- **Meeting Outcomes**
  - Stakeholder understanding of technical analysis
  - Agreement with approach of utilizing existing implementation measures
  - Confirmation of plan for Groundwater Monitoring

<u>Workshop 5</u> - **June 3, 2013** (held with Bay Area IRWM Coordinating Committee)

- **Discussion Topics**
  - Proposition 84 Planning Grant SNMP Element
  - Key Steps in Preparing an SNMP
  - Review of Draft Guidance Document for SNMPs for the Bay Area Region and Off-Ramp Language within Document
  - Incorporation of Guidance Document into IRWM Plan Update
- **Meeting Outcomes**
  - Confirmation of approach
  - Modification of title wording and revisions to introductory text

<u>Workshop 6</u> - **July 18, 2013 (held as a public workshop following the BAP meeting)**

- **Discussion Topics**
  - Background on Recycled Water Policy and SNMP Requirements
  - Review SNMP Process and Findings
  - Process for Providing Input on Draft SNMP Report
  - Regulatory Coordination and SNMP Finalization
- **Meeting Outcomes**
  - Informed public of SNMP Process
  - Received clarifying questions

3.3 Regulatory Coordination

Sonoma Valley is one of three groundwater basins in the Bay Area Region that is nearing completion of its SNMP. The Regional Water Board has been part of the SNMP development processes over the last 18-months through a series of meetings and region-wide workshops. Two Bay Area Region-wide SNMP coordination meetings have been held with the Regional Water Board, SVCSD, Zone 7 Water Agency and the Santa Clara Valley Water District, the first in January 2012, and the second in June 2013. The inter-regional coordination meetings provided a forum to share SNMP develop approaches and progress; and to understand and provide feedback on the Regional Water Board's planning process.

In addition to the two inter-regional regulatory meetings, three Sonoma Valley SNMP-specific meetings have been held with the Regional Water Board to share findings and obtain concurrence on critical elements of the technical analysis and the development approach for the SNMP. These coordination meetings were held at critical points in the technical analysis to obtain feedback on preliminary findings so that modifications and new approaches could be accounted for. Meeting minutes from the January and May meetings which pertained directly to the Sonoma Valley SNMP are included as Appendix B.

The first meeting was held in January 2013, in which the SNMP plan development process, collaboration and stakeholder make-up, existing water quality and assimilative capacity findings, goal setting, and the approach for the loading analysis and future water quality analysis was shared. The Regional Water Board staff agreed with the SNMP's approach for using the 2000-2012 period for establishing current basin averages, and agreed with the goal setting (utilizing recycled water use goals from the 2010 UWMPs, and not including numeric goals for stormwater recharge until recharge projects in Sonoma Valley are further developed). Additionally, Regional Water Board staff agreed that it made sense to continue to distinguish between the Inland and Baylands area for the assimilative capacity assessment. There was significant discussion regarding the proposed approach for establishing average TDS and nitrate and assimilative capacity, which was to average across the basin and across all depth intervals to estimate one TDS and one nitrate concentration for the entire subbasin. While Regional Water Board staff preferred a depth discrete analysis of the assimilative capacity, this was not possible given the limited data set. Moving forward, a reasonable mixing depth was assumed for the basin in the mixing analysis (approximately 400 feet), and the shallow and deep zones are accounted for in the monitoring plan.

The second meeting held in May 2013 shared the methodology and findings from the loading and future water quality analysis, future assimilative capacity, existing implementation measures, and planned SNMP groundwater monitoring program. The results of the technical analysis showing good water quality with relatively flat trends through 2035 were shared. A third meeting with the Regional Water Board was held on June, 24 2013 to present and discuss the Draft Guidance Document for SNMP for the Bay Area Region (Appendix C).

3.4 Coordination with the Bay Area Integrated Regional Water Management Plan

The *Guidance Document for Salt and Nutrient Management Plans for the San Francisco Bay Region* was developed as a result of the Sonoma Valley SNMP preparation effort. The SVCSD, along with the Zone 7 Water Agency and the Santa Clara Valley Water District are leading SNMP development efforts in three groundwater basins for the San Francisco Bay Region. The Sonoma Valley SNMP received partial funding through the Proposition 84 Planning Grant for the SNMP preparation and development of a guidance document to assist other Bay Area agencies wanting to undergo a similar process in developing their SNMPs.

The purpose of the *Guidance Document* (included as Appendix C) is to describe the common steps that may be undertaken by Bay Area groups in preparing an SNMP. The Regional Water Board is expected to consider the size, complexity, level of activity, and site-specific factors within a basin in reviewing the level of detail and the specific tasks required for each SNMP.

Chapter 4 Goals

This chapter presents the goals for using recycled water and stormwater in the Sonoma Valley Subbasin. The goals were developed based on stakeholder input and on the information contained in UWMPs and other planning documents. The UWMPs are developed by the individual water purveyors (SCWA, VOMWD, and the City), so the information contained in those UWMPs was summarized and merged together to meet the needs of this Plan. Additionally, water conservation programs provide a useful basis for understanding and assessing recycling activities. The agencies within the basin implement extensive water conservation programs, ranging from residential, commercial, industrial and municipal to agricultural programs. More information on individual agency conservation programs can be found in each individual agency's UWMP.

4.1 Recycled Water Goals

Recycled water goals are based on information provided in 2010 UWMPs and 2012 recycled water usage data. Recycled water goals were set based on 2010 UWMP recycled water use projections.

Existing recycled water use is presented in Table 4-1, and is based on 2012 recycled water usage data provided by SVCSD. These values represent recycled water use within the Subbasin, which is currently used for agricultural irrigation. Future expansion of the recycled water system is planned to provide recycled water to urban areas in the City, environmental enhancement, and more water for agricultural customers.

Table 4-1 also presents the projected 2035 recycled water use in the basin. These future estimates represent the recycled water goals for the Sonoma Valley Subbasin.

Table 4-1: Current Use and Future Goals for Recycled Water

Provider	2012 Use (AFY)	2035 Use (AFY)
SVCSD	1,100	4,100
Increase over 2012 usage	n/a	2,750

4.2 Stormwater Recharge Goals

Agencies and stakeholders in the Sonoma Valley Subbasin are actively working to increase the ability to put stormwater to beneficial use. For example in 2012, SCWA completed a watershed scoping study for a stormwater management/groundwater recharge project in the Sonoma Valley and performed similar studies for other area watersheds. The goal of the study was to evaluate the feasibility of implementing multi-benefit projects that will provide stormwater detention and groundwater recharge, while maximizing opportunities for flood control, water quality enhancement, and potential open space benefits.

Additionally, there is a trend towards requiring implementation of Low Impact Development (LID) features in development and redevelopment that increase recharge of stormwater. The Southern Sonoma County Resource Conservation District recently published the "Slow It, Spread It, Sink It" LID Guidance Document for Sonoma Valley. Water management planning efforts related to stormwater and their corresponding implementation schedules are shown in Table 4-2.

Table 4-2: Basin Water Management Studies and Timeline

Study/Project	General Scope	Implementing and Cooperating Agencies	Schedule
Stormwater LID Technical Design Manual	Provide design guidance to mitigate water quality impacts due to development and encourage infiltration of storm water.[a.]	City of Santa Rosa, Sonoma County Water Agency, County of Sonoma	Completed in 2011
Groundwater Banking Feasibility Study	Evaluate feasibility of using excess wintertime water from Russian River drinking water facilities for storage and subsequent recovery in the Santa Rosa Plain and/or Sonoma Valley groundwater basins during dry weather conditions or emergency situations.	Sonoma County Water Agency, Cities of Cotati, Rohnert Park and Sonoma, Town of Windsor, Valley of the Moon Water District	Complete by Winter 2013
Sonoma Valley Stormwater Management and Groundwater Recharge Scoping Study	Assess potential projects in the watershed that can provide both flood control and groundwater recharge.	Sonoma County Water Agency	Scoping Study Completed Spring 2012

a. SCWA is also developing a "WaterSmart Manual" to promote water smart practices including conservation, recycling and low impact development. The WaterSmart Manual is scheduled to be completed in Winter 2013.

While these efforts and others are continuing in the subbasin, the benefit of recharging stormwater (which is likely to be low in TDS) is not included in the groundwater quality analyses in this Plan due to uncertainties in the projected quantity and volumes of stormwater recharge at this time. Not including stormwater in the future water quality analysis at this point is a conservative approach as stormwater would likely decrease TDS and nitrate concentrations in the subbasin. Future updates to the Plan will consider these efforts as they continue to be developed and implemented. Future updates to the Plan could also include quantitative goals for stormwater recharge as they are established through these planned efforts.

Chapter 5 Existing Groundwater Quality Analysis

Determining the existing groundwater quality is a critical step in SNMP technical analysis. A summary of the existing groundwater quality is presented below with additional detail contained in the *Existing and Future Groundwater Quality TM (Todd, 2013)* attached as Appendix A.

5.1 Existing Groundwater Quality

5.1.1 Indicator Parameters of Salts and Nutrients

TDS and nitrate are the indicator salts and nutrients selected for the Sonoma Valley SNMP. Total salinity is commonly expressed in terms of TDS in mg/L. TDS (and electrical conductivity data that can be converted to TDS) are available for source waters (both inflows and outflows) in the valley. While TDS can be an indicator of anthropogenic impacts such as infiltration of runoff, soil leaching, and land use, there is also a natural background TDS concentration in groundwater.

Nitrate is a widespread contaminant in California groundwater. High levels of nitrate in groundwater are generally associated with agricultural activities, septic systems, confined animal facilities, landscape fertilization, and wastewater treatment facility discharges. Nitrate is the primary form of nitrogen detected in groundwater. Natural nitrate levels in groundwater are generally very low, with concentrations typically less than 10 mg/L for nitrate as nitrate (nitrate-NO_3) or 2 to 3 mg/L for nitrate as nitrogen (nitrate-N). Nitrate is commonly reported as either nitrate-NO_3 or nitrate-N; and one can be converted to the other. Nitrate-N is selected for the assessment in this SNMP.

5.1.2 Water Quality Objectives

Water quality objectives provide a reference for assessing groundwater quality in the Sonoma Valley Subbasin. The CDPH has adopted a Secondary Maximum Contaminant Level (SMCL) for TDS. SMCLs address aesthetic issues related to taste, odor, or appearance of the water and are not related to health effects, although elevated TDS concentrations in water can damage crops, affect plant growth, and damage municipal and industrial equipment. The recommended SMCL for TDS is 500 mg/L with an upper limit of 1,000 mg/L. It has a short-term limit of 1,500 mg/L. The Regional Water Board has established a basin plan objective (BPO) of 500 mg/L for TDS for municipal and domestic supply in their Basin Plan (December 2010).

The MCL for nitrate plus nitrite as nitrogen (as N) is 10 mg/L. The Regional Water Board has established the BPOs at the maximum contaminant levels (MCLs) for these constituents. Table 5-1 lists numeric BPOs for groundwater with municipal and domestic water supply and agricultural water supply beneficial uses in the San Francisco Bay Region.

Table 5-1: Basin Plan Objectives

Constituent	Units	BPOs
TDS	mg/L	500
Nitrate-N	mg/L	10

5.1.3 TDS and Nitrate Fate and Transport

Salt and nutrient fate and transport describes the way salts and nutrients move and change through an environment or media. In groundwater, it is determined by groundwater flow directions and rate, the characteristics of individual salts and nutrients, and the characteristics of the aquifer media.

Water has the ability to naturally dissolve salts and nutrients along its journey in the hydrologic cycle. The types and quantity of salts and nutrients present determine whether the water is of suitable quality for its intended uses. Salts and nutrients present in natural water result from many different sources including atmospheric gases and aerosols, weathering and erosion of soil and rocks, and from dissolution of existing minerals below the ground surface. Additional changes in concentrations can result due to ion exchange, precipitation of minerals previously dissolved, and reactions resulting in conversion of some solutes from one form to another such as the conversion of nitrate to gaseous nitrogen. In addition to naturally occurring salts and nutrients, anthropogenic activities can add salts and nutrients.

TDS and nitrate are contained in the source water that recharges the Sonoma Valley. Addition of new water supply sources, either through intentional or unintentional recharge, can change the groundwater quality either for the worse by introducing contamination or for the better by diluting some existing contaminants in the aquifer. Another important influence on salts and nutrients in groundwater is unintentional recharge, which can occur, for example, when irrigation water exceeds evaporation and plant needs and infiltrates into the aquifer (i.e., irrigation return flow). Irrigation return flows can carry fertilizers high in nitrogen and soil amendments high in salts from the yard or field into the aquifer. Similarly, recycled water used for irrigation also introduces salts and nutrients.

TDS is considered conservative in that it does not readily attenuate in the environment. In contrast, processes that affect the fate and transport of nitrogen compounds are complex, with transformation, attenuation, uptake, and leaching in various environments. Nitrogen is relatively stable once in the saturated groundwater zone and nitrate is the primary form of nitrogen detected in groundwater. It is soluble in water and can easily pass through soil to the groundwater table.

5.1.4 Analysis Methodologies

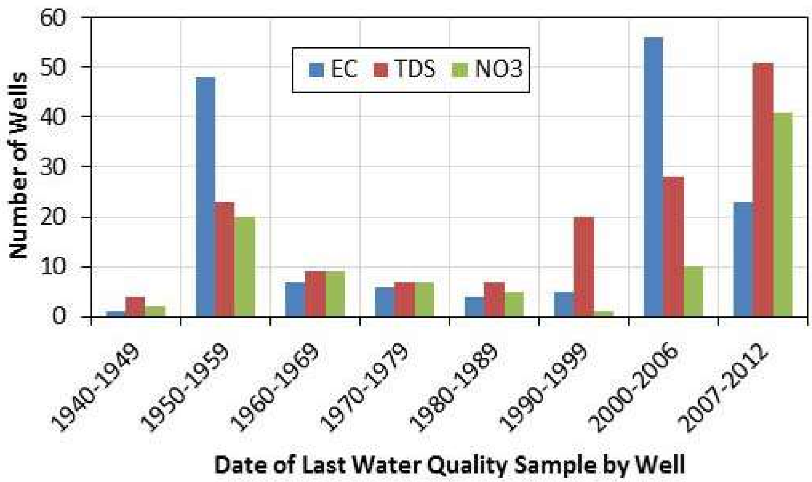
Lateral and Vertical Segmentation

Initially, the available groundwater quality data and well completion information were assessed to determine if the subbasin groundwater quality characterization could be divided into subareas (north and south) and layers (shallow and deep) to assess differences in groundwater quality laterally and vertically. Unfortunately, well completion information for many of the monitored wells is unavailable, and the available data are considered insufficient to reliably differentiate groundwater quality in the shallow and deep zones. The Baylands Area shown in Figure 2-1 is defined as the area with median TDS concentrations greater than 750 mg/L. This general area has been recognized for decades as an area of historical brackish groundwater (Kunkel and Upson, 1960; USGS, 2006). Due to the elevated salt in this area and land cover which is primarily tidal marshlands, groundwater pumping is limited, and the area is unlikely to be developed for groundwater supply in the future. There are a limited number of wells in the Baylands Area based on DWR well logs acquired for the USGS study (2006). Many of the wells in the Baylands Area have been destroyed and agricultural land use in the area is primarily limited to non-irrigated crops such as hay. Accordingly, this area is considered separately from the remainder of the subbasin referred to as the Inland Area. Available monitoring data do not indicate clear differences between groundwater quality in the northern and southern portion of the Inland Area. Therefore average groundwater quality in the subbasin is characterized for the Inland Area, the Baylands Area, and the combined Inland and Baylands areas as one aquifer. This approach was shared with the Regional Water Board in January 2013.

Groundwater Quality Averaging Period

In accordance with the Policy, the available assimilative capacity shall be calculated by comparing the BPOs with the average ambient salt and nutrient concentrations in the subbasin over the most recent five years of available data (2007 to 2012) or a time period approved by the Regional Water Board. Figure 5-1 shows the number of wells sampled over the history of sampling in the subbasin. As shown in the figure, a significant number of wells were sampled in the 2000 to 2006 time period, predominantly as part of the work conducted by the USGS (2006). In order to provide a more robust dataset, data collected during the 12 year period from 2000 to 2012 are used to assess the average groundwater quality in the subbasin. The Regional Water Board approved this baseline period duration in the January 2013 regulatory coordination meeting. Evaluation of concentration trends finds overall relatively stable or flat trends for TDS and nitrate in most wells in the subbasin, which also supports use of a longer averaging period.

Figure 5-1: Summary of Available Water Quality Data



Calculation of Existing Ambient Groundwater Quality and Assimilative Capacity

The median groundwater concentration for samples collected from individual wells over the 12-year averaging period for TDS and nitrate are plotted on maps with different size and color circles representing median concentrations (dots maps). The TDS and nitrate dots maps are then used to develop concentration contour maps for TDS and nitrate.

The average TDS and nitrate concentrations for each area (Inland and Baylands) and for the entire subbasin are compared to the BPOs to determine the current available assimilative capacity.

Time-Concentration Plots and Trends

Time-concentration plots are prepared and evaluated to assess whether TDS and nitrate groundwater concentrations across the subbasin have been historically increasing, decreasing, or showing no significant change. The trend analysis facilitates the comparison of observed concentration trends in individual wells with simulated average groundwater concentration trends from the mixing model over the baseline period, from 1996-97 (water year 1997) through 2005-06 (WY 2006), for calibration purposes. A water year is from October 1 to September 30 of the following year and is commonly used for hydrogeologic analysis.

5.1.5 TDS in Groundwater

Figure 5-2 shows TDS concentration contours in the subbasin. Generally, relatively low TDS concentrations (less than 500 mg/L) are observed throughout most of the subbasin. A few wells with elevated concentrations (above 750 mg/L) are seen in the southeastern portion of the subbasin. The southeastern portion of the subbasin is an area of historical brackish groundwater.

The area of very high TDS near San Pablo Bay with TDS greater than 1,500 mg/L is based on older well sampling conducted between 1954 and 1973 by DWR. Use of these older data is conservative in that their use results in higher average concentrations in the Baylands Area and there are no more recent data available for this area.

The average TDS concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in Table 5-2. The average Inland Area TDS concentration is 372 mg/L, well below the BPO of 500 mg/L, resulting in available assimilative capacity of 128 mg/L. As expected the average TDS concentration in the Baylands Area is high, with an average concentration of 1,220 mg/L, resulting in no available assimilative capacity. The average TDS concentration for the combined subbasin including both the Inland and Baylands Areas is 635 mg/L, also resulting in no available assimilative capacity.

Table 5-2: Average TDS Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	635	372	1,220
BPO	500	500	500
Available Assimilative Capacity	**-135**	**128**	**-720**

TDS – total dissolved solids
mg/L – milligrams per liter

TDS Trends

Figure 5-3 shows time-concentration plots for TDS, along with the applicable BPO. The well dots and charts are shaded to indicate the wells depths with red wells and charts indicating wells less than 200 feet deep, yellow wells and charts indicating wells between 200 and 500 feet deep and green wells and charts indicating wells greater than 500 feet deep. Wells and charts shaded gray indicated wells with unknown completion depths. The figure shows relatively flat TDS trends in the subbasin indicating generally stable conditions. However, Wells 5N/5W-28R1 and 5N/5W-28N1 located in the southern portion of the subbasin near the Baylands Area show modest increasing concentration trends, which could be attributed increasing saline intrusion as well as other sources. One well is an intermediate zone well (200 to 500 feet deep) and the other is a shallow zone well (less than 200 feet deep). The shallow well (5N/5W-28N1) is owned by a dairy, and this well also shows increasing nitrate concentrations as discussed in the next section. Therefore, it is possible that the increasing TDS concentrations could be associated with local surface sources rather than saline intrusion. The other intermediate well with increasing TDS does not have a similar increasing nitrate trend.

The analysis indicates the importance of preventing additional saline intrusion into the Inland Area. The Baylands brackish groundwater area is a concern in the Sonoma Valley. One of the objectives of developing and increasing the use of recycled water for irrigation is to reduce groundwater pumping in the southern Sonoma Valley, prevent additional saline intrusion, and potentially reduce the existing inland extent of brackish groundwater. Irrigation with recycled water began in 1992 and is projected to increase in the future. To date, the data are insufficient to determine if the replacement of groundwater with recycled water has reduced the areal extent of brackish groundwater. However, continued monitoring of this area is a key component of the ongoing SVGMP and SNMP.

Figure 5-2: Total Dissolved Solids Concentration Contours (2000 to 2012)

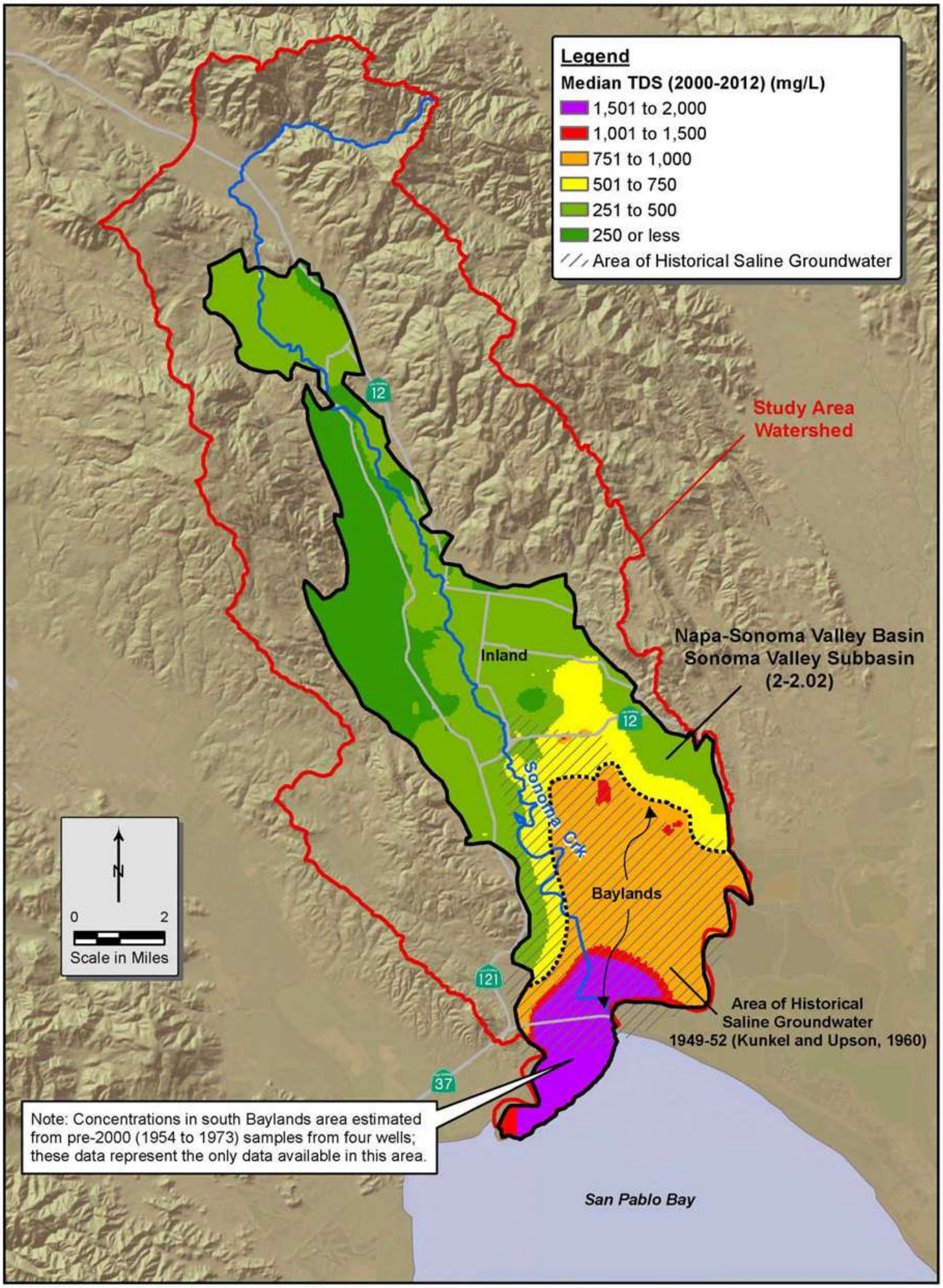
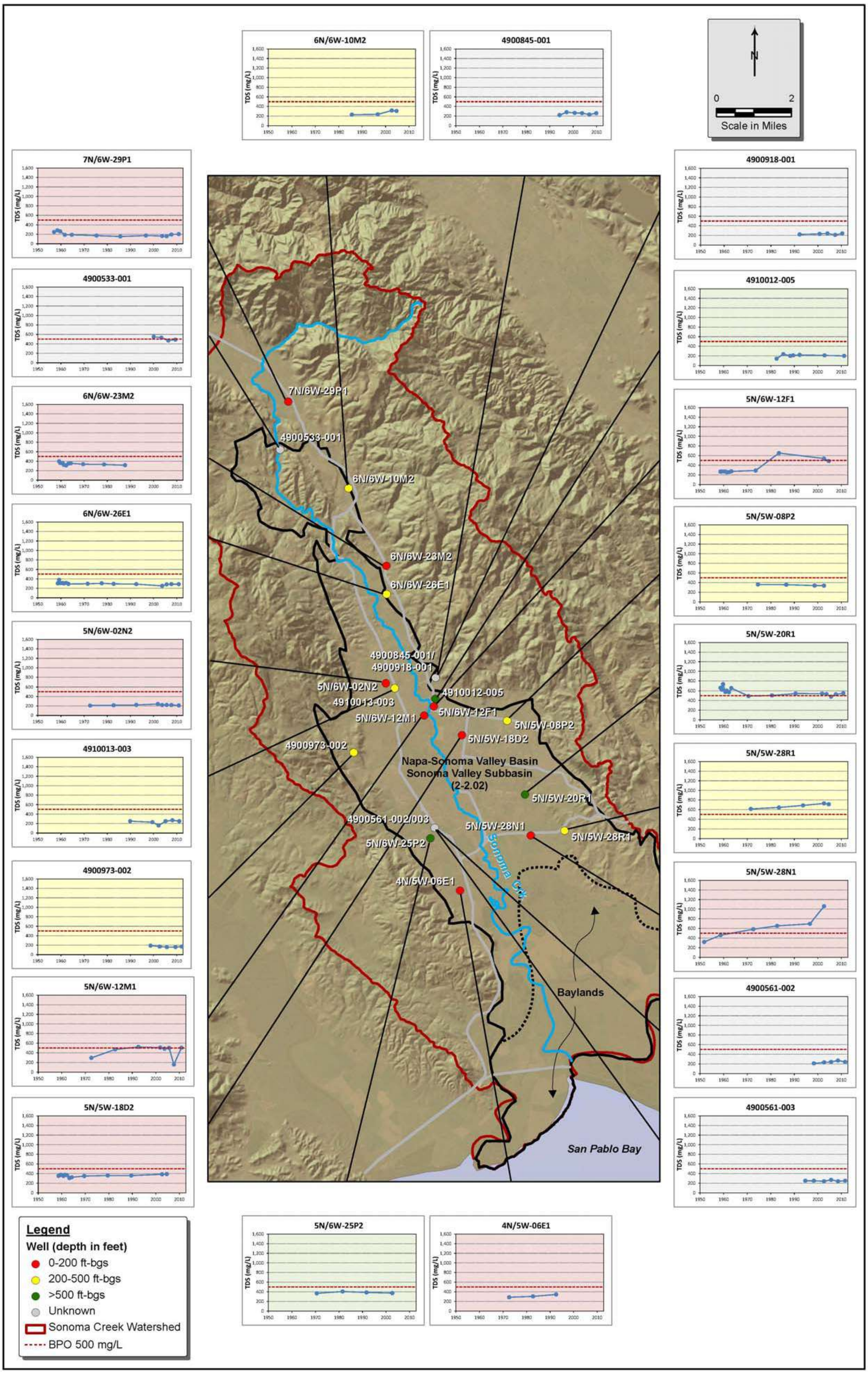


Figure 5-3: Time-Concentration Plots Total Dissolved Solids



5.1.6 Nitrate in Groundwater

A nitrate concentration contour map is shown in Figure 5-4. Generally low nitrate concentrations are observed throughout most of the subbasin. The nitrate-N BPO is 10 mg/L. The area of nitrate between 2.6 and 5.0 mg/L near the San Pablo Bay is based on older well sampling conducted by the DWR between 1954 and 1973. The average nitrate concentration in the Inland Area, Baylands Area, and combined Sonoma Valley Subbasin area are shown in Table 5-3.

Table 5-3: Average Nitrate-N Concentrations and Available Assimilative Capacity

Concentrations in mg/L	Sonoma Valley Subbasin	Inland Area	Baylands Area
Average	0.06	0.06	0.07
BPO	10.00	10.00	10.00
Available Assimilative Capacity	**9.94**	**9.94**	**9.93**

TDS – total dissolved solids
mg/L – milligrams per liter

Nitrate Trends

Figure 5-5 shows time-concentration plots for nitrate-N along with the applicable BPO. As discussed above, the wells and charts are shaded to indicate relative well depth. Generally flat concentrations are observed in most wells in the subbasin, typically well below the BPO of 10 mg/L.

Figure 5-4: Nitrate as N Concentration Contours (2000 to 2012)

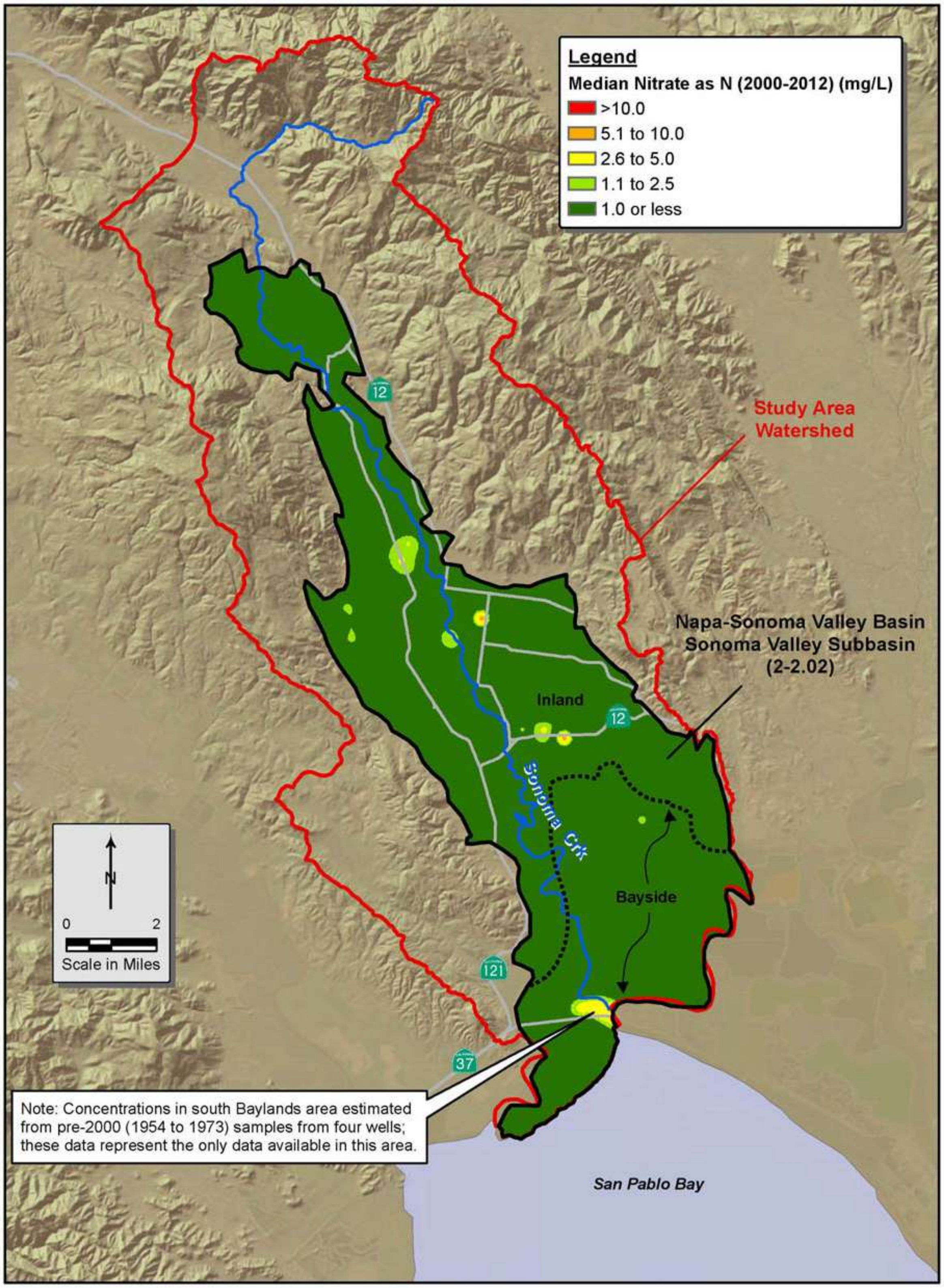
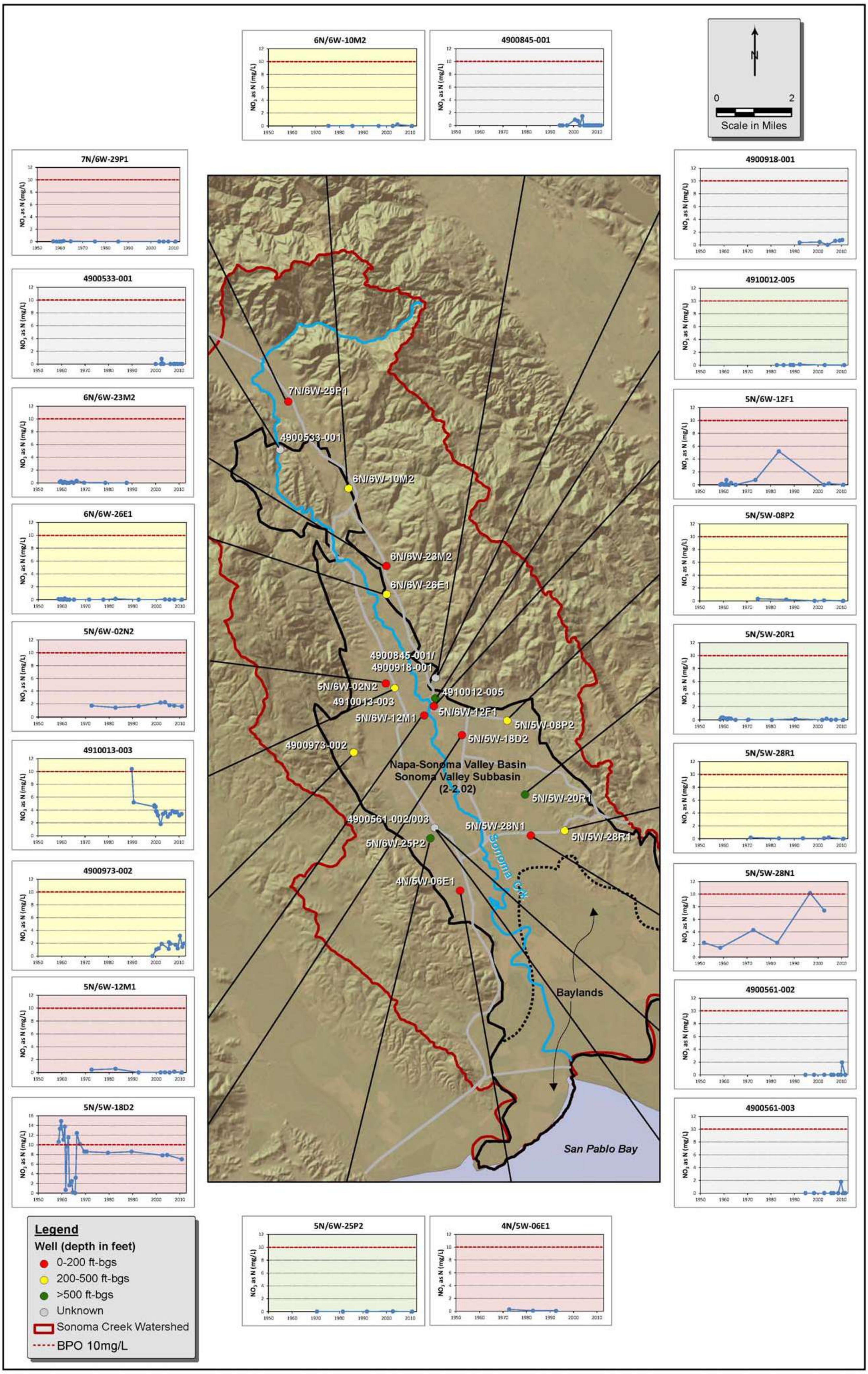


Figure 5-5: Time-Concentration Plots Nitrate as N



Chapter 6 Source Identification and Loading Analysis

An analysis of salt and nutrient loading occurring due to surface activities is presented to identify sources of salt and nutrients, evaluate their linkage with the groundwater system, and estimate the mass of salts and nutrients loaded to the Sonoma Valley groundwater subbasin associated with those sources.

Salt and nutrient loading from surface activities to the Sonoma Valley groundwater basin are due to various sources, including:

- Irrigation water (potable water, surface water, groundwater, and recycled water)
- Agricultural inputs (fertilizer, soil amendments, and applied water)
- Residential, commercial, and industrial inputs (septic systems, fertilizer, soil amendments, and applied water)
- Animal waste (dairy manure land application)

Most of these sources, or "inputs", are associated with rural and agricultural areas except for turf irrigation in commercial and industrial areas. Urban area salt and nutrient loads (e.g. due to indoor water use) are assumed to be primarily routed to the municipal wastewater system for recycling or discharge rather than to groundwater, except for landscape irrigation. Other surface inputs of salts and nutrients, such as atmospheric loading, are not considered a significant net contributing source of salts and nutrients and are not captured in the loading analysis. In addition to surface salinity inputs, potential subsurface inputs of high salinity waters from San Pablo Bay, thermal water upwelling and connate groundwater exists within the basin.

6.1 Methodology for Loading Model

To support the Sonoma Valley SNMP and to better understand the significance of various loading factors, a GIS-based loading model was developed. The loading model is a simple, spatially based mass balance tool that represents TDS and nitrogen loading on an annual-average basis. Calibration of the model was limited to focusing on comparing recent historical trends to changes in concentrations estimated through incorporating the loading model results into the mixing model. In addition to the limited calibration activities, extensive stakeholder coordination was performed to refine the parameters in the loading model, including land use, applied water, TDS and nitrogen application (in applied water, as fertilizers and amendments, and in land applied manure), irrigation water source quality, and sewer service areas (to determine septic loads). Given these activities, the model is considered suitable for this analysis of basin conditions.

Primary inputs to the model are land use, irrigation water source and quality, recycled water storage pond locations and percolation, septic system areas and loading, and soil characteristics. These datasets are described in the following sections. The general process used to arrive at the salt and nutrient loads was:

- Identify the analysis units to be used in the model. In the case of Sonoma Valley, parcels from the Sonoma County Assessor's Office are the analysis units.
- Categorize land use into discrete groups. These land use groups represent land uses that have similar water demand as well as salt and nutrient loading and uptake characteristics.
- Apply the land use group characteristics to the analysis units.
- Apply the irrigation water source to the analysis units. Each water source is assigned concentrations of TDS and nitrogen.
- Apply the septic system assumption to the analysis units.
- Apply the soil texture characteristics to the analysis units.
- Estimate the water demand for the parcel based on the irrigated area of the parcel and the land use group.

- Estimate the TDS load applied to each parcel based on the land use practices, irrigation water source and quantity, septic load, and infrastructure load. The loading model makes the conservative assumption that no salt is removed from the system once it enters the system. Other transport mechanisms (such as runoff draining to creeks exiting the basin) likely reduce the total quantity of salt in the subbasin.
- Estimate the nitrogen load applied to each parcel based on the land use practices, irrigation water source and quantity, septic load, and infrastructure (e.g. wastewater ponds) load. The loading model assumes that a portion of the applied nitrogen is taken up by plants and (in some cases) removed from the system (through harvest of plant material). Additional nitrogen is converted to gaseous forms and lost to the atmosphere. Remaining nitrogen is assumed to convert to nitrate and to be subject to leaching. Soil texture is used to estimate and account for mobility of leaching water and the efficiency of nitrate transport through the root zone.

6.2 Data Inputs

Data inputs to the model include the spatial distribution of land uses (with associated loading factors), irrigation water sources (with associated water quality), septic inputs, wastewater infrastructure loads, and soil textures. These inputs are summarized below, and are further described in the *Salt and Nutrient Source Identification and Loading* TM (RMC, 2013).

6.2.1 Land Use

Land use data were obtained from the 2012 Sonoma County Assessor's Office parcel dataset. This dataset contains several hundred discrete land use categories. These categories are consolidated into the following land use groups for the Sonoma Valley subbasin area:

- Flowers and nursery
- Pasture
- Vines
- Other row crops
- Dairy production areas
- Other livestock operations
- Non-irrigated vines
- Non-irrigated field crops
- Non-irrigated orchard
- Shrub/Scrub
- Grassland/ Herbaceous
- Barren land
- Farmsteads
- Urban commercial and industrial
- Urban commercial and industrial, low impervious surface (e.g. maintenance yards, schools)
- Urban landscape/golf course
- Urban residential
- Paved areas (roads and parking lots)

Local stakeholders and SNMP partners confirmed that the land use is substantially unchanged since the 2012 dataset, within the accuracy requirements of this type of analysis. The spatial distribution of land uses is shown in Figure 6-1. Upon review of the land use dataset, stakeholders provided updates to the dairies and grassland/herbaceous categories in the October 10, 2012 SNMP Workshop with the SVGMP's TAC. Because there are so many distinct categories, a discrete color for each type could not be assigned. Therefore, land use categories with similar characteristics (i.e. urban, non- irrigated agriculture, irrigated agriculture) are shown combined into a color category.

Each land use group is assigned characteristics including:

- Applied water
- Percent irrigated
- Applied nitrogen

- Used nitrogen
- Leachable nitrogen
- Applied TDS

Leachable nitrogen is assumed to be the applied nitrogen less 10 percent of the applied nitrogen for gaseous loss, less nitrogen removal in harvested plant material. Table 6-1 consists of a matrix of values for the land use categories and characteristics. These values were also presented to the stakeholder group and refined based on their input. Refinements included adjustments to vineyards, farmsteads/rural residential, and non-irrigated field crops. For vineyards, coordination with stakeholders included modification to applied TDS and irrigation volume to reflect practices in the area. For farmsteads/rural residential, modifications were made to applied TDS, applied N, and irrigation volume based on improved understanding of land uses on these diverse parcels. Finally, non-irrigated field crops were given the non-irrigated designation based on stakeholder input on the farming practices of what are generally small-grain hay crops in the southern portion of the basin.

Figure 6-1: Land Use

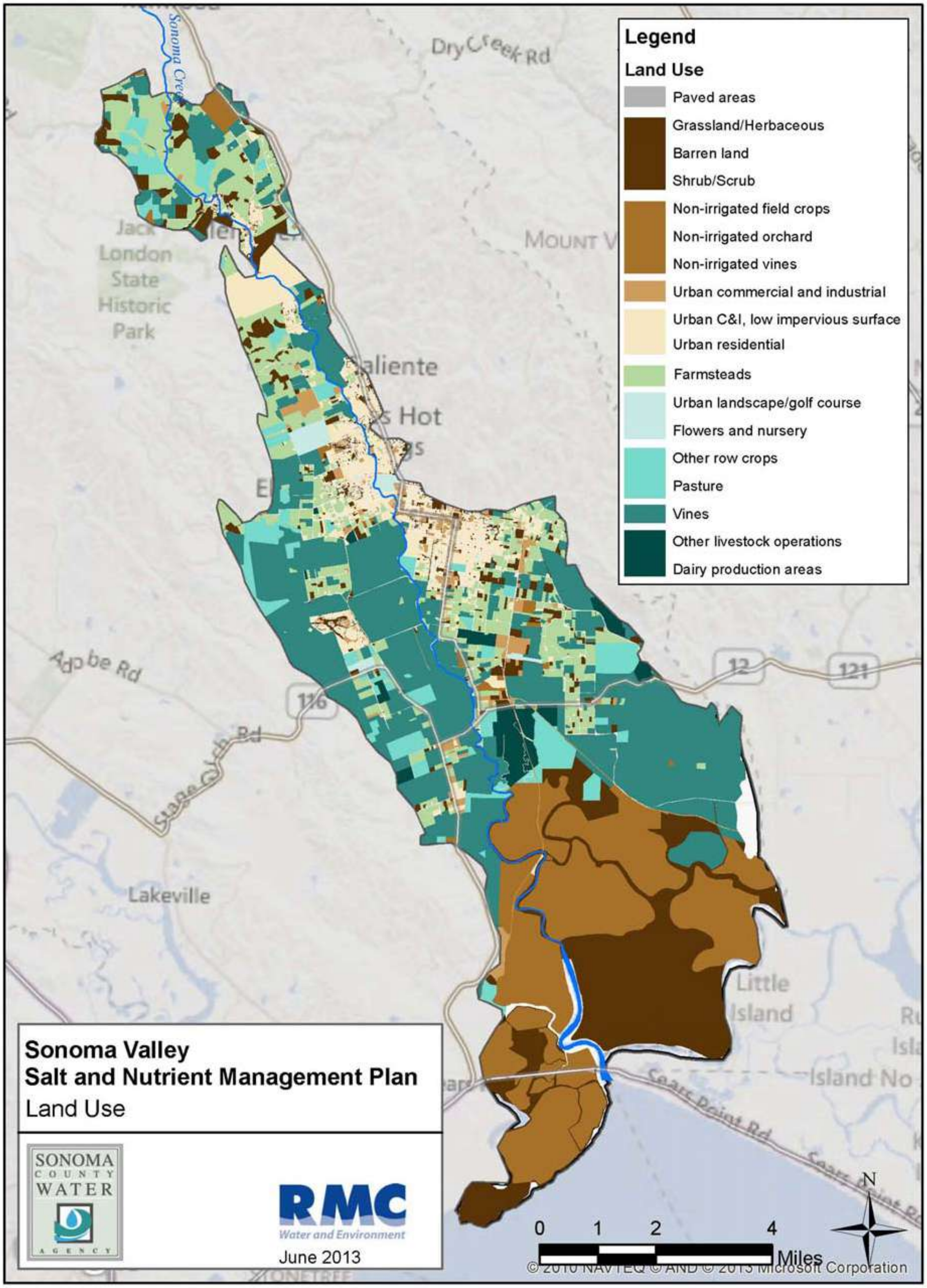


Table 6-1: Land Use Related Loading Factors

Land Use Group	Total Area (acres)	Percent Cultivated[1]	Applied Water[2] (in/yr)	Applied Nitrogen[3] (lbs/acre-year)	Nitrogen Uptake[4] (lbs/acre-year)	Leachable Nitrogen[5] (lbs/acre-year)	Applied TDS[6] (lbs/acre-year)
Paved Areas (roads and parking lots)	28	0%	0	0	0	0	0
Grasslands/Barren/ Herbaceous	7,212	0%	0	0	0	0	0
Non-irrigated vines	284	80%	0	18	16	0	84
Non-irrigated Orchard	41	80%	0	75	60	8	292
Non-irrigated field crops (hay)	8,489	80%	0	34	22	8	170
Urban Commercial and Industrial	1,018	5%	48.5	92	60	23	657
Urban C&I, Low Impervious Surface	807	30%	48.5	92	60	23	438
Farmsteads/Rural-Residential[7]	5,608	10%	28.7	60	42	13	303
Urban Residential	2,238	15%	51.1	92	60	23	438
Urban Landscape/Golf Course	327	75%	48.5	92	60	23	584
Pasture	2,266	40%	51.1	110	90	14	584
Vines[8]	13,075	100%	6.3	29	23	3	168
Other Livestock Operations	102	10%	0.0	84	-	75	730
Dairy[9]	769	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

1 Percent of land area assumed to be cultivated within each class is estimated is based review of aerial photography and agricultural scientist professional judgment of a reasonable, broad average for each class.

2 Applied water values and other climatic data are taken from Department of Water Resources (DWR) land and water use data (http://www.water.ca.gov/landwateruse/anlwuest.cfm). On this website, four years of data are available. Climatic data averages, based on these four years of data, was compared to the 21-year average of available CIMIS climatic data for the Sonoma Valley area. As the two data sets correspond well, the average DWR applied water values were used, with some adjustment using crop coefficients for the Sonoma Valley area to fit the study land use classes.

3 Applied nitrogen estimates are based on literature review for individual land cover classes and professional judgment. Applied nitrogen was then calculated for total acreage and checked against fertilizer sales records for Sonoma County (available from the California Department of Food and Agriculture). Application rates were then scaled to match sales records, and adjusted if appropriate based on discussions with growers in the region.

4 Uptake of nitrogen was estimated from available literature by multiplying reported yield figures by reported nitrogen concentrations for harvested plant parts. Balances between uptake and application were checked to ensure that nitrogen use efficiencies were in the reported ranges, adjusted for professional knowledge of irrigation and fertilization practice in each land cover class.

5 Maximum nitrogen leaching calculations for each land cover unit were calculated based on the balance between application, gaseous loss (volatilization and denitrification), and uptake. The maximum was then reduced based on soil conditions mapped for the area.

6 Applied TDS estimates are based on literature review for individual land cover classes and professional judgment. Applied TDS was then calculated for total acreage and checked against amendment sales records for Sonoma County (available from the California Department of Food and Agriculture). Application rates were then scaled to match sales records. Amendment application rates were adjusted if appropriate based on discussions with growers in the region.

7 Farmstead irrigated areas are assumed to be a mix of turf grasses and vineyards.

8 Assumes that irrigated vines have a larger percent cultivation due to increased production efficiency from irrigation and a conservative value of 100% cultivation was used. An additional assumption for vines is that vines irrigated with recycled water utilize the same fertilizer and amendment application rates as those irrigated with groundwater (conservative estimate).

9 See discussion on dairy parcels below.

Due to the importance of dairies, some additional consideration is applied to dairy parcels. To better reflect land use practices, the applied, used, and leachable nitrogen characteristics and the applied TDS characteristic are further subdivided into production areas, ponds, and land application areas. Leachable nitrogen is calculated the same way as for the other land use groups except that gaseous loss is assumed to be 20 percent, as opposed to the 10 percent assumed loss for other land use groups, mainly due to the regular timing and highly organic nature of applied nitrogen.

Table 6-2: Assumed Characteristic Dairy Values for the Loading Model

Dairy Subdivision Designation	Percent of Total Parcel Area Used Per Designation	Applied Nitrogen **(lbs/acre-year)**	Used Nitrogen **(lbs/acre-year)**	Leachable Nitrogen **(lbs/acre-year)**	Applied TDS **(lbs/acre-year)**
Production Area	6%	20	0	8	82
Ponds	1%	141	0	113	933
Land Application Area	93%	367	352	30	1,280

6.2.2 Irrigation Water Source

The irrigation water source forms the basis to determine the TDS and nitrate loads that result from irrigation of the land uses described above. Source water quality for any given parcel was identified based on the location of the parcel relative the water retailers in the area. Parcels not supplied by potable municipal water sources or recycled water are assumed to obtain irrigation water from local groundwater wells. Table 6-3 summarizes the water quality inputs used for each irrigation water source.

Table 6-3: Water Quality Parameters for Loading Model Water Sources

Source	TDS (mg/L)	Nitrate (as N) (mg/L)
Valley of the Moon Water District	162	0.2
City of Sonoma	172	0.4
Groundwater	372	0.1
Recycled Water	440	5.2

6.2.3 Septic Systems

Salt and nutrient loads due to septic systems were estimated based on typical wastewater production and TDS and nitrate concentrations. It has been assumed that parcels outside of the SVCSD Service Area use a septic system or multiple systems. Of those parcels, septic systems are assumed where a residence is identified in the land use dataset. Each parcel with a septic system is assumed to produce 263 gallons per day (gpd), based on 75 gpd/person with 3.5 people per system. The 75 gpd/person estimate is based domestic use quantity estimates per California Code of Regulations, Title 23, Section 697. An estimate of 3.5 persons per household is a conservative estimate which assumes that household size for homes with septic is larger than that that of homes within the City (per the census bureau, persons per household for

2007-2011 is 2.54 in Sonoma County, with the City at only 2.07 people per household, therefore the outlying areas must be greater than 2.54 persons per household).The septic waste is assumed to have TDS concentrations of 572 mg/L, based on typical groundwater concentrations plus an assumed household contribution of 200 mg/L (Metcalf & Eddy, 2003 Table 3-7). Nitrate-N concentrations were assumed to be 30 mg/L, based on typical wastewater concentrations for medium strength wastewater (Metcalf & Eddy, 2003) of 40 mg/L minus an assumed volatization rate of 25% within the septic system.

6.2.4 Wastewater/Recycled Water Infrastructure

SVCSD operates five recycled water ponds within the groundwater basin; these are indicated in Attachment 1 of Appendix D. Two of the ponds use clay liners, while the other three ponds use plastic liners. Due to the liners, it is assumed that no significant loading occurs at pond locations. It is also assumed that leakage from wastewater (sanitary sewer) and recycled water pipelines is not likely to be a significant source of salt and nutrient loading.

An effort was also undertaken to quantify potential salt and nutrient loading from winery wastewater ponds. These ponds are often lined with plastic or clay and contain rinsewater with salt and TDS concentrations similar to the source water (likely groundwater), because no additional salts and nutrients are added in the winemaking process. This effort showed that salt and nutrient loading from these ponds were likely negligible, with biological oxygen demand (BOD) the primary concern. These loads were not included in the model, beyond the loads already included through irrigation of the vineyards.

6.2.5 Soil Textures

Soil textures (NRCS, 2013) were obtained from the Soil Survey of Sonoma County (SCS, 1972). Soil textures were assigned a hydraulic conductivity (NRCS, 1993). Hydraulic conductivity was used to develop an adjustment factor through linearly scaling the estimated conductivities from 0.1 (lowest) to 1.00 (highest). The adjustment factor is used to represent the proportion of nitrate that will migrate to the aquifer, relative to the other textural classes. Where conductivity is lower, it is reasoned (and observed) that nitrogen resides longer in the soil, increasing the proportion that is either taken up or lost through conversion to gaseous species. Similar logic is not applied to TDS as salts are mostly not subject to conversion to gaseous forms, and rapidly saturate soil capacity to absorb and retain them.

6.3 Loading Model Results

Based on the loading parameters and methodology described above, the loading model is used to develop TDS and nitrogen loading rates across the subbasin. Table 6-4 summarizes the overall contribution of each land use group to total TDS and nitrogen loading. The spatial distribution of TDS and nitrogen loading rates are shown in Figure 6-2 and Figure 6-3, respectively. The loading analysis estimates somewhat higher loading of TDS in the rural and agricultural areas of the subbasin, while nitrate loading is higher in the urban areas largely due to the low nitrogen application rates on vineyards.

Figure 6-2: TDS Loading in Study Area

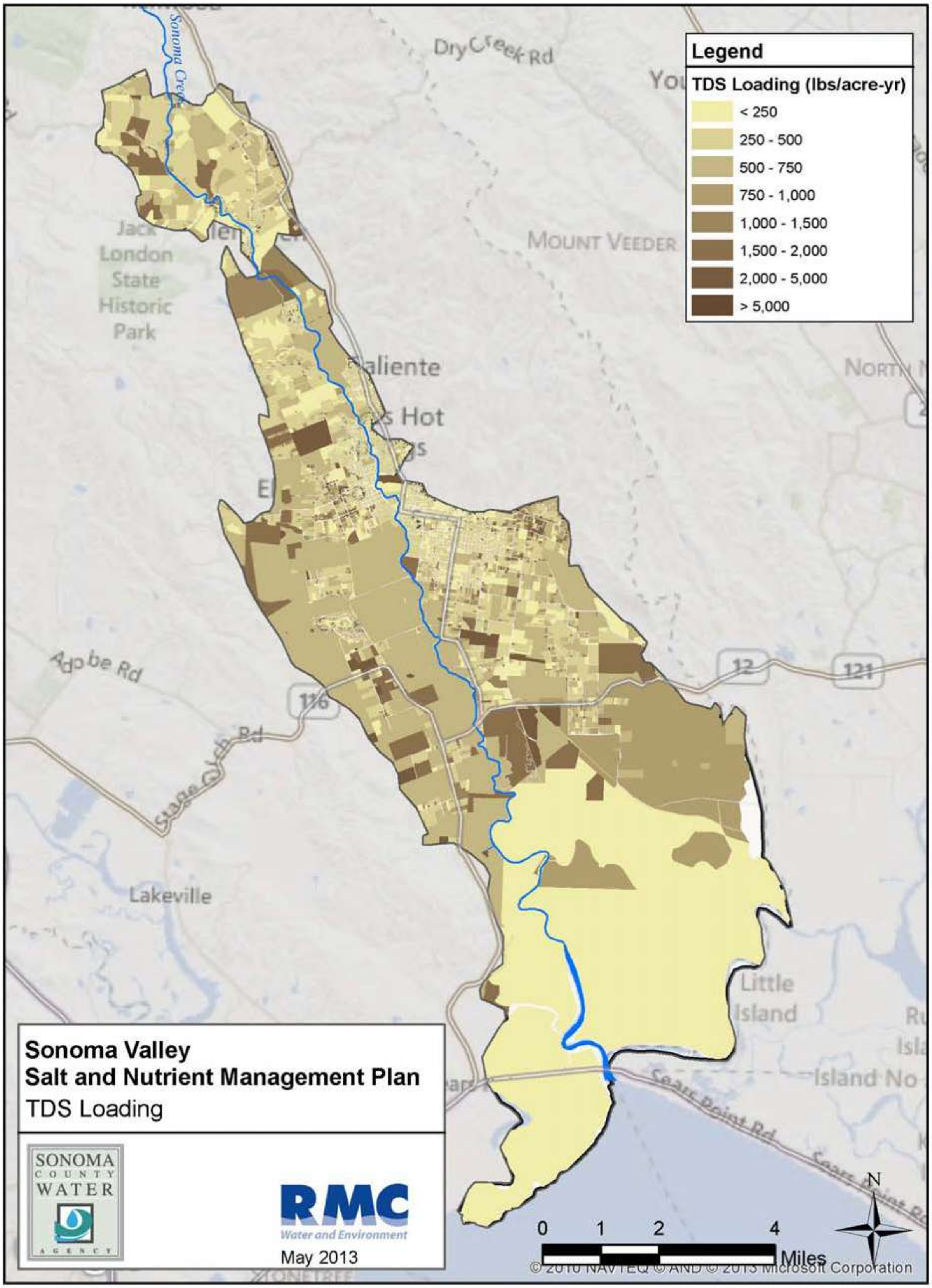


Figure 6-3: Nitrate Loading in Study Area

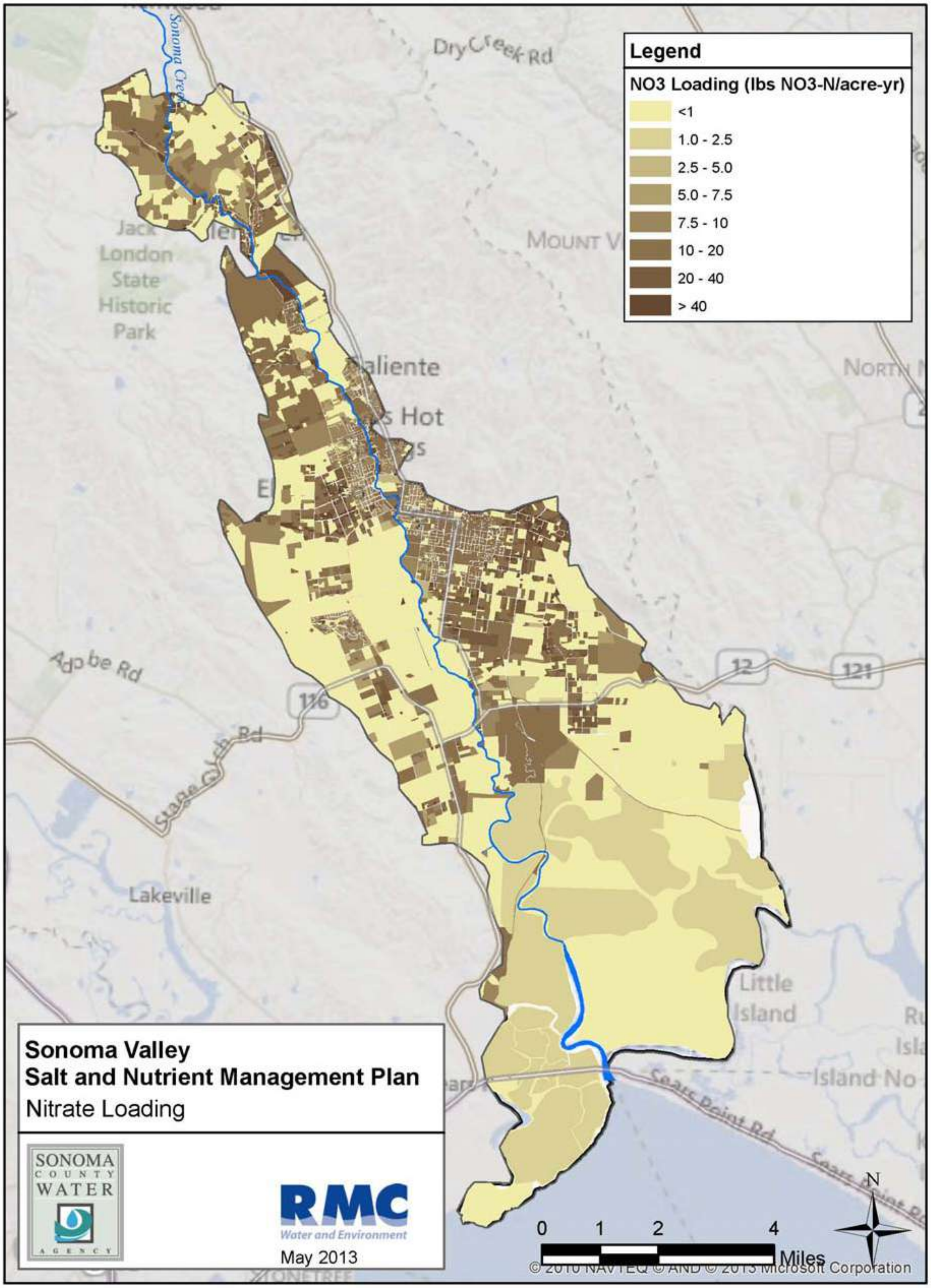
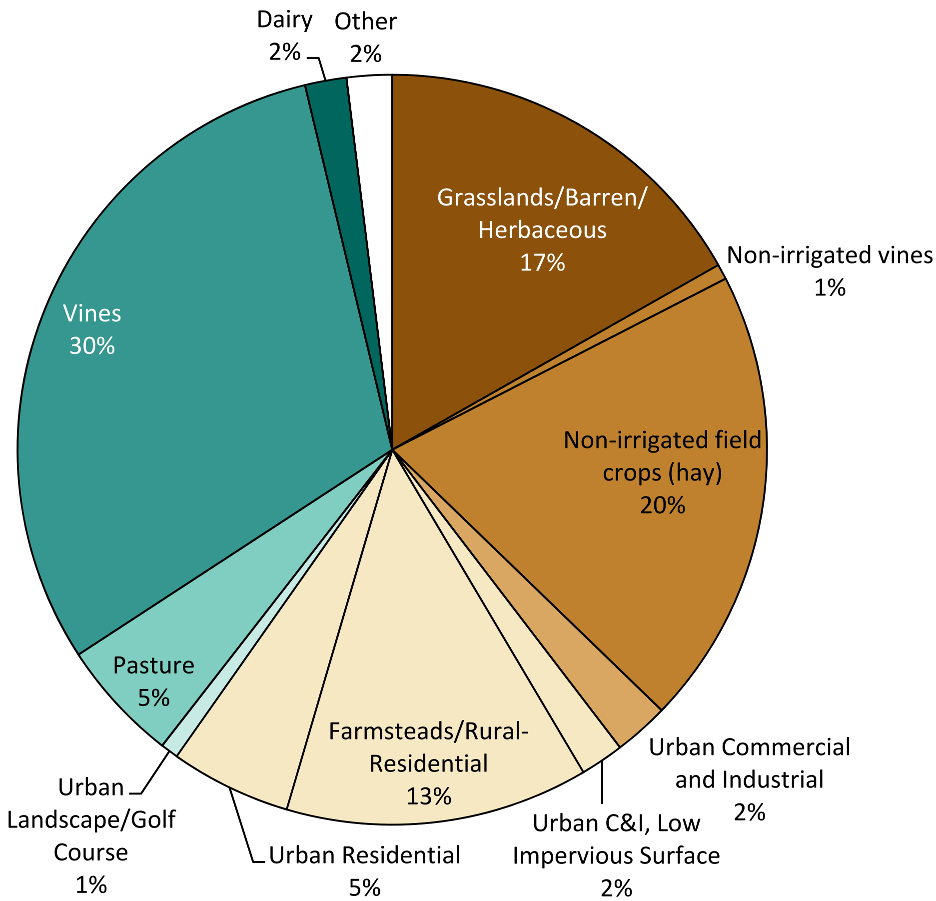


Table 6-4: TDS and Nitrate Loading Results

Land Use Group	Total Area **(acres)**	Percent of Total Area	Percentage of Total TDS Loading	Percentage of Nitrogen Loading
Paved Areas (roads and parking lots)	28	0%	0%	0%
Grasslands/Barren/ Herbaceous	7,212	17%	0%	0%
Non-irrigated vines	284	1%	0%	0%
Non-irrigated Orchard	41	0%	0%	0%
Non-irrigated field crops (hay)	8,489	20%	5%	6%
Urban Commercial and Industrial	1,018	2%	1%	8%
Urban C&I, Low Impervious Surface	807	2%	5%	7%
Farmsteads/Rural-Residential	5,608	13%	11%	37%
Urban Residential	2,238	5%	6%	22%
Urban Landscape/Golf Course	327	1%	5%	1%
Pasture	2,266	5%	17%	10%
Vines	13,075	31%	42%	3%
Other livestock operations	102	0%	0%	0%
Dairy	769	2%	7%	5%

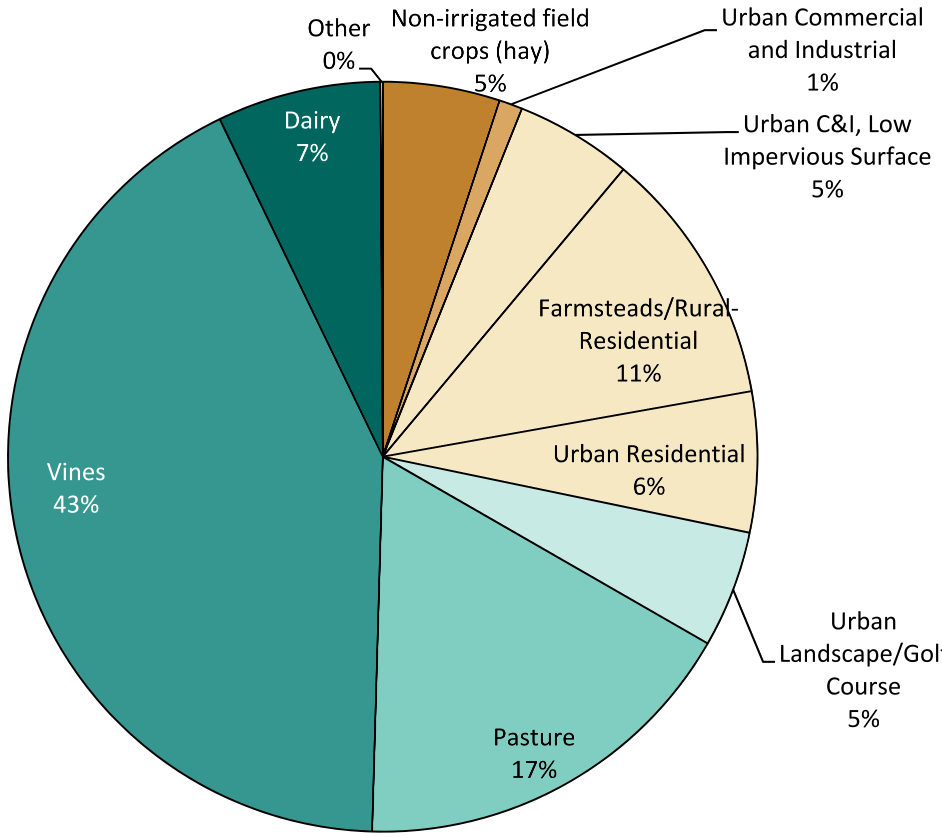
The relative proportion of the land uses by area, nitrogen loading, and TDS loading are shown in Figure 6-4, Figure 6-5, and Figure 6-6, respectively.

Figure 6-4: Percentage of Land Use in Study Area



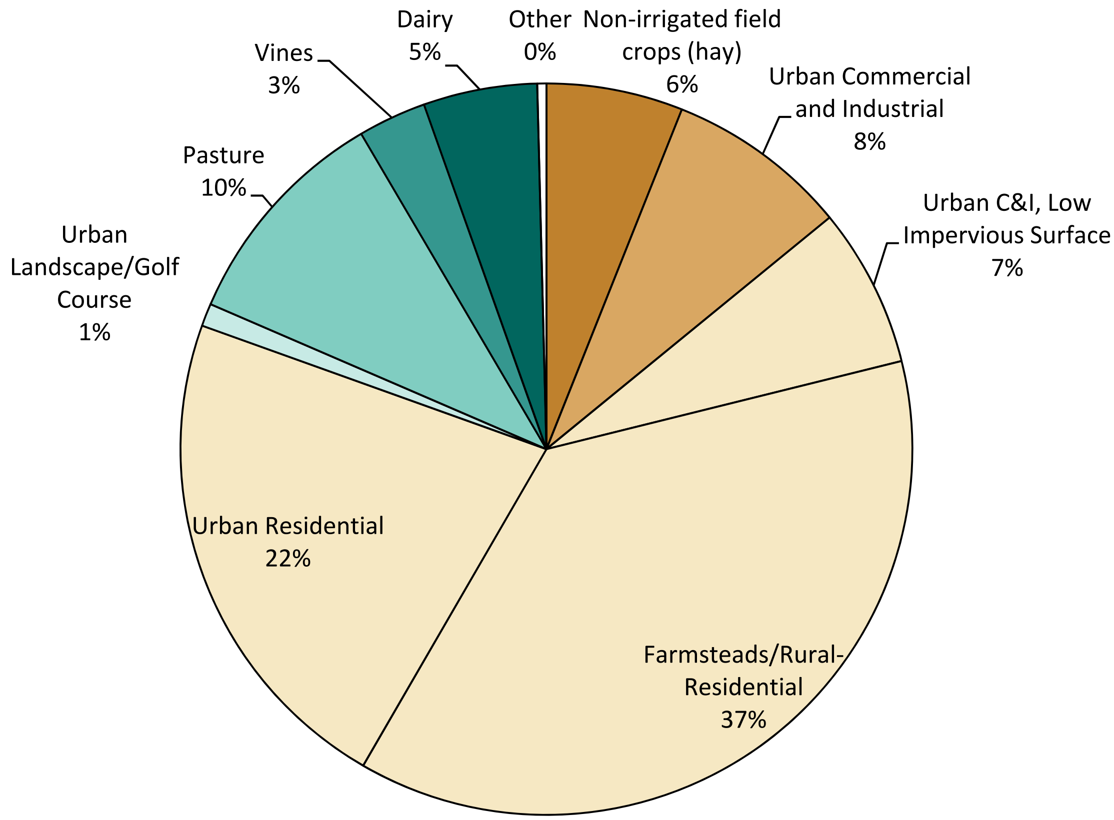
Other: Categories contributing less than 1% of land area: paved areas, non-irrigated orchards, livestock operations

Figure 6-5: Percentage of TDS Loading in Study Area, by Land Use



Other: Categories contributing less than 1% of TDS loading: paved areas, grasslands/barren/shrubs, non-irrigated vines, non-irrigated orchards, livestock operations

Figure 6-6: Percentage of Nitrogen Loading in Study Area, by Land Use



Other: Categories contributing less than 1% of nitrogen loading: paved areas, grasslands/barren/shrubs, non-irrigated vines, non-irrigated orchards, livestock operations

Chapter 7 Future Groundwater Quality Analysis

This chapter describes the development and results from the future groundwater quality analysis. The future groundwater quality analysis is described in more detail in the *Existing and Future Groundwater Quality TM* (Todd, 2013) included as Appendix A.

7.1 Simulation of Baseline and Future Groundwater Quality

Groundwater quality concentrations for TDS and nitrate are simulated for the baseline period and future planning period using a mixing model. Concentration estimates are based on water and mass inflows and outflows (balances) mixed with the volume of water in the aquifer and the average ambient groundwater quality. The baseline period is from WY 1997 to 2006. This baseline period was selected based on the period for which water balances were available from the USGS (2006) groundwater flow model and updated groundwater model (Bauer, 2008). The future planning period is from WY 2014 to WY 2035 based on the planning horizon in supporting planning documents.

The baseline period water balances estimate all groundwater inflows and outflows for the baseline period and the associated change in storage based on estimates provided in the groundwater model and updated model. Future changes simulated include increased use of recycled water for irrigation.

TDS and nitrate concentrations are associated with each water balance inflow and outflow component. In order to simulate the effect of current and future salt and nutrient loading on groundwater quality in the Sonoma Valley Subbasin, the spreadsheet mixing model mixes the volume and quality of each inflow and outflow with the existing volume of groundwater and mass of TDS and nitrate in storage and tracks the annual change in groundwater storage and salt and nutrient mass for the baseline and future planning period. The existing volume of water in the groundwater basin is calculated based on the subbasin or subarea (Inland and Baylands) surface areas, a uniform saturated thickness of 400 feet and a porosity of 0.1. The mixing model produces an average TDS and nitrate concentration for each year of the baseline and future planning period.

7.2 Use of Assimilative Capacity by Recycled Water Projects

In accordance with the Policy, a recycled water irrigation project that meets the criteria for a streamlined irrigation permit and is within a basin where a SNMP is being prepared, may be approved by the Regional Water Board by demonstrating through a salt and nutrient mass balance or similar analysis that the project uses less than 10% of the available assimilative capacity (or multiple projects use less than 20% of available assimilative capacity). Accordingly, the recycled water irrigation projects in place and planned for the Sonoma Valley Subbasin are assessed in terms of their use of available assimilative capacity.

7.3 Baseline Period Analysis

The baseline period water balance tracks groundwater inflows and outflows and storage changes from WY 1996-97 through WY 2005-06. This period represents a recent time period characterized by average climatic conditions. The primary source of information used to develop the water balance is the Sonoma Valley groundwater flow model. The flow model was originally developed by the USGS (2006) and later updated by Bauer (2008). Groundwater recharge from natural precipitation in the flow model for the baseline period represented 94% of the natural recharge over the historical flow model period.

Major inflows accounted for in the baseline water balance include:

- deep percolation of precipitation and mountain front recharge,
- natural stream recharge,
- agricultural irrigation water return flow,
- domestic/municipal irrigation water (including recycled water) return flow,

- septic system return flow, and
- subsurface groundwater inflow (from Baylands Area)

Major outflows accounted for in the water balance include:

- groundwater pumping,
- groundwater discharge to streams, and
- subsurface groundwater outflow (to Baylands Area)

Areal anthropogenic recharge sources (return flows from agricultural and municipal irrigation and septic systems) are not independently considered in the flow model but instead subsumed within the model aerial recharge rates. Model areal recharge rates were apportioned into natural sources (precipitation) and anthropogenic sources (return flows) based on the results of the salt and nutrient loading evaluation conducted for the SNMP (RMC, 2013).

7.3.1 Water Quality of Inflows and Outflows

Initial and adjusted TDS and nitrate concentration estimates for subbasin inflows and outflows in the water balance are described below followed by a discussion of the baseline mixing model calibration and results.

Sonoma Creek Leakage

TDS and nitrate data from available surface water quality monitoring stations in the watershed were assessed to characterize the water quality of stream leakage from Sonoma Creek, the second largest subbasin inflow. Based on recent water quality sampling a constant TDS concentration of 210 mg/L and constant nitrate-N concentration of 0.19 mg/L was applied to Sonoma Creek leakage for the baseline period.

Deep Percolation of Areal Precipitation and Mountain Front Recharge

Recharge from deep percolation of areal precipitation and mountain front recharge represents 65% of total subbasin inflows and is the primary controlling salt and nutrient load factor. Generally, precipitation contains minimal salts and nutrients. However, due to its low solute content, precipitation also dissolves (or leaches) salts and nutrients along its subsurface flow path from near-surface soils through the vadose zone sediments and saturated zone sediments. The degree of leaching is dependent on numerous site-specific factors and is difficult to predict reliably. Based on available groundwater quality wells located in the watershed, nitrate deposition information, and mixing model calibration, a constant concentration of 250 mg/L TDS and 0.06 mg/L nitrate-N was applied to deep percolation of areal precipitation and mountain front recharge was applied.

Return Flows – Agricultural (Groundwater and Recycled Water), Municipal, and Septic System

Salt and nutrient loads from agricultural, municipal, and septic sources are described in Chapter 6 - Source Identification and Loading Analysis. For the mixing model, the TDS and nitrogen mass load for each return flow component was mixed with its respective annual return flow volume to obtain a concentration. For the loading estimate, it was conservatively assumed that all nitrogen mass is converted to nitrate. Based on initial simulation results for the baseline period, nitrate loading from return flows was reduced by 15% to account for attenuation processes beneath the soil root zone and septic system, in order to provide a better match between simulated average concentrations and observed regional trends.

Table 7-1 shows the initial calculated and adjusted (during calibration) TDS and nitrate mass and concentrations for each return flow component. The adjusted concentrations are applied as a constant concentration over the baseline period.

Table 7-1: Return Flow TDS and Nitrate-N Mass and Concentrations for Baseline Period Analysis

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	1,415	**4,347**	**28.0**	**23.8**
Agricultural (Recycled Water) Irrigation	91	**4,344**	**28.0**	**23.8**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,552**	**27.0**	**23.0**

[1]Initial TDS and nitrate concentrations calculated from mass loading estimates in *Salt and Nutrient Source Identification and Loading TM* (RMC, 2013). Initial TDS concentrations for return flows were not adjusted during calibration. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.

As shown in Table 7-1, the initial and final adjusted TDS concentration of agricultural irrigation water (groundwater and recycled water source water) at about 4,300 mg/L is the highest of the return flow components. Differences between agricultural return flow concentrations/mass for groundwater and recycled water are attributable to differences in source water quality. The TDS concentration of municipal irrigation water (1,182 mg/L) is lower than for agricultural irrigation. Septic system return flows have the lowest TDS concentration (572 mg/L) compared to the irrigation return flows. Overall, the volume weighted-average TDS concentration of the irrigation and septic system return flows is 2,552 mg/L.

Subsurface Inflows from Baylands Area

While groundwater levels and the flow model-based water balance indicate that subsurface groundwater flows generally from the Inlands area to the Baylands Area, there is a small component of subsurface inflow from the Baylands Area. This is likely caused by groundwater pumping, which has created a pumping depression in the southern portion of the subbasin.

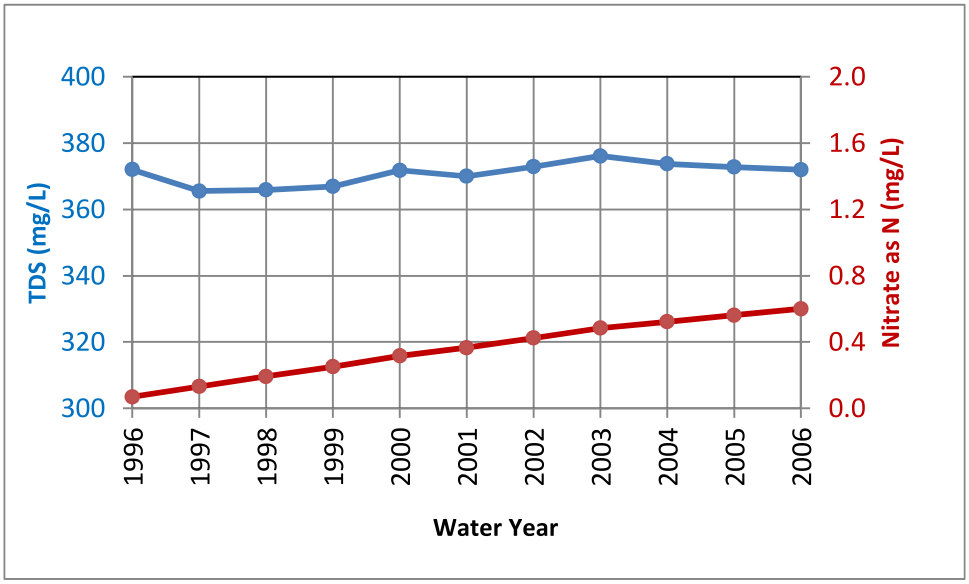
The concentrations applied to subsurface inflows from the Baylands Area were assumed to be the current average concentration in the Baylands Area (1,220 mg/L for TDS and 0.07 mg/L for nitrate-N).

7.3.2 Mixing Model Calibration and Salt and Nutrient Balance

In order to simulate the effect of current salt and nutrient loading on groundwater quality in the Inland Area of the subbasin, a spreadsheet mixing model was developed. In the mixing model, the simulated baseline period concentrations and trends were compared to the predominant pattern of observed concentrations and trends. From this comparison, loading factors were adjusted (calibrated) to achieve a better match between simulated and observed concentrations and trends.

Figure 7-1 shows the final simulated average subbasin TDS and nitrate concentrations over the 10-year baseline period (WY 1996 represents the hypothetical initial water quality condition equivalent to the current ambient condition).

Figure 7-1: Final Simulated Baseline Average Groundwater Concentrations for Inland Area of Sonoma Valley Subbasin (WYs 1997-2006)



As shown in the figure, simulated average subbasin TDS concentrations vary slightly from year to year, but exhibit no change over the 10-year baseline period. This flat trend compares well to observed flat trends in wells across the subbasin over the baseline period.

In contrast to the TDS trend, simulated average nitrate-N concentrations increase by about 0.5 mg/L over the baseline period, despite nitrate loading from return flows being reduced by 15% to account for additional attenuation below the root zone/septic system. Observed nitrate concentrations in monitoring wells across the subbasin are not increasing regionally, but instead show overall flat or stable concentrations over time. The discrepancy between simulated and observed trends may be caused by an overestimate of the nitrate load due to one or more of the following:

1. Assumption that 100% of nitrogen is converted to nitrate
2. Potential underestimation of ambient average groundwater nitrate concentrations due to limited spatial distribution of wells with recent nitrate data
3. Application of all nitrate loading associated with recycled water use within the Inland Area in the mixing model, despite portions of existing (and proposed future) recycled water use areas being located south of the Inlands area in the Baylands area (see Figure 2-1)
4. Underestimation of nitrate attenuation below the root zone/septic system in the mixing model

For the reasons mentioned above, simulated nitrate concentrations generated from the calibrated mixing model are likely conservative and overestimated for both baseline and future nitrogen loading. While application of higher nitrate attenuation rate was considered, given the limited distribution of monitoring wells with long-term nitrate trend data in the subbasin, a 15% attenuation rate was maintained.

7.4 Future Planning Period Water Quality

The spreadsheet mixing model developed for the baseline analysis was modified to evaluate the effects of planned future salt and nutrient loading on overall groundwater quality in the Sonoma Valley Subbasin for the future planning period (WY 2013-14 through WY 2034-35). Future project changes are superimposed over average water balance conditions during the 10-year baseline period (described above) to simulate future groundwater quality.

The mixing model is used to predict future water quality, water quality trends, and the percentage of the existing available assimilative capacity used by recycled water projects in the subbasin during the future planning period. The mixing model is designed to incorporate the existing volume of groundwater and mass of TDS and nitrate in storage and track the annual change in groundwater storage and salt and nutrient mass for the subbasin as a whole.

Three future scenarios were simulated:

- Future Scenario 0 (No-Project): Assumes average baseline water balance conditions and no additional enhanced stormwater capture and recharge is applied.
- Future Scenario 1: Assumes 2035 planned recycled water use of 4,100 AFY (applied consistently from WY 2013-14 through WY 2034-35)
- Future Scenario 2: Assumes 2035 planned recycled water use plus an additional 5,000 AFY of recycled water (applied consistently from WY 2013-14 through WY 2034-35).

7.4.1 Future Scenarios

The average TDS and nitrate concentrations for the baseline period were applied to all future scenarios for the following inflows:

- Deep percolation of areal precipitation and mountain front recharge
- Leakage from Sonoma Creek
- Subsurface inflow from Baylands area

Concentrations for future return flow components are described below.

Return Flows – Agricultural, Municipal Irrigation and Septic System

The same methodology used to estimate TDS and nitrogen loading from return flows over the baseline period was used to estimate future return flow loading.

Table 7-2 through Table 7-4 show the estimated TDS and nitrate mass and concentrations of each return flow for Scenario 0 (No-Project), Scenario 1, and Scenario 2, respectively. The adjusted values are applied as a constant concentration over the entire future planning period. For both TDS and nitrate, the total cumulative mass and weighted-average concentration of return flows increases slightly from Scenario 0 (No-Project) to Scenario 1 to Scenario 2.

Table 7-2: Future Scenario 0 (No-Project)

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	1,415	**4,347**	**28.0**	**23.8**
Agricultural (Recycled Water) Irrigation	91	**4,344**	**28.0**	**23.8**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,552**	**27.0**	**23.0**

[1]Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.

Table 7-3: Future Scenario 1 (2035 recycled water conditions)

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	998	**4,481**	**29.3**	**24.9**
Agricultural (Recycled Water) Irrigation	508	**4,479**	**29.3**	**24.9**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,615**	**27.6**	**23.5**

[1]Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.

Table 7-4: Future Scenario 2 (2035 recycled water conditions plus 5,000 AFY recycled water)

Return Flows	Volumetric Rate	Iniitial and Adjusted TDS Concentration[1]	Initital Nitrate-N Concentration[1]	Adjusted Nitrate-N Concentration[1]
	AFY	mg/L	mg/L	mg/L
Agricultural (Groundwater) Irrigation Return	374	**4,706**	**31.6**	**26.8**
Agricultural (Recycled Water) Irrigation	1,132	**4,706**	**31.6**	**26.8**
Municipal Irrigation	1,074	**1,182**	**23.9**	**20.3**
Septic System	621	**572**	**30.0**	**25.5**
Total	3,201			
Weighted-average		**2,722**	**28.7**	**24.4**

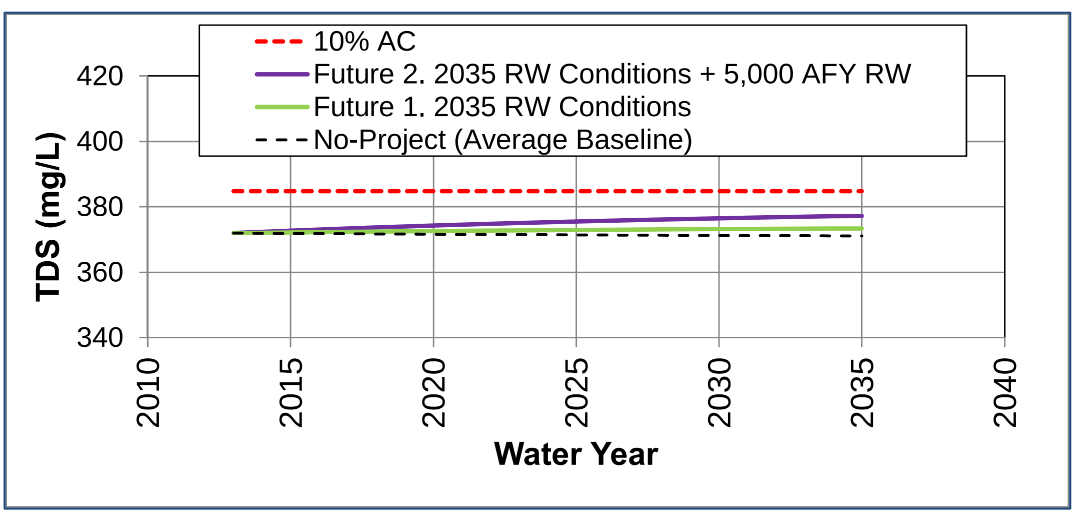
[1]Initial TDS concentrations for return flows were not adjusted for future simulations. Adjusted nitrate concentrations reflect 15% reduction to account for additional attenuation below the root zone/septic system in the mixing model.

7.4.2 Future Water Quality Results

TDS Groundwater Concentrations

Figure 7-2 shows the simulated future TDS concentrations from the calibrated mixing model for the three future scenarios from WY 2013-14 through 2034-35 for the Inland Area of the Sonoma Valley Subbasin. Also shown on the chart is the 10% assimilative capacity threshold.

Figure 7-2: Simulated Future Groundwater TDS Concentrations



The following conclusions can be made for future TDS groundwater concentrations:

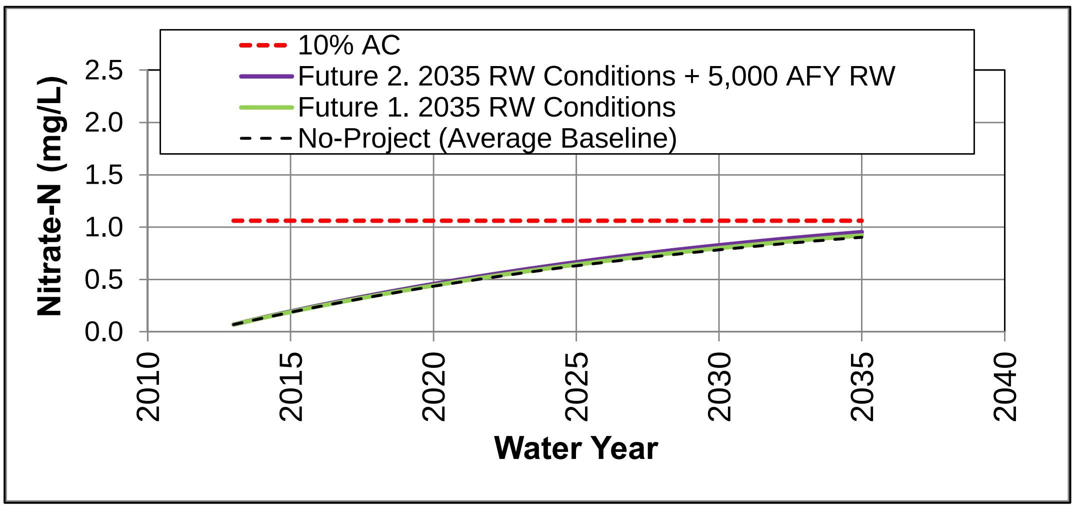
- Average TDS concentrations in the subbasin Inland Area are projected to decrease from WY 2013 through WY 2035 by 0.9 mg/L for Scenario 0 (No-Project).
- Average TDS concentrations in the subbasin Inland Area are projected to increase from WY 2013 through WY 2035 by 1.4 mg/L for Scenario 1 and by 3.5 mg/L for Scenario 2.
- For all three scenarios, recycled water projects use less than 10% of the available assimilative capacity, and projected TDS concentrations remain well below the BPO of 500 mg/L.

When considering the differences between Scenarios 1 and 2 and the No-Project Scenario (i.e., loading associated with the No Project components is removed), Scenarios 1 uses 1.8% (2.3 mg/L) of the available assimilative capacity, while Scenario 2 use 4.8% (6.1 mg/L) of the assimilative capacity.

Nitrate-N Groundwater Concentrations

Figure 7-3 shows the simulated results of the calibrated mixing model for nitrate for the three future scenarios from WY 2013-14 through 2034-35 for the Inland Area of the Sonoma Valley Subbasin. The chart shows the simulated concentration trends for each scenario and the 10% assimilative capacity threshold.

Figure 7-3: Simulated Future Groundwater Nitrate-N Concentrations



The following conclusions can be made for future nitrate-N groundwater concentrations:

- Average nitrate concentrations in the subbasin Inland Area are projected to increase similarly for all three scenarios from WY 2013 to WY 2035 (between 0.83 and 0.88 mg/L).
- For all three scenarios, recycled water projects use less than 10% of the available assimilative capacity, and projected nitrate concentrations remain well below the BPO of 10 mg/L.
- When considering the difference between Scenarios 1 and 2 and the No-Project Scenario (i.e., loading associated with the No Project components is removed), Scenarios 1 uses 0.2 % (0.02 mg/L) of the available assimilative capacity (9.93 mg/L), while Scenario 2 uses 0.5 % (0.05 mg/L) of the available assimilative capacity.

It is noted that projected increases in nitrate concentrations in the Inland area of the subbasin are considered conservative given the assumptions incorporated in the calibration of the mixing model for nitrate. Additionally, despite portions of existing and proposed future recycled water use areas being located south of the Inlands area in the Baylands area (see Figure 2-1), all TDS and nitrate loading associated with recycled water use was applied within the Inlands area in the mixing model and salt and nutrient balance. Average groundwater nitrate concentrations are predicted to increase asymptotically toward the volume-weighted average nitrate concentration of basin inflows for each scenario (1.31 mg/L for Scenario 0, 1.33 mg/L for Scenario 1, and 1.38 mg/L for Scenario 2).

Chapter 8 Implementation Measures

The findings from the technical analysis completed for the SNMP indicate that overall groundwater quality in the basin is stable with low salinity and nutrient values, well below the Regional Water Board's BPOs. Analysis of future water quality (through 2035) indicates good water quality and stable trends. Therefore, no new implementation measures or BMPs as part of the SNMP process are recommended at this time; however, the SNMP would like to endorse existing measures or practices already in place to manage groundwater quality in the basin and see that they continue.

8.1 Existing Implementation Measures and Ongoing Management Programs

Given that future groundwater quality concentration estimates are not expected to exceed BPOs for TDS and nitrate, and recycled water projects do not use more than 10% of the basin's assimilative capacity, no new implementation measures are recommended to manage salts and nutrients within the basin. Several programs are already underway in the basin, which help manage groundwater supplies and quality. These programs fall under five categories, as follows:

- Agricultural
- Recycled Water Irrigation
- Groundwater Management
- Onsite Wastewater Treatment System Management
- Municipal Wastewater Management

Implementation measures that are underway in the basin within these broad categories are described below.

8.2 Agricultural BMPs

Agricultural best management practices (BMPs) are categorized for vineyard, dairy or other agriculture below.

8.2.1 Vineyard

Land management practices within vineyards include various on-going BMPs. Several practices are listed below:

- Drip irrigation – water application is minimized by focusing the amount and area applied.
- Soil and petiole testing – it is common practice for vineyard managers to conduct annual soil testing to understand soil characteristics for grape production and flavor. Soil testing includes review of TDS and nitrate. Vineyard managers also typically test petioles to further refine vine nutrient needs.
- Focused application of fertilizer and soil amendments – application of salts and nutrients is limited to the area at the point of the irrigation drip emitter, rather than broadcast across a large area.

8.2.2 Dairy

Land management practices at dairy operations include various on-going BMPs. Several practices are listed below:

- Pavement and cover (roofing) in intensive manure areas to control runoff

- Spreading liquid manure at agronomic rates
- Manure application (solids) on vegetated fields – spreading on vegetated areas allows for greater uptake of nutrients by plants
- Organic dairies utilize larger land base for grazing area, allowing for greater uptake of nutrients.

8.2.3 Other Agriculture

In Sonoma Valley, the bulk of agriculture that is non-viticulture occurs mainly over the brackish groundwater area (referred to as "Baylands" area in the SNMP) and was not a focus for cataloging implementation measures.

8.3 Recycled Water Irrigation BMPs

The implementation of recycled water is regulated by the Title 22 California Code of Regulations (Title 22). Numerous BMPs and operating procedures are required to be followed when using recycled water for irrigation to ensure safety. The following BMPs are implemented in recycled water operations:

- Water quality monitoring at the treatment plant to ensure regulatory compliance with Title 22, and meet monitoring requirements for indicator emerging contaminants as part of the Recycled Water Policy.
- Irrigation at agronomic rates – irrigation is applied at a rate that does not exceed the demand of the plants and does not exceed the field capacity of the soil.
- Site Supervisor – a site supervisor who is responsible for the system and for providing surveillance at all times to ensure compliance with regulations and Permit requirements is designated for each site. The Site Supervisor is trained to understand recycled water, and supervision duties. In addition to monitoring the recycled water system, the Site Supervisor must also conduct an annual self-inspection of the system.
- Minimize runoff of recycled water from irrigation –Irrigation is not allowed to occur at any time when uncontrolled runoff may occur, such as during times of rainfall or very low evapotranspiration; and any overspray must be controlled.

8.4 Groundwater Management Plan – Ongoing Programs

The SVGMP set forth a management structure and process for conducting projects to maintain the health of the groundwater basin. The SVCSD will continue to participate with the SVGMP. Programs underway as part of the SVGMP, include the following:

- Basin-wide groundwater level monitoring
- Groundwater quality monitoring
- Installation and monitoring of two new multi-level groundwater wells
- Plans for additional monitoring well installation and development of grants to fund installation
- Groundwater banking study and pilot-project
- Stormwater management-groundwater recharge study and pilot-project
- Encouraging LID to increase stormwater recharge and limit nutrient loading to runoff. The County of Sonoma has an LID Design Manual which requires capture and treatment requirements for runoff at new construction of a certain size, and the Southern Sonoma County Resource Conservation District developed a "Slow It, Spread It, Sink It" guidance manual for stormwater management.

- Offstream infiltration study and project
- Water recycling projects to offset groundwater pumping
- Public Outreach Plan
- Seepage runs to understand basin water balance inflow and outflows
- Development of a rainfall monitoring program
- Study to develop seawater intrusion mitigation measures
- Encouraging conservation and BMPs for viticulture and non-viticulture agriculture
- Update to land cover maps, and groundwater flow model

8.5 Onsite Wastewater Treatment System Management

A large percentage of the groundwater basin is overlain by ranchettes and farmsteads with houses and structures that manage waste through individual onsite wastewater treatment system (OWTS), also known as septic systems. Individual property owners are responsible for managing their own system and employ a variety of BMPs such as monitoring and frequent pumping to manage the operation of the system. In June of 2012, the State Water Resources Control Board adopted the Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems. The intent of the Policy is "to allow the continued use of OWTS, while protecting water quality and public health". BMPs required in the Policy include site evaluations, setbacks, and percolation tests for new systems.

8.6 Municipal Wastewater Management

SVCSD owns and operates the only large-scale wastewater treatment plant within the groundwater basin. SVCSD implements source control programs including industrial waste management measures (i.e. educational outreach, coordination with wineries, and I/I programs) to control salinity and nutrients in influent waters, which ultimately improves the quality of recycled water.

Chapter 9 Groundwater Monitoring Plan

A Groundwater Monitoring Plan is a required element of all SNMPs. A comprehensive Groundwater Monitoring Plan has been developed for the Sonoma Valley SNMP and is included as Appendix E.

The Recycled Water Policy states that the SNMP should include a monitoring program that consists of a network of monitoring locations "... adequate to provide a reasonable, cost-effective means of determining whether the concentrations of salts, nutrients, and other constituents of concern as identified in the salt and nutrient plans are consistent with applicable water quality objectives." Additionally, the SNMP "... must focus on basin water quality near water supply wells and areas proximate to large water recycling projects, particularly groundwater recharge projects. Also, monitoring locations shall, where appropriate, target groundwater and surface waters where groundwater has connectivity with the adjacent surface waters." The preferred approach is to "... collect samples from existing wells if feasible as long as the existing wells are located appropriately to determine water quality throughout the most critical areas of the basin. The monitoring plan shall identify those stakeholders responsible for conducting, sampling, and reporting the monitoring data. The data shall be reported to the Regional Water Board at least every three years." With regards to constituents of emerging concern (CECs), the Recycled Water Policy Attachment A states that "Monitoring of health-based CECs or performance indicator CECs is not required for recycled water used for landscape irrigation due to the low risk for ingestion of the water."

9.1 Existing Monitoring Programs

Groundwater quality in the Sonoma Valley has been monitored since 1949. Most data represent one-time samples for short-term studies or individual well-specific assessments. The SVGMP monitoring program and the proposed SNMP monitoring program rely on three existing ongoing programs:

- DWR Monitoring
- CDPH Required Monitoring
- SVGMP Monitoring

The SNMP monitoring program will also collect and consider data from any other special studies conducted in the subbasin, such as studies conducted through the GMP to evaluate salinity sources in southern Sonoma Valley and studies conducted under the California Groundwater Ambient Monitoring and Assessment (GAMA) Program.

9.2 SNMP-Specific Groundwater Monitoring Program

For the SNMP Monitoring Program, 47 wells that are currently monitored by DWR, CDPH, and SVGMP will be included in the monitoring program (Table 9-1 and Figure 9-1). Wells will be monitored on the same schedule as their current monitoring, and results will be reported through the Geotracker database system to the Regional Water Board every three years in an SNMP Groundwater Monitoring Report. Parameters to be monitored include electrical conductivity (EC), TDS and nitrate.

The SNMP Groundwater Monitoring Report will include the following:

- Discussion of TDS and EC water quality including
  - Water quality summary tables (TDS and specific conductance)
  - Water quality concentration maps (TDS and specific conductance)
  - Time-concentration plots (specific conductance) to assess trends
  - Comparison of detections with BPOs
- Status of recycled water use and stormwater capture projects and implementation measures

- Review of future planned use of recycled water and any changes in planned use (which may trigger CEC monitoring requirements)

The SNMP Groundwater Monitoring Program will be reviewed and assessed every three years as part of the triennial SNMP groundwater monitoring reporting.

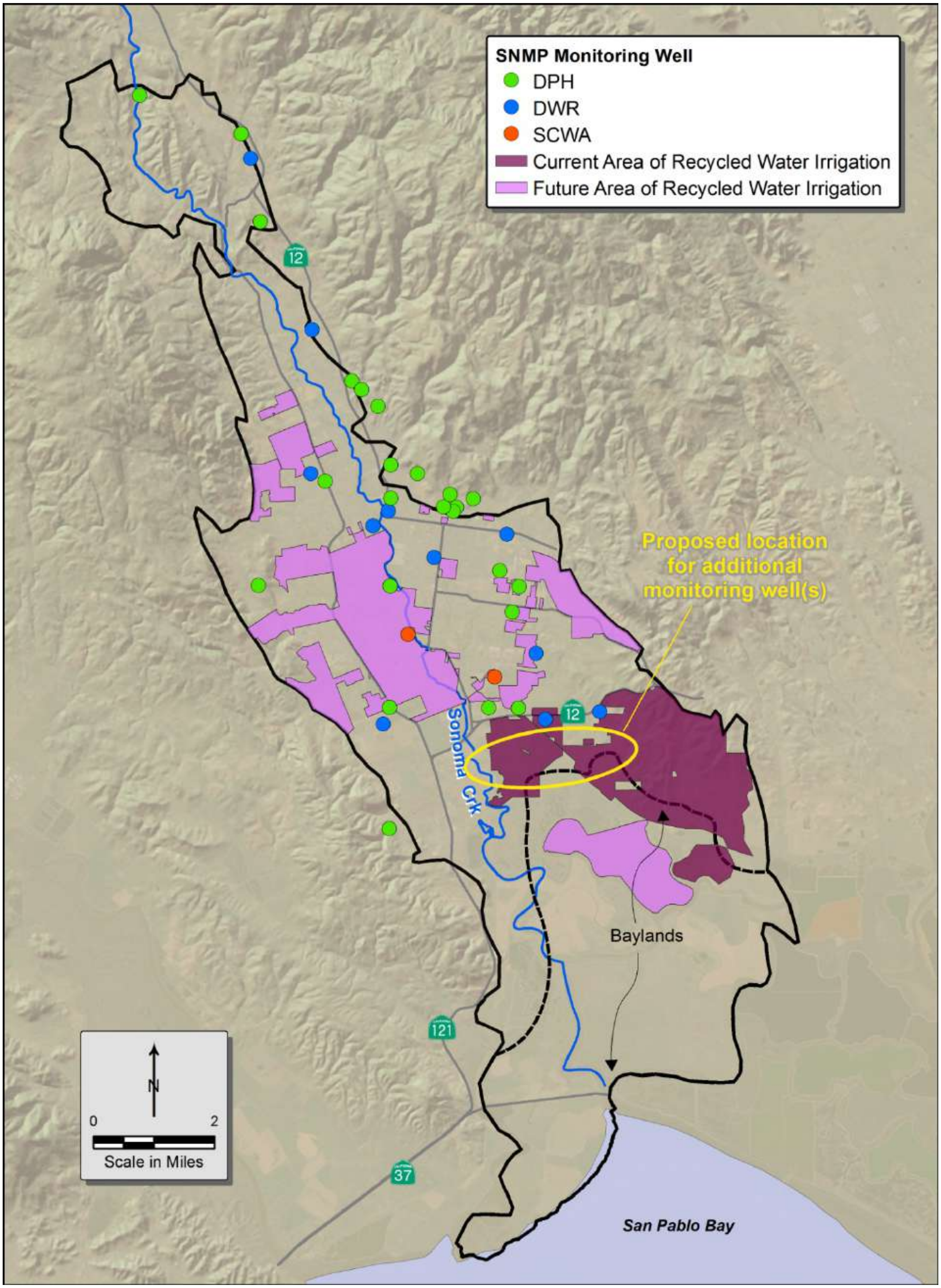
Table 9-1: SNMP Groundwater Monitoring Program

Program	No. of Wells	Monitoring Frequency	Constituents
DWR	12	Every 2 years	EC, TDS, and nitrate
CDPH	26 (varies)	Between 1-3 years	EC, TDS, or nitrate
SVGMP	9	Once per year	EC, TDS, and nitrate

9.3 Data Gaps

Additional monitoring data in the area where the Baylands zone transitions to the Inland area would be useful in the future to better understand if there is movement in the salinity intrusion area. When additional funding becomes available for the installation of additional monitoring wells, this will be the target area.

Figure 9-1: SNMP Monitoring Program



Chapter 10 Antidegradation Assessment

10.1 Recycled Water Irrigation Projects

Recycled water project(s) in the Sonoma Valley include existing and projected increased use of recycled water for irrigation through the end of the future planning period in the WY 2035.

10.2 SWRCB Recycled Water Policy Criteria

Section 9 Anti-Degradation of the SWRCB's Recycled Water Policy states, in part:

a. The State Water Board adopted Resolution No. 68-16 as a policy statement to implement the Legislature's intent that waters of the state shall be regulated to achieve the highest water quality consistent with the maximum benefit to the people of the state.

b. Activities involving the disposal of waste that could impact high quality waters are required to implement best practicable treatment or control of the discharge necessary to ensure that pollution or nuisance will not occur, and the highest water quality consistent with the maximum benefit to the people of the state will be maintained…..

d. Landscape irrigation with recycled water in accordance with this Policy is to the benefit of the people of the State of California. Nonetheless, the State Water Board finds that the use of water for irrigation may, regardless of its source, collectively affect groundwater quality over time. The State Water Board intends to address these impacts in part through the development of salt/nutrient management plans described in paragraph 6.

(1) A project that meets the criteria for a streamlined irrigation permit and is within a basin where a salt/nutrient management plan satisfying the provisions of paragraph 6(b) is in place may be approved without further antidegradation analysis, provided that the project is consistent with that plan.

(2) A project that meets the criteria for a streamlined irrigation permit and is within a basin where a salt/nutrient management plan satisfying the provisions of paragraph 6(b) is being prepared may be approved by the Regional Water Board by demonstrating through a salt/nutrient mass balance or similar analysis that the project uses less than 10 percent of the available assimilative capacity as estimated by the project proponent in a basin/sub-basin (or multiple projects using less than 20 percent of the available assimilative capacity as estimated by the project proponent in a basin/sub-basin).

10.3 Assessment

The average TDS and nitrate concentrations and the available assimilative capacities for baseline conditions and the future planning period with the recycled water irrigation project(s) were discussed in Section 7. Irrigation with recycled water contributes only very minor salt and nutrient loading to the subbasin and recycled water projects do not use more that 10 % of the available assimilative capacity.

In addition to the minimal negative water quality impacts associated with recycled water irrigation project(s) in the Subbasin, the Recycled Water Policy and other state-wide planning documents recognize the tremendous need for and benefits of increased recycled water use in California. As stated in the Recycled Water Policy "*The collapse of the Bay-Delta ecosystem, climate change, and continuing population growth have combined with a severe drought on the Colorado River and failing levees in the Delta to create a new reality that challenges California's ability to provide the clean water needed for a healthy environment, a healthy population and a healthy economy, both now and in the future. …….We strongly encourage local and regional water agencies to move toward clean, abundant, local water for California by emphasizing appropriate water recycling, water conservation, and maintenance of supply* *infrastructure and the use of stormwater (including dry-weather urban runoff) in these plans; these sources of supply are drought-proof, reliable, and minimize our carbon footprint and can be sustained over the long-term."* Clearly, the benefits in terms of sustainability and reliability of recycled water use cannot be overstated.

Another benefit of recycled water use for irrigation is that it reduces groundwater pumping in the southern part of the subbasin in the vicinity of a pumping depression helping to mitigate saline water intrusion from the Baylands Areas.

The SNMP analysis finds that recycled water use can be increased while still protecting and improving groundwater quality for beneficial uses. Table 10-1 provides an explanation of why proposed future recycled projects are in compliance with SWRCB Resolution No. 68-16.

Table 10-1: Antidegradation Assessment

<table>
<tr><th>SWRCB Resolution No. 68-16 Component</th><th>Anti-Degradation Assessment</th></tr>
<tr><td>Water quality changes associated with proposed recycled water project(s) are consistent with the maximum benefit of the people of the State.</td><td rowspan="3">• The irrigation projects will not use more than 10% of the available AC
• Recycled water irrigation project(s) will not cause groundwater quality to exceed applicable BPOs
• Use of recycled water for irrigation reduces groundwater pumping and helps mitigate saline water intrusion from the Baylands Area</td></tr>
<tr><td>The water quality changes associated with proposed recycled water project(s) will not unreasonably affect present and anticipated beneficial uses.</td></tr>
<tr><td>The water quality changes will not result in water quality less than prescribed in the Basin Plan.</td></tr>
<tr><td>The projects are consistent with the use of best practicable treatment or control to avoid pollution or nuisance and maintain the highest water quality consistent with maximum benefit to the people of the State.</td><td>• Concentrations of TDS and nitrate in recycled water produced by SVCSD are 440 mg/L and 5.2 mg/L, respectively. Concentrations are well below BPOs of 500 mg/L and 10 mg/L.</td></tr>
<tr><td>The proposed project(s) is necessary to accommodate important economic or social development.</td><td>• The recycled water projects are an integral part of Subbasins UWMPs</td></tr>
<tr><td>Implementation measures are being or will be implemented to help achieve BPOs in the future.</td><td>• Various measures, as described in Chapter 8 have been or will be implemented in the subbasin to address salts and nutrients</td></tr>
</table>

Chapter 11 Plan Approval Process

Following the presentation of the Draft SNMP at the July 18, 2013 public workshop, public comments on the Draft SNMP Report were considered and incorporated into this Final SNMP Report. This SNMP is being submitted to the Regional Water Board (in September 2013) for their review and incorporation to their Basin Planning process and subsequent environmental documentation process. The Regional Water Board template to be utilized for incorporating this SNMP into their Basin Planning Process has been filled in and is included as Appendix F along with environmental considerations.
The Final SNMP Report has been posted online at the following web address:
www.scwa.ca.gov/svgroundwater/

It is anticipated that this SNMP will be updated in the future. The timing of an SNMP update is not tied to a scheduled reoccurrence interval, however, an update could be triggered by the following:

- Major changes in land use or land management practices
- New information from the SNMP Groundwater Monitoring Program
- Changes in basin management (e.g. recharge projects)

Any future SNMP updates would be conducted utilizing a similar collaborative process as was utilized for development of this SNMP.

Chapter 12 Conclusion

The findings from the technical analysis completed for the SNMP indicate that overall groundwater quality in the basin is stable with low salinity and nutrient values (well below the Regional Water Board's BPOs), resulting from a combination of factors including the high percentage of mountain front recharge with very low TDS and nitrate concentrations, the low amount of loading from the few sources identified, and the low volume and high quality of recycled water used. Analysis of future water quality (through 2035) also indicates good water quality and stable trends.

In conclusion, no new implementation measures or BMPs as part of the SNMP process are recommended at this time. The SNMP would like to endorse existing measures or practices already in place to manage groundwater supplies and quality in the basin and see that they continue.

References

Bauer, Jacob P., December 2008, “Update to Regional Groundwater Flow Model simulation of Sonoma Valley Including a New Model for Recharge and Three Future Scenarios”, A Thesis Submitted to the Department of Geological and Environmental Sciences and the committee on graduate studies at Stanford University

City of Sonoma, 2011, “Annual Water Quality Report”

Hem, J.D., 1989, “Study and Interpretation of the Chemical Characteristics of Natural Water (third edition)”, U. S. Geological Survey Water-Supply Paper 2254

Metcalf & Eddy. (2003). *Wastewater Engineering: Treatment and Reuse*. New York: McGraw-Hill

Sonoma County Water Agency (SCWA), 2010, “Sonoma Valley Groundwater Management Program: 2010 Annual Report”

Sonoma County Water Agency (SCWA), December 2007, “Sonoma Valley Groundwater Management Plan”

San Francisco Regional Water Quality Control Board (SFRWQCB), December 31, 2010, “San Francisco Bay Region (Region 2) Water Quality Control Plan (Basin Plan)

State Water Resources Control Board (SWRCB), May 2009 Draft, amended September 2012, October 2012, and January 2013, approved January 2013, “Recycled Water Policy”

United States Geological Survey, 2006, “Geohydrologic Characterization, Water-Chemistry, and Ground-Water Flow Simulation Model of the Sonoma Valley Area, Sonoma County, California”, Scientific Investigation Report 2006-5092.

Valley of the Moon Water District, 2011, “Annual Water Quality Report”

NOVEMBER 2014









Salt and Nutrient Management Plan

Santa Clara Subbasin

Santa Clara Valley Water District

This page is intentionally left blank

REVISED FINAL
SALT AND NUTRIENT MANAGEMENT PLAN:
SANTA CLARA SUBBASIN

Originally posted online in November, 2014; Revised in June 2016 to add San Francisco Bay Regional Water Quality Control Board comments and Santa Clara Valley Water District responses

ACKNOWLEDGMENTS

PREPARED BY:
Thomas Mohr, P.G., H.G.
Senior Hydrogeologist

UNDER THE DIRECTION OF:
James Fielder
Chief Operating Officer,
Water Utility Enterprise

Garth Hall
Deputy Operating Officer
Water Supply Division

Behzad Ahmadi
Unit Manager,Groundwater (retired)

CONTRIBUTORS:
Chanie Abuye, *Civil Engineer*
Randy Behrens, *Geologist*
Ellen Fostersmith, *Geologist (retired)*
Ardy Ghoreishi, *Engineering Technician*
Robert Siegfried, *Soil Scientist (retired)*
Miguel Silva, *Associate Civil Engineer*
Xiaoyong Zhan, *Civil Engineer*

GRAPHICS DESIGN:
Benjamin Apollo

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

Page

TABLES

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

Page

FIGURES

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

Page

ACRONYMS

LIST OF ACRONYMS USED

ABAG	Association of Bay Area Governments
AF	Acre-feet
AF/yr	Acre-feet per year (about 326,000 gallons)
AGR	agricultural water supply
AWWA	American Water Works Association
BAWSCA	Bay Area Water Supply and Conservation Agency
BDCP	Bay-Delta Conservation Plan
BMO	basin management objectives (defined in the Groundwater Management Plan)
CASTNET	Clean Air Status and Trends Network
CEQA	California Environmental Quality Act
CDPH	California Department of Public Health
CECs	Constituents of Emerging Concern
CMAQ	Congestion Mitigation and Air Quality Improvement model
CVMOD	Coyote Valley Groundwater Flow Model
CVP	Central Valley Project
DDW	Division of Drinking Water (part of SWRCB, formerly part of CDPH)
DPR	direct potable reuse
DSOD	Division of Safety of Dams
DWR	Department of Water Resources
DWSAP	Drinking Water Source Assessment Program
EBMUD	East Bay Municipal Utility District
GIS	Geographic Information System
gpad	gallons per acre per day
gpimd	gallons per inch diameter per mile of sewer per day
GWI	groundwater infiltration
GWMP	Groundwater Management Plan
ha	hectare
INAAP	Infield Nutrient Assessment Assistance Program
IND	Industrial water supply
IPR	Indirect Potable Reuse (of recycled water)
IRWMP	Integrated Regional Water Management Plan
LAMS	LAMS = Large Area Mosaicing Software
LID	Low Impact Development
MCL	Maximum Contaminant Level
M&I	municipal and Industrial (pumping)
MFR	Mountain Front Recharge
MLE	Maximum Likelihood Estimate (a statistical method)
MGD	million gallons per day
MODFLOW	the USGS's three-dimensional, modular, finite-difference groundwater flow model used for simulating and predicting groundwater conditions and groundwater/surface-water interactions.
MRLC	Multi-Resolution Land Characteristics Consortium
MRP	Municipal Regional Permit (for Stormwater/NPDES)
MUN	Municipal and domestic water supply

NAPD	National Atmospheric Data Program
NO_3	nitrate as nitrate
NPDES	National Pollution Discharge Elimination System
OM	Outcome Measures in the Groundwater Management Plan
OWTS	On-site Wastewater Treatment System
OWTSO	Onsite Wastewater Treatment System Ordinance
PARWQCP	Palo Alto Regional Water Quality Control Plant
PCA	Potentially Contaminating Activities
PCBs	polychlorinated biphenyls (a class of toxic and bioaccumulative chemicals used as dielectric coolant in transformers)
PROC	industrial process supply
RWQCB	Regional Water Quality Control Board
ROWD	Report of Waste Discharge
RW	Recycled Water
SBWR	South Bay Water Recycling
SCADA	Supervisory Control and Data Acquisition (computer system for gathering and analyzing real time data)
SDWA	Safe Water Drinking Act
SCPMOD	Santa Clara Plain Groundwater Flow Model
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SJ-SC RWF	San José-Santa Clara Regional Wastewater Facility
SFPUC	San Francisco Public Utilities Commission
SJWC	San Jose Water Company
SMCL	Secondary Maximum Contaminant Level
S/N	salt and nutrient
SNMP	Salt and Nutrient Management Plan
SRWS	Self Regenerating Water Softener
SSO	Sanitary System Operator
SVAWPC	Silicon Valley Advanced Water Purification Center
SVWPCP	Sunnyvale Water Pollution Control Plant
SWID	Stormwater Infiltration Device
SWP	State Water Project
SWRCB	State Water Resources Control Board
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Loads
TPY	Tons Per Year
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
VCP	Vitrified Clay Pipe
VWA	Volume-weighted average
WDRs	Waste Discharge Requirements
WSIMP	Water Supply Infrastructure Master Plan

EXECUTIVE SUMMARY

In February 2009, the State Water Resources Control Board (SWRCB) adopted the statewide Recycled Water Policy that encourages increased use of recycled water and local stormwater, together with enhanced water conservation. The Recycled Water Policy calls for basin-wide management of salts and nutrients from all sources with the goal of attaining water quality objectives (WQOs) and protecting beneficial uses of groundwater.

Because recycled water can contribute salts and nutrients to groundwater, the Recycled Water Policy requires local entities to develop a Salt and Nutrient Management Plan (SNMP) to support streamlined permitting of new recycled water projects while managing salts and nutrients basin-wide.

This SNMP for the Santa Clara Groundwater Subbasin was prepared by the Santa Clara Valley Water District (District) with input from stakeholders, including the San Francisco Bay Regional Water Quality Control Board, Santa Clara County, water retailers and recycled water producers, the farm bureau, and interested stakeholders such as environmental groups.

The purpose of this SNMP is to comply with the SRWCB Recycled Water Policy by:

- Evaluating all sources of salt and nutrient loading to the Santa Clara Subbasin,
- Determining whether current and projected salt and nutrient concentrations are consistent with applicable WQOs
- Developing recycled water and stormwater goals and objectives,
- Providing a plan for long-term groundwater monitoring, and
- Identifying sustainable measures to manage salt and nutrient loading to groundwater.

An overview of the SNMP, including key findings, is provided below.

Study Area

The Study Area for this SNMP is the Santa Clara Groundwater Subbasin[1] in northern Santa Clara County, including the Santa Clara Plain and Coyote Valley. Groundwater typically provides about 45 percent of the water used in the Santa Clara Plain. Treated water provides the majority of the water used, with minor portions served by local surface water and recycled water. Tertiary-treated recycled water is used for irrigation and industrial purposes in Palo Alto, Mountain View, Sunnyvale, Santa Clara, San Jose, and Milpitas. Advanced-treated recycled water from the Silicon Valley Advanced Water Purification Center is now blended into recycled water serving San Jose and Santa Clara. The Coyote Valley relies almost entirely on groundwater, with small amounts of surface water used.

Water supply management of the Santa Clara Subbasin includes active groundwater replenishment operations conducted by the District. Significant volumes of imported water and surface water released from local reservoirs, along with local runoff are recharged in ponds and in-stream facilities. On average, the District's Managed aquifer recharge (MAR) represents two-

[1] The Santa Clara Subbasin is part of the Department of Water Resources-defined Santa Clara Valley Groundwater Basin.

thirds of the annual groundwater pumping in the Santa Clara Plain and 120% of pumping in the Coyote Valley.

Existing Groundwater Quality

Groundwater quality within the Santa Clara Subbasin is very good and is acceptable for all beneficial uses designated in the Basin Plan. Total dissolved solids (TDS) and nitrate (as NO_3) are used as representative salt and nutrient indicators for this SNMP. The volume-weighted average for the Santa Clara Subbasin is 425 mg/L.

Average TDS and nitrate concentrations were compared with the recommended secondary drinking water standard of 500 milligrams per liter (mg/L) and the primary drinking water standard of 45 mg/L, respectively. Average TDS and nitrate concentrations in all areas are well below their respective WQOs. Accordingly, there is available assimilative capacity. Trend analyses indicate nearly all wells analyzed show stable or decreasing trends for TDS and nitrate.

Salt and Nutrient Sources

Major current sources of TDS loading to the Santa Clara Plain include landscape irrigation and managed aquifer recharge, and in Coyote Valley, managed aquifer recharge and agricultural irrigation. Minor sources of TDS loading include recycled water, drainage and conveyance losses (leaks in storm drain, sewer, and water transmission pipes). The primary sources of nitrate in the Santa Clara Plain are landscape irrigation with potable and recycled water, and groundwater flowing into the Santa Clara Plain from Coyote Valley. In the Coyote Valley, agricultural fertilizer and irrigation, and septic systems are the primary sources of nitrate.

All sources of groundwater recharge add salt and nutrient load to the subbasin. Recharge sources with lower TDS and nitrate than ambient groundwater will result in improved groundwater quality. Average concentrations of TDS and nitrate in all sources of groundwater recharge combined are much lower than average groundwater concentrations.

Salts and nutrients are removed from the subbasin through groundwater pumping, basin outflow, gaining reaches of streams, and groundwater infiltration into storm drains and sewer mains. The difference between total salt and nutrient loading and removal determines whether there is currently net loading or net removal, as summarized in Table 1.

Table 1 – Net Loading of Salts and Nutrients in the Santa Clara Subbasin

	Santa Clara Plain		Coyote Valley		Santa Clara Subbasin	
	TDS	**Nitrate**	**TDS**	**Nitrate**	**TDS**	**Nitrate**
Total Loading, tons per year	89,600	1,130	7,850	226	97,450	1,356
Total Removal, tons per year	58,080	890	10,860	670	68,940	1,560
Net Loading, tons per year	**31,520**	**240**	**- 3,010**	**- 444**	**28,510**	**- 204**

Future Salt and Nutrient Loading and Assimilative Capacity

Loading and removal categories were quantified to support a salt and nutrient mass balance. Fate and transport of salt and nutrients was estimated, and nitrate attenuation factors were developed. A ten-year baseline mass balance was developed for 2001-2010 to establish median loading rates by category. Forecasts were developed for future loading and removal, accounting for improvements to recycled water quality through advanced treatment, planned indirect potable reuse projects, water supply demand projections, and other factors. These forecasts were used to project future TDS and nitrate concentrations, compare those concentrations to applicable WQOs, and evaluate available assimilative capacity. For the SNMP planning horizon ending in 2035, TDS concentrations are projected to decrease in Coyote Valley and increase the Santa Clara Plain. Nitrate is projected to decrease in both the Coyote Valley and Santa Clara Plain. Under the future salt and loading forecast in this SNMP, it is projected that there will be available assimilative capacity for both TDS and nitrate as shown in Table 2, below.

Table 2 – Projected Salt and Nutrient Concentrations and Assimilative Capacity

Sub-Area/Aquifer	Volume Weighted Average TDS, mg/L	TDS Assimilative Capacity	Volume Weighted Average Nitrate as NO_3	NO_3 Assimilative Capacity
Basin Plan Objective	***500***		***45***	
Santa Clara Plain – Shallow	528	**-28**	9.1	**35.9**
Santa Clara Plain – Principal	410	**90**	11.0	**34.0**
Santa Clara Subbasin	425	**75**	10.7	**34.3**
Coyote Valley	377	**123**	20.0	**25.0**

Assimilative capacity is the difference between the Basin Plan Objective and the average groundwater concentration.

Anti-Degradation Analysis

The SNMP analysis finds that current and planned recycled water use by 2035 causes only minor water quality changes to the subbasin with respect to salts and nutrients. Accordingly, recycled water project(s) are consistent with the maximum benefit of the people of the State and can be increased while still protecting groundwater quality for beneficial uses.

Salt and Nutrient Groundwater Quality Management Programs

Projects and programs to manage salt and nutrient loading on a sustainable basis have been implemented by the District and subbasin stakeholders for many years. The SWRCB Recycled Water Policy states that within one year of the receipt of a proposed SNMP, the RWQCBs shall consider for adoption revised Basin Plans for groundwater basins where WQOs for salts and nutrients are being, or are threatening to be exceeded. Accordingly, the need for implementation measures to limit and reduce salt and nitrate concentrations is determined by comparing current average and simulated future groundwater quality with WQOs.

Current and projected TDS and nitrate concentrations in the Santa Clara Subbasin do not exceed WQOs, so implementation measures are not required. Nonetheless, many groundwater quality management initiatives have been conducted in the Santa Clara Subbasin by the District and SNMP stakeholders, and may continue as deemed appropriate by their proponents. A summary of groundwater quality management initiatives is provided in Appendix 4.

SNMP Monitoring Program

For many years the District has conducted regular and comprehensive monitoring that includes TDS and nitrate, as well as other water quality parameters. The District also analyzes data from public water supply wells. The proposed SNMP Monitoring Program is the District’s voluntary subbasin monitoring and reporting for TDS and nitrate. The District prepares an annual groundwater report that documents monitoring results, provides trend analyses for TDS and nitrate, and compares detections with WQOs. District reports are available on the District website.

CHAPTER 1: INTRODUCTION AND BACKGROUND

This chapter provides an overview of the Salt and Nutrient Management Plan (SNMP) for the Santa Clara Groundwater Subbasin, including related state and local policy. This chapter also summarizes the stakeholder process related to the Santa Clara Groundwater Subbasin SNMP.

1.1 Introduction

This SNMP was developed through a stakeholder process led by the Santa Clara Valley Water District (District), the manager of the Santa Clara groundwater Subbasin. The District was formed by the Santa Clara Valley Water District Act (District Act)[2] for the primary purpose of providing comprehensive management for all beneficial water uses and protection from flooding within Santa Clara County. Per Sections 4 and 5 of the District Act, the District's objectives and authority related to groundwater management are to recharge groundwater basins, conserve water, manage and store water for beneficial and useful purposes, increase water supply, protect surface and groundwater from contamination, prevent waste or diminution of the District's water supply, and do any and every lawful act necessary to ensure sufficient water is available for present and future beneficial uses.

Sources of water for Santa Clara County include local reservoirs, groundwater, imported surface water from the State and Federal Water Projects (including water banking in Kern County), San Francisco Public Utilities Commission supplies, and recycled water. In addition, the District operates a highly successful water conservation program. As much as half the water used in the county is pumped from the ground with the proportion of water supplied by groundwater varying by city and by different water companies. Consequently, groundwater protection from salt and nitrate accumulation is critical to ensure long-term water supply reliability in Santa Clara County.

Recycled water is a small but important and growing source of water in Santa Clara County. It is currently used for non-potable uses including irrigation, industrial applications (e.g., cooling), and agriculture. Using recycled water helps conserve drinking water supplies, provides a drought-proof, locally controlled water supply, and reduces dependency on imported water and groundwater. The District has established partnerships with the four recycled water producers in the county to expand recycled water use. Future recycled water plans include use of advanced treated recycled water for indirect potable reuse and possibly direct potable reuse.

The State Water Resources Control Board (SWRCB) recognizes the importance of recycled water as a key element in local water supply portfolios and adopted the 2009 Recycled Water Policy to guide the preparation of SNMPs to support expanding recycled water uses. The purpose of this Santa Clara SNMP is to evaluate all sources of salts and nutrients (S/Ns) loading to groundwater in the Santa Clara Groundwater Subbasin, develop recycled water and stormwater goals and objectives, provide a plan for long term groundwater monitoring for S/Ns, and identify measures to manage S/N loading to groundwater on a sustainable basis.

1.2 State Water Resources Control Board 2009 Recycled Water Policy

SWRCB Resolution, 2009-0011 adopted a policy for water quality control for recycled water (Recycled Water Policy). The Recycled Water Policy encourages increased use of recycled

[2] Santa Clara Valley Water District Act, Water Code Appendix, Chapter 60.

water and local stormwater to enhance drought-proof, reliable, and sustainable water supplies over the long-term. The intent of the Policy is to ensure that every groundwater basin/subbasin in California has a consistent SNMP. The SWRCB found that the appropriate way to address S/N issues is through the development of regional or sub-regional S/N management plans rather than through imposing requirements solely on individual recycled water projects. A full copy of the Recycled Water Policy is provided in Appendix 1.

The key provisions of the Recycled Water Policy related to S/N planning are:

- SNMPs will be developed for each groundwater basin/subbasin in California by local water and wastewater entities, together with local S/N contributing stakeholders, through a locally driven and controlled collaborative processes open to all stakeholders and with participation by the RWQCB staff;

- The salt and nutrient management planning process should comply with the California Environmental Quality Act (CEQA);

- The SWRCB intends that stormwater use and recharge become a component within the SNMPs because this water is typically lower in nutrients and salts and can augment local water supplies, providing a long-term sustainable use of water in California;

- SNMPs must address and implement provisions, as appropriate, for all sources of salts and nutrients to groundwater basins, including recycled water irrigation projects and groundwater recharge reuse projects; and

- The policy requires that SNMPs be completed and proposed to the RWQCB by 2014. However, if the stakeholders can demonstrate substantial progress towards completion, a two-year extension may be granted.

The Recycled Water Policy also specifies that each SNMP include the following components:

- A subbasin wide monitoring plan that includes an appropriate network of monitoring locations;

- A provision for annual monitoring of Constituents of Emerging Concern (CECs), such as endocrine disruptors, personal care products, pharmaceuticals consistent with recommendations by the California Department of Public Health and any SWRCB action;

- Water recycling and stormwater recharge/use goals;

- S/N source identification, subbasin assimilative capacity, and loading estimates;

- Implementation measures to manage S/N loading in the subbasin on a sustainable basis; and

- An anti-degradation analysis demonstrating that the projects included within the plan will collectively satisfy the requirements of SWRCB Resolution No. 68-16.

1.3 Stakeholder Participation

The District, as the groundwater management agency for the county, led the salt and nutrient management planning effort in collaboration with local water and wastewater entities, contributors of salts and nutrients, and stakeholders. Table 3 lists SNMP stakeholders, stakeholder meeting dates, and topics addressed.

Table 3 – Santa Clara Groundwater Subbasin SNMP Stakeholders and Stakeholder Meetings

<table>
<tr><th>Stakeholders</th><th>Meetings</th><th>Topics</th></tr>
<tr><td rowspan="4">California Water Services Company

City of Milpitas

City of Mountain View

City of Palo Alto

City of San Jose

City of Santa Clara

City of Sunnyvale

San Francisco Bay Regional Water Quality Control Board

San Jose Water Company

Santa Clara Basin Watershed Management Initiative

Santa Clara County Farm Bureau

South Bay Water Recycling

Stanford University</td><td>May 31, 2011</td><td>• Introduction to SNMPs
• Santa Clara Groundwater Subbasin Overview
• Approach to developing SNMP
• Stakeholder Input</td></tr>
<tr><td>October 12, 2011</td><td>• SNMP Process
• S/N Source Identification
• Approach to Loading Estimates
• Stakeholder Input</td></tr>
<tr><td>April 11, 2013</td><td>• Overview of SWRCB Recycled Water Policy Update
• Recycled water and stormwater goals
• Basin Water Balance
• Loading Estimates
• Assimilative Capacity</td></tr>
<tr><td>June 20, 2013</td><td>• Review of SNMP Process
• Loading analysis results
• Forecasted Assimilative Capacity
• Causes of trends
• Implementation Measures
• SNMP Monitoring Plan</td></tr>
</table>

1.4 Related Plans and Policies

Several state, regional, and local water quality plans and policies are related to the SWRCB's Recycled Water Policy and its provision for the development of SNMPs. These plans and policies are discussed below.

1.4.1 Anti-Degradation Policy

The SWRCB adopted the Anti-Degradation Policy in 1968 (Resolution 68-16). This policy states that existing high water quality should be maintained and that dischargers should use best practicable treatment to avoid pollution. The policy provides for some degradation of water quality if such degradation is consistent with maximum benefits to the people of the state, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in Regional Water Quality Control Plans. Projects that are included in the SNMP will need to satisfy the requirements of the Anti-Degradation Policy.

1.4.2 Regional Water Quality Control Plan

Each RWQCB prepares a Water Quality Control Plan (Basin Plan) for their region. The Basin Plans are designed to achieve the highest water quality consistent with maximum benefit to the people of the State. The San Francisco Bay Basin Plan designates beneficial uses and water quality objectives for waters of the State, including surface waters and groundwater. The plan also includes implementation programs to achieve water quality objectives. The beneficial uses for northern Santa Clara County groundwater and associated water quality objectives related to salts and nutrients are discussed below.

1.4.2.1 Beneficial Uses

Existing and potential beneficial uses of groundwater in northern Santa Clara County are municipal and domestic water supply (MUN), industrial water supply (IND), industrial process supply (PROC), and agricultural water supply (AGR). Unless otherwise designated by the RWQCB, all groundwater is currently considered suitable, or potentially suitable, for municipal or domestic water supply.

1.4.2.2 Water Quality Objectives

The Basin Plan identifies water quality objectives for groundwater throughout the region. The maintenance of existing high quality of groundwater (i.e., "background") is the primary groundwater objective. At a minimum, groundwater may not contain concentrations of chemical constituents or substances producing taste and odor in excess of the objectives listed in Table 4. An exception is made when naturally occurring background concentrations are greater than the thresholds listed in Table 4.

As explained in Section 2.3, the water quality parameters used as surrogates for salt and nitrate in this SNMP are Total Dissolved Solids and Nitrate as NO_3. Table 4 lists numeric objectives for salt (as Total Dissolved Solids – TDS) and nutrients (as Nitrate) for municipal and domestic water supply (MUN) and agricultural water supply (AGR) beneficial uses.

Table 4 – Basin Plan Water Quality Objectives

Parameter	Units	MUN	AGR
TDS	mg/L	500	10,000
Nitrate (as NO3)	mg/L	45	
Nitrate + Nitrite (as N)	mg/L	10	30

1.4.3 Integrated Regional Water Management Plan Objectives

Water, wastewater, flood protection, and stormwater management agencies, together with cities, counties, and environmental interests, have developed an Integrated Regional Water Management (IRWM) Plan for the San Francisco Bay Area. IRWM is a collaborative effort to manage all aspects of water resources in a region. IRWM crosses jurisdictional, watershed, and political boundaries; involves multiple agencies, stakeholders, individuals, and groups; and, attempts to address the issues and differing perspectives of all the entities involved through mutually beneficial solutions. The Bay Area IRWM Plan specifies regional goals and objectives. Table 5 lists the regional goals and objectives that apply to salt and nutrient management planning for Santa Clara County groundwater:

Table 5 – San Francisco Bay Area Integrated Regional Water Management Plan Goals and Objectives

Regional Goal	Objectives
Promote Environmental, Economic, and Social Sustainability	• Minimize health impacts associated with polluted water. • Develop policies, ordinances and programs that promote IRWM goals, and determine areas of integration among projects. • Promote community education involvement and stewardship.
Contribute to improved supply reliability and quality	• Provide adequate water supplies to meet demands. • Provide clean, safe, and reliable drinking water. • Implement water use efficiency to meet or exceed state and federal requirements. • Increase recycled water use of potable water replaced by non-potable supply. • Expand water storage and conjunctive management of surface and groundwater. • Provide for groundwater recharge while protecting groundwater resources from overdraft. • Protection of groundwater resources from contamination.
Protect and improve watershed health and function	• Minimize point-source and nonpoint-source pollution. • Improve infiltration capacity. • Control pollutants of concern (TMDLs, 303(d) etc.) • Manage floodplains to reduce flood damages to homes, businesses, schools, and transportation.

1.4.4 District Board Ends Policies

The District Board has adopted Ends Policies that provide direction to staff on the intended results, organizational products, impacts, benefits, outcomes, recipients, and their relative worth. The following Ends Policies are related to salt and nutrient management planning:

1.1 An integrated and balanced approach in managing a sustainable water supply, effective natural flood protection, and healthy watersheds is essential to prepare for the future.

1.2 Effective public engagement in accomplishing the District mission is achieved through communication that involves the community and key stakeholder groups in a transparent and open manner.

2.1 Current and future water supply for municipalities, industries, agriculture and the environment is reliable.

2.1.1 Aggressively protect groundwater from the threat of contamination and maintain and develop groundwater to optimize reliability and to minimize land subsidence and saltwater intrusion.

2.1.2 Protect, maintain, and develop local surface water.

2.1.4 Protect, maintain, and develop recycled water.

The CEO has adopted interpretations of the Board policy. The interpretations include strategies to increase recycled water use to ten percent of total water demands by 2025 in partnership with the community and agencies in the county, and maintaining contaminant concentrations below Basin Plan water quality objectives in wells.

1.4.5 Groundwater Management Plan Basin Management Objectives

The purpose of the District's Groundwater Management Plan (GWMP) is to describe basin management objectives. Objectives include strategies, programs, and activities that support those objectives, and outcome measures to gauge performance (District, 2012b). A more detailed discussion of the GWMP, objectives, and outcome measures is provided in Appendix 2.

The GWMP establishes the following basin management objectives (BMOs):

- BMO 1: Groundwater supplies are managed to optimize water supply reliability and minimize land subsidence.
- BMO 2: Groundwater is protected from existing and potential contamination, including saltwater intrusion.

These BMOs describe the overall goals of the District's groundwater management program. The basin management strategies are the methods that will be used to meet the BMOs. Many of these strategies have overlapping benefits to groundwater resources and act to improve water supply reliability, minimize subsidence, and protect or improve groundwater quality. The strategies are listed below:

a. Manage groundwater in conjunction with surface water through direct and in-lieu recharge programs to sustain groundwater supplies and to minimize saltwater intrusion and land subsidence.

b. Implement programs to protect or promote groundwater quality to support beneficial uses.

c. Maintain and develop adequate groundwater models and monitoring systems.

d. Work with regulatory and land use agencies to protect recharge areas, promote natural recharge, and prevent groundwater contamination.

The District has developed the following outcome measures to gauge performance in meeting the basin management objectives:

Projected end of year groundwater storage is greater than 278,000 AF in the Santa Clara Plain and 5,000 in Coyote Valley.

a. Groundwater levels are above subsidence thresholds at the subsidence index wells.

b. At least 95% of countywide water supply wells meet primary drinking water standards and at least 90% of South County wells meet Basin Plan agricultural objectives.

c. At least 90% of wells in both the shallow and principal aquifer zones have stable or decreasing concentrations of nitrate, chloride, and total dissolved solids (TDS).

d. Programs and policies that achieve management of groundwater quality are described in Appendix 4.

1.5 Regulatory Framework

This section describes how S/N discharges to groundwater are regulated and controlled by regional and local agencies.

1.5.1 Waste Discharge Permitting Program

The RWQCB generally controls point source discharges to surface water through waste discharge requirements issued under the federal National Pollutant Discharge Elimination System (NPDES) permits. Although the NPDES program was established by the federal Clean Water Act the permits are prepared and enforced by the RWQCB per California's delegated authority for the act.

Issued in five-year terms, a NPDES permit usually contains components such as discharge prohibitions, effluent limitations, and necessary specifications and provisions to ensure proper treatment, storage, and disposal of the waste. The permit often contains a monitoring program that establishes monitoring stations at effluent outfall and receiving waters.

Under the state's Porter-Cologne Water Quality Control Act, any person discharging or proposing to discharge waste within the region (except discharges into a community sewer system) that could affect the quality of the waters of the state is required to file a Report of Waste Discharge (ROWD). The RWQCB reviews the nature of the proposed discharge and adopts Waste Discharge Requirements (WDRs) to protect the beneficial uses of waters of the state. WDRs are issued for discharges to land, including discharge of treated wastewater to land, landfills, agricultural activities, and water recycling programs. Waste discharge requirements could be adopted for an individual discharge, or a specific type of discharges, in the form of a general permit. The RWQCB may waive the requirements for filing a ROWD or issuing WDRs for a specific discharge where such a waiver is not against the public interest. NPDES requirements may not be waived.

Acceptable control measures for point source discharges must ensure compliance with NPDES permit conditions, including discharge prohibitions and the effluent limitations specified in the Basin Plan. In addition, control measures must satisfy water quality objectives set forth in the Basin Plan unless the RWQCB judges that related economic, environmental, or social considerations merit a modification after a public hearing process has been conducted. Control measures employed must be sufficiently flexible to accommodate future changes in technology, population growth, land development, and legal requirements.

Table 6 summarizes general permits that the San Francisco Bay RWQCB has issued for discharges that could contribute salts and/or nutrients to groundwater. In addition, individual permits have been issued to the following types of operations:

- Food processing wastewater treatment and disposal.
- Alternative and large septic systems.
- Package sanitary wastewater treatment systems.

Individual orders are discussed further in Section 1.6 on potential S/N contributors and sources.

Table 6 – San Francisco Bay RWQCB General Orders for Discharges that Could Contribute Salt and Nutrients to Groundwater

Order Number	Name	Description
96-011	General Water Reuse Requirements for Municipal Wastewater and Water Agencies	The Order serves as a General Water Reuse Order authorizing municipal wastewater reuse by producers, distributors, and users of non-potable recycled wastewater throughout the region. The intent of this Order is to streamline the permitting process and delegate the responsibility of administrating water reuse programs to local agencies to the fullest extent possible. The Order is intended to serve as a region-wide general permit for publicly owned wastewater and water agencies that recycle treated municipal wastewater. It is intended to replace individual reuse Orders.
97-10-DWQ	Discharges to Land By Small Domestic Wastewater Systems	SWRCB general WDRs. Revisions being considered consistent with AB 885. Basin Plan includes criteria for onsite wastewater systems. Small systems are typically regulated by the County of Santa Clara in accordance with the Basin Plan and through delegation of authority from the RWQCB.
R2-2009-0074	Municipal Regional Stormwater NPDES Permit	Waste Discharge Requirements and NPDES Permit for the discharge of stormwater runoff from the municipal separate storm sewer systems of the following jurisdictions and entities: the cities of Campbell, Cupertino, Los Altos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, and Sunnyvale. Included are the towns of Los Altos Hills and Los Gatos, the Santa Clara Valley Water District, and Santa Clara County, which have joined together to form the Santa Clara Valley Urban Runoff Pollution Prevention Program (Santa Clara Permittees).

1.5.2 Total Maximum Daily Loads

Total Maximum Daily Loads (TMDLs) are action plans to restore clean water. Section 303(d) of the federal Clean Water Act requires that states identify water bodies -- bays, rivers, streams, creeks, and coastal areas -- that do not meet water quality standards, and the pollutants that impair them. TMDLs examine the water quality problems, identify sources of pollutants, and specify actions that create solutions. These plans have been adopted by the RWQCB as amendments to the region's Basin Plan.

Several water bodies within northern Santa Clara County do not meet water quality standards. The impairments that have been identified include mercury, PCBs, pesticides, sediment, and trash. None of these impairments are significant in terms of salt and nutrient management in groundwater.

1.5.3 Local Regulations

Local land use agencies also play a role in managing S/N loading to groundwater. Specific examples are listed here and enumerated further in Appendix 4.

- City and County General Plans provide policies and strategies for protecting water quality and maintaining water supply reliability.

- County Septic Ordinance regulates the location, construction, and operation of smaller septic systems, which are potential sources of salts and nutrients.

- County Design Guidelines for golf courses include guidelines related to water quality protection from fertilizers.

- Urban Runoff Management programs are typically implemented to meet the Municipal Regional Stormwater permit requirements and include provisions to protect water quality.

- Santa Clara Valley Water District Stormwater Infiltration Device Policy regulates the use of stormwater infiltration devices and is being updated to be consistent with Municipal Regional Stormwater permit requirements.

1.5.4 Goals and Objectives for Recycled Water and Stormwater

The District has established the following goals and objectives for recycled water and stormwater:

- Recycled Water:
  - Goal: Protect, maintain, and develop recycled water.
  - Objective: At least 10% of total annual county water demands are met with recycled water by 2025.

- Stormwater:
  - Goal: Promote natural recharge and the infiltration of high quality stormwater.
  - Objective: Maintain facilities to recharge about 50,000 AF of stormwater each year and evaluate opportunities to expand recharge capacity.

CHAPTER 2: GROUNDWATER SUBBASIN CHARACTERIZATION

This chapter describes the Santa Clara Groundwater Subbasin, which includes the Santa Clara Plain and the Coyote Valley areas (see Figure 1). Basin-wide groundwater attributes are described, including water balance, storage capacities, inflows and outflows for both the Santa Clara Plain and the Coyote Valley subareas. Trends in pumping, groundwater elevations, and groundwater quality are also included. The description of the subbasin provided in this chapter will aid in understanding the S/N source analysis that is presented in later chapters.

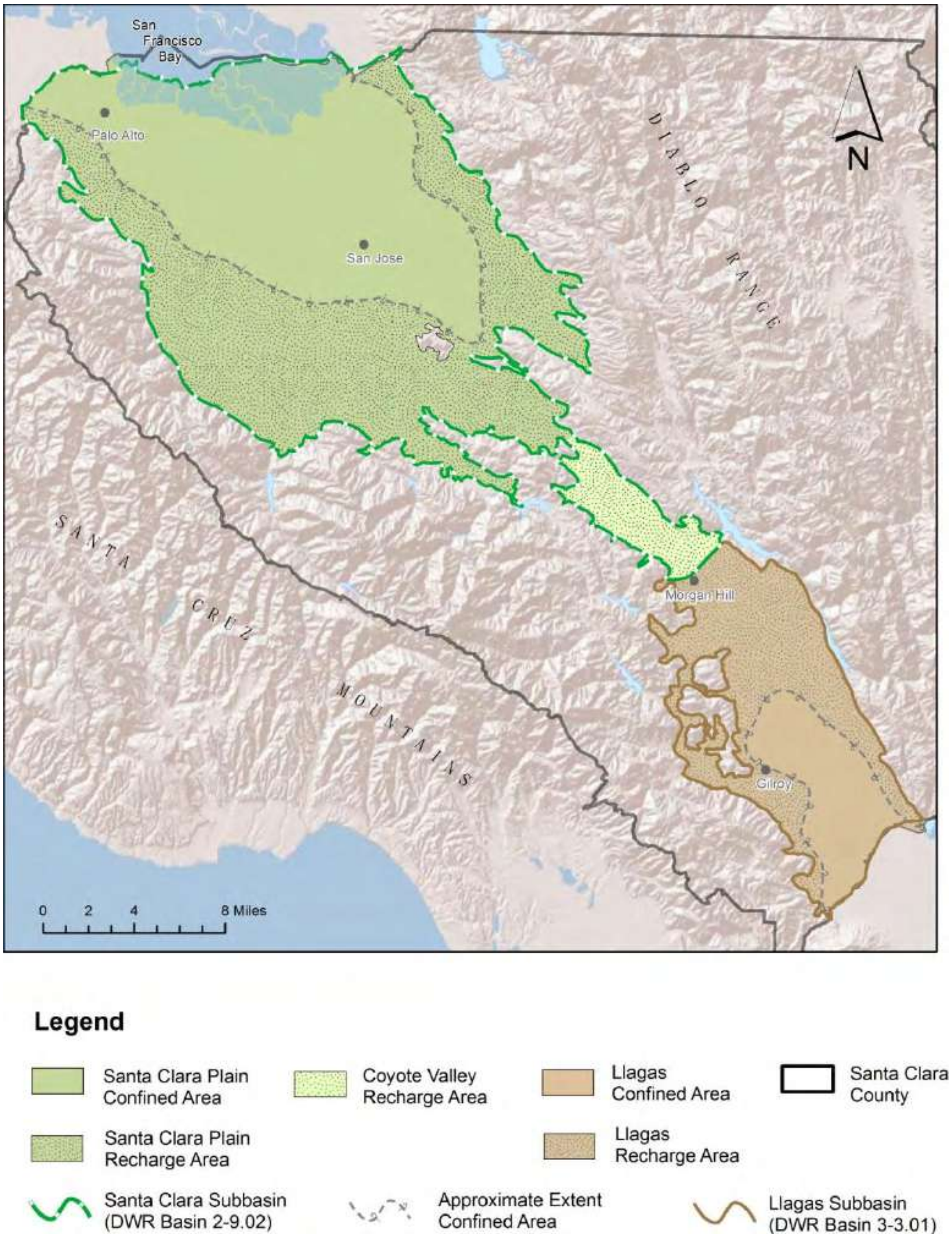


Figure 1 – Locations of Santa Clara Plain and Coyote Valley

2.1 Groundwater Basin

The groundwater basins in Santa Clara County transmit, filter, and store water. Water enters the basin through recharge areas and undergoes natural filtration as it is transmitted into deeper aquifers. Groundwater recharge and basin inflow replaces water removed from the basin by basin-outflow and by groundwater pumping. The District's managed aquifer recharge program maintains aquifer pressure, which helps avoid land subsidence. Storing surplus water in the groundwater basin enables part of the County's supply to be carried over from wet years to dry years.

Santa Clara County includes portions of two groundwater basins as defined by the California Department of Water Resources (DWR) Bulletin 118 Update 2003 – the Santa Clara Valley Basin (Basin 2-9) and the Gilroy-Hollister Valley Basin (Basin 3-3). The Santa Clara Valley Basin generally forms an elongated valley bounded by the Santa Cruz Mountains to the west and Diablo Range to the east, and extends north into San Mateo and Alameda Counties. The boundary between the Santa Clara Valley and the Gilroy-Hollister Valley Groundwater Basins is the Coyote Creek alluvial fan in the Morgan Hill area. The alluvial fan comprises a topographic and hydrologic divide between the groundwater and surface water flowing to the San Francisco Bay and water flowing to the Monterey Bay. The groundwater divide is approximately located at Cochrane Road in Morgan Hill. The boundary moves as much as a mile to the north or south depending on local groundwater conditions. The Santa Clara Groundwater Subbasin, which includes the Santa Clara Plain and Coyote Valley subareas, is located in the Santa Clara Valley Basin. The Llagas Groundwater Subbasin is located within the Gilroy-Hollister Valley Groundwater Basin. A separate SNMP has been prepared for the Llagas Groundwater Subbasin (Todd Groundwater, 2014).

While basin boundaries are primarily based on geologic and hydrologic information, subbasins are commonly based on institutional boundaries. DWR Bulletin 118 Update 2003 states that "subbasins are created for the purpose of collecting and analyzing data, managing water resources, and managing adjudicated basins." The Santa Clara Groundwater Subbasin, as defined by DWR, extends from the southern boundary of the Santa Clara Valley Basin in Morgan Hill north to the San Francisco Bay and the county boundaries. The subbasin includes two study areas – the Santa Clara Plain and the Coyote Valley. Although hydraulically connected to the Santa Clara Plain, the District refers to the Coyote Valley separately since it is largely an agricultural area and water supply is provided exclusively by municipal, domestic, and agricultural wells. The Santa Clara Plain portion of the Santa Clara Groundwater Subbasin is largely urban/suburban and primarily served by major water retailers using both groundwater and treated surface water. Some of the groundwater supplied to customers in the Santa Clara Plain is pumped in Coyote Valley.

2.1.1 Santa Clara Plain Hydrogeology

The Santa Clara Plain is the northern area of the Santa Clara Groundwater Subbasin, which is the southern extension of the Santa Clara Valley Groundwater Basin. The Santa Clara Plain is 280 square miles, comprising a large trough-like depression filled with alluvium, or unconsolidated sediments such as gravel, sand, silt, and clay, that were deposited from the mountains by water and gravity into the valley. The alluvium comprises inter-fingering alluvial fans, stream deposits, and terrace deposits The thickness of the alluvium varies from a few feet at the subbasin boundaries to over 1,500 feet in the basin interior.[3] The alluvium thins towards the western and eastern edges of the Santa Clara Plain.

The Santa Clara Plain is divided into confined and recharge (unconfined) areas (Figure 1). The recharge area includes the alluvial fan and deposits found along the edge of the groundwater subbasin where high lateral and vertical sediment allow surface water to infiltrate the aquifers. Surface water replenishes unconfined groundwater within the recharge area and contributes to the recharge of deep aquifers in the confined area through subsurface flow. As groundwater pumping exceeds natural recharge, the District operates managed groundwater recharge facilities within the recharge area to replenish groundwater storage.

The confined area of the Santa Clara Plain is located in the northern and central portion of the subbasin. It is characterized by upper and lower aquifers, divided by laterally extensive, low-permeability clays and silts, which restrict the vertical flow of groundwater. The District refers to these aquifers as the shallow and principal aquifer zones. The shallow and principal aquifer zones are represented by wells primarily drawing water from depths less than and greater than 150 feet, respectively. The principal aquifer zone is less vulnerable to contamination than shallow aquifers since the confining layers also restrict the movement of contaminants that may be present in infiltrating water. The boundary between the confined and recharge areas is a simplification of the natural conditions in the subbasin and two prior versions of this boundary have been published by the USGS[4] and State Water Resources Control Board.[5] A generalized cross-section of the Santa Clara Plain is shown in Figure 2.

Groundwater in the Santa Clara Plain is found at different depths in the unconfined aquifer and under artesian conditions in the confined aquifer. Groundwater movement generally follows surface water patterns, flowing to the northwest. Local groundwater also moves toward areas of intense pumping. Regional groundwater elevations in the Santa Clara Plain range from 60 to 90 feet below sea level in the middle of the subbasin, to 220 to 480 feet above mean sea level near the southern extent of the eastern and western hills of the Santa Clara Plain. There has been a significant recovery in groundwater levels since the District's managed groundwater recharge program was started. As seen in the hydrograph (Figure 3) typical seasonal fluctuations are about 10 to 20 feet.

2.1.2 Santa Clara Plain Pumping and Recharge

In 2010, groundwater pumping in the Santa Clara Plain was approximately 81,100 AF. As shown on Figure 4, 96% of the water pumped was for municipal and industrial uses, with minor amounts used for agriculture and domestic purposes. Figure 4 also shows the number of wells reporting groundwater pumped for each of these uses in 2010. It should be noted that a single well may be used for more than one purpose. Water retailer pumping accounted for nearly 90% of the groundwater pumped from the Santa Clara Plain in 2010. Although there is some variation from year to year, this represents typical recent pumping patterns for the Santa Clara Plain.

Subbasin water levels reflect the amount of groundwater in storage and are strongly influenced by groundwater pumping. The distribution and pumping of these wells for 2010 indicate that the

[3] Santa Clara Valley Water District, Standards for the Construction and Destruction of Wells and other Deep Excavations in Santa Clara County, June 1989.
[4] USGS, Ground water in Santa Clara Valley, California, Water-Supply Paper 519, 1924.
[5] California State Water Resources Control Board, Santa Clara Valley Investigation, Bulletin Number 7, 1955.

greatest numbers of high production wells (500 to 4,000 AF per year) are in the central and southern portion of the Santa Clara Plain as shown in Figure 5.

The annual groundwater production for the Santa Clara Plain is shown in Figure 2–6. For the time period shown, the maximum groundwater production of 181,000 AF in the Santa Clara Plain occurred in 1985. A sharp decrease in groundwater production in the Santa Clara Plain can be noted in 1989, the year that the District's third and largest water treatment plant (Santa Teresa) came on-line to utilize water imported from the Central Valley Project. Prior to 1989, the average annual pumping in the Santa Clara Plain was 157,000 AF. After the Santa Teresa plant came on-line, average pumping dropped to 106,000 AF per year. Managed recharge provides the majority of water available for groundwater production, as shown in Table 7 and Figure 6.

The Santa Clara Groundwater Subbasin is actively managed by the District. On average, more than 76,000 acre-feet per year (AF/yr) of local reservoir and imported water are percolated into Santa Clara Groundwater Subbasin aquifers through the District's Managed Aquifer Recharge programs. The addition of water through planned or incidental recharge sustains the groundwater supply, and can improve water quality by diluting existing contaminants in the aquifer, diminish water quality by introducing contaminants[6], or induce geochemical changes in the aquifers. The District has been recharging local reservoir water into the aquifers since the 1930s and water imported from the Sacramento-San Joaquin Delta since the 1960s.

The District's managed recharge program is an important management tool that has contributed to aquifer storage recovery, cessation of unacceptable levels of inelastic land subsidence, and improved water quality in impacted areas. Another important influence on groundwater quality is infiltration from applied irrigation water or stormwater. Applied irrigation water from any source can contribute salt and other constituents. Recycled water has a higher concentration of S/Ns than groundwater or treated water. Salts and Nutrients are introduced to groundwater through landscape irrigation with tertiary treated recycled water. Recycled water producers are actively pursuing advanced treatment and other measures to reduce the salinity of recycled water. For example, the District constructed the Silicon Valley Advanced Water Purification Center that produces water with TDS that is about 5% of tertiary treated recycled water. The City of Palo Alto has achieved recycled water salinity reduction by repairing sections of submerged sewer lines subject to infiltration of saline groundwater near the Bay.

[6] The District's Recharge Water Quality Monitoring Program periodically confirms that only high quality water is used to recharge the subbasin.

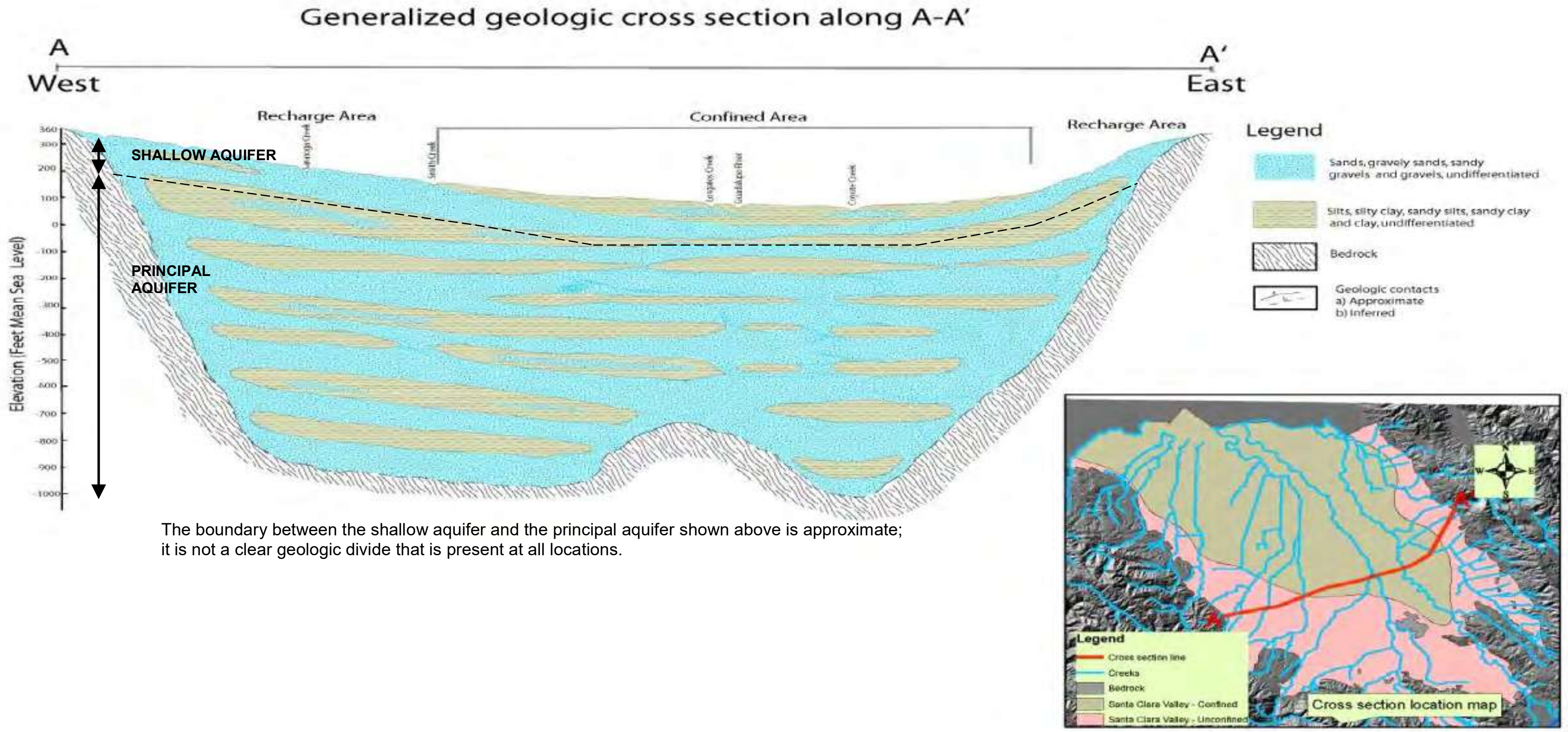


Figure 2 – Generalized Geologic Cross-Section of the Santa Clara Plain

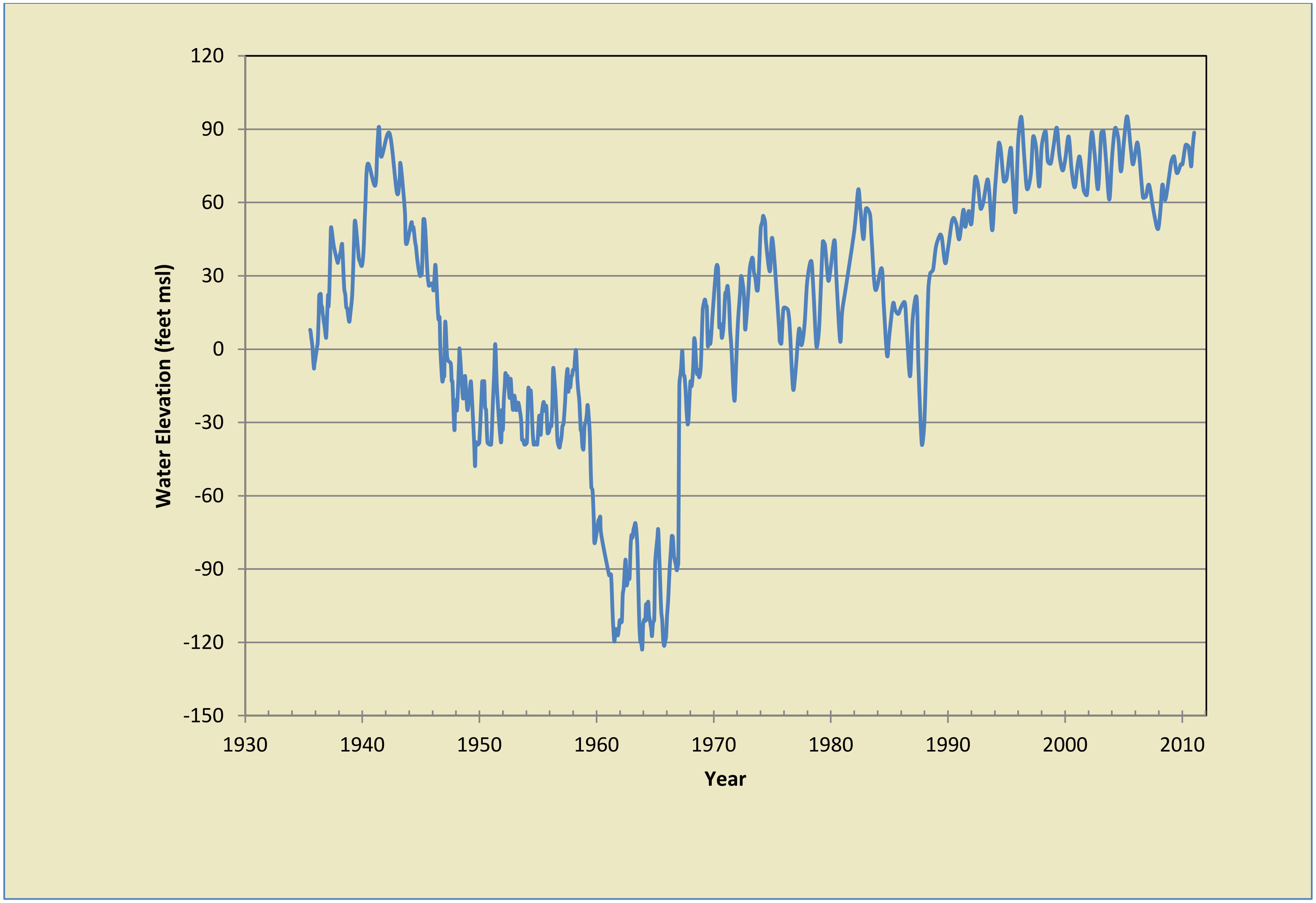


Figure 3 – Santa Clara Plain Index Well Hydrograph

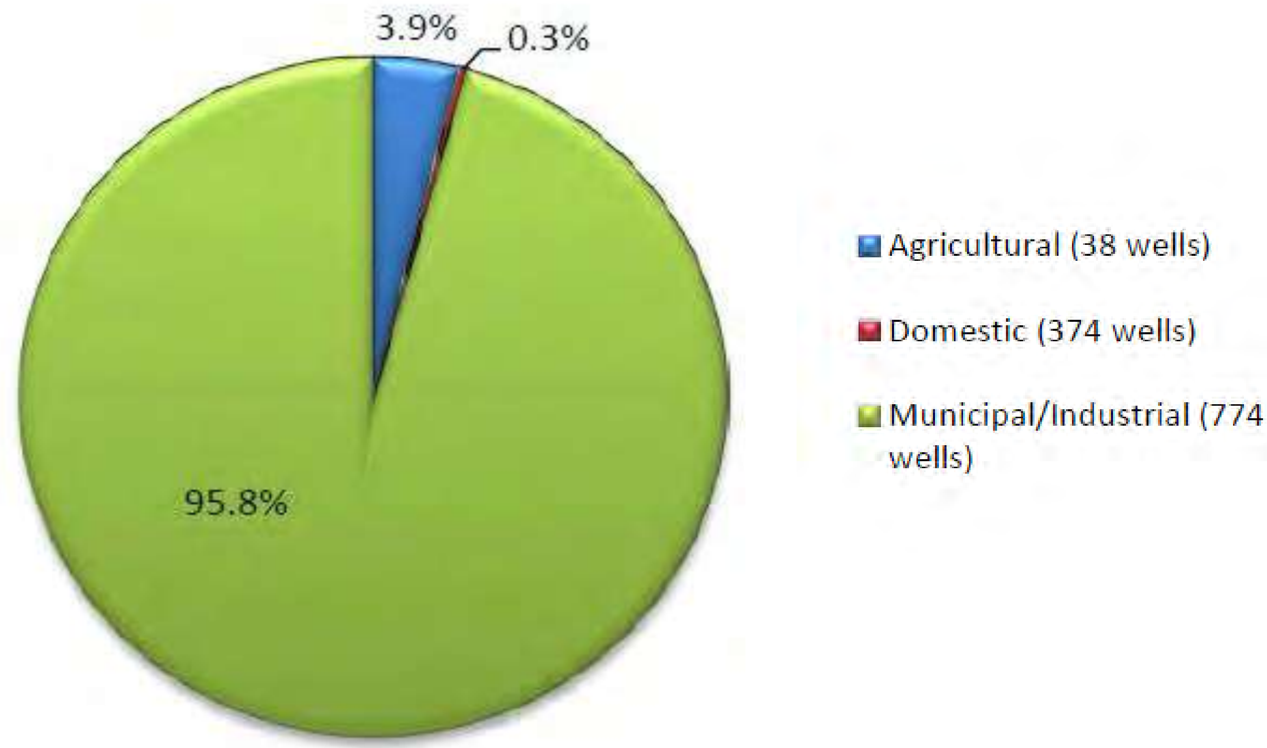


Figure 4 – Santa Clara Plain 2010 Groundwater Use

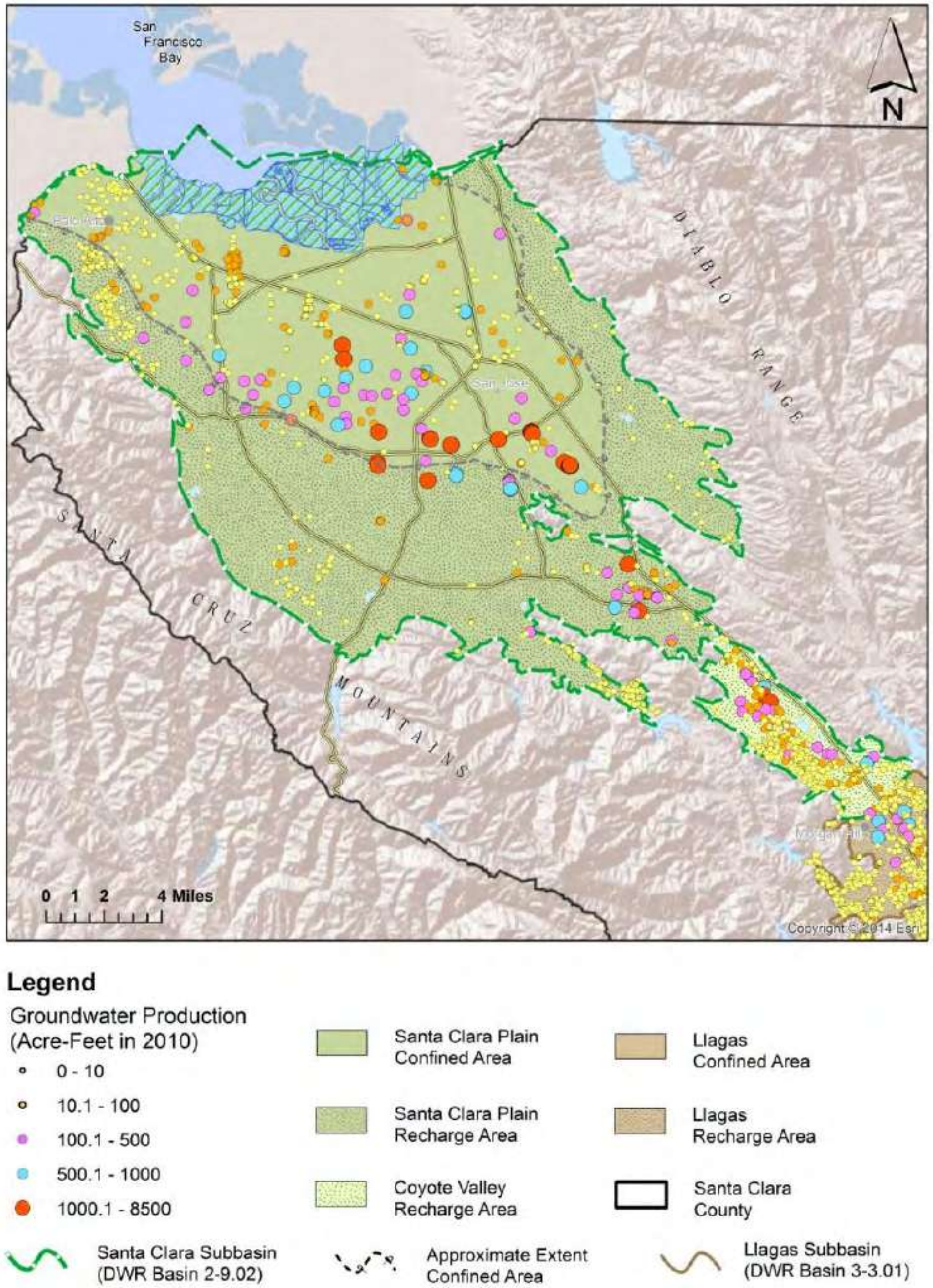


Figure 5 – 2010 Groundwater Pumping in the Santa Clara Groundwater Subbasin

Table 7- Santa Clara Plain Principal Aquifer Water Budget (2002 to 2011)

Water Budget Component	Acre-Feet
Inflow	
Managed Recharge	64,000
Natural Recharge	30,000
Subsurface Inflow	8,000
Total Inflow	102,000
Outflow	
Groundwater Pumping	95,000
Subsurface Outflow	6,000
Total Outflow	101,000
Change in Storage	1,000

Notes:

1. Managed recharge represents direct replenishment by the District using local and imported water.
2. Natural recharge includes all uncontrolled recharge, including the deep percolation of rainfall, septic system and/or irrigation return flows, and natural seepage through creeks.
3. Subsurface inflow represents inflow from adjacent aquifer systems, including inflow from the Coyote Valley.
4. Groundwater pumping is based on pumping reported by water supply well owners.
5. Subsurface outflow represents outflow to adjacent aquifer systems, including outflows to San Francisco Bay.

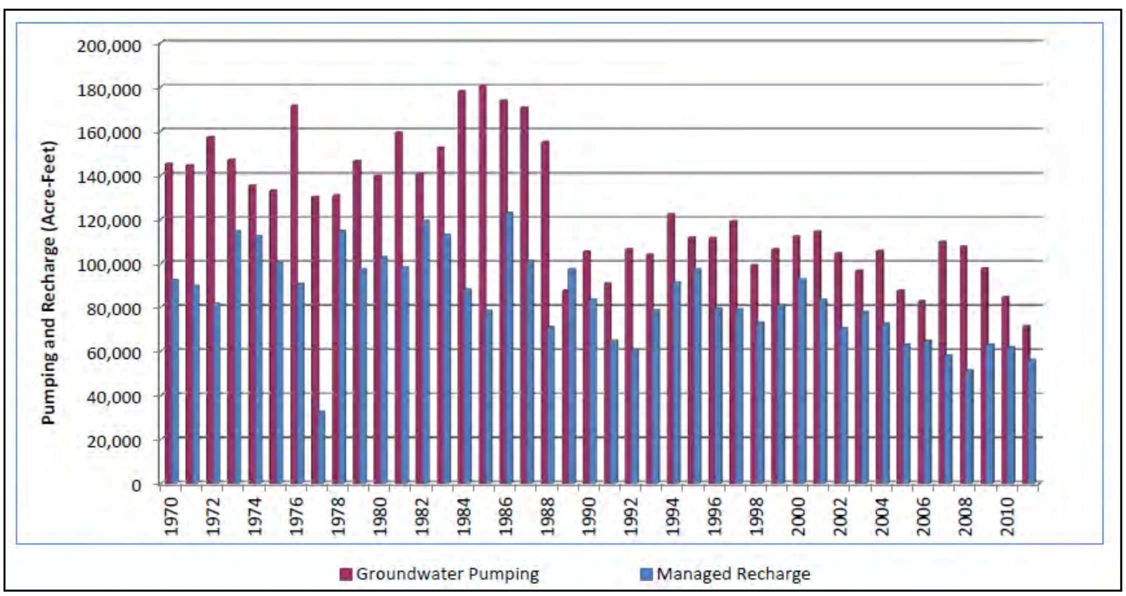


Figure 6 – Santa Clara Plain Groundwater Pumping and Managed Recharge

2.1.3 Santa Clara Plain Groundwater Elevation Trends

Groundwater elevations are affected by natural and managed recharge and groundwater extraction, and are an indicator of how much groundwater is in storage at a particular time. Both low and high elevations can cause adverse conditions. Low groundwater levels can lead to land subsidence or saltwater intrusion, and high water levels can lead to groundwater intrusion into basements, parking garages, elevator shafts, and other below-ground structures.

Figure 7 depicts changes in groundwater elevations over the last hundred years for the Santa Clara Plain. Annual fluctuations reflect recharge in winter and spring and pumping in summer.

The increase in groundwater elevations through the late 1930s and 1940s are attributed to the expansion of the District's conjunctive use program. An increase in groundwater elevations are also attributed with the construction of the District's local reservoirs and increased volumes of recharge utilizing reservoir releases. Downward trends beginning in 1940 are a result of increased agricultural pumping. Long term declines, starting in the late 1940s and later, reflect growing municipal and industrial demands in Silicon Valley that correlate with rapid population growth. The increase in groundwater elevations in the late 1960s and 1970s is due to the delivery of State Water Project water through the South Bay Aqueduct, and the completion of the District's Rinconada and Penitencia Water Treatment Plants. Even with a significant drought from 1987 to 1992, groundwater elevations improved beginning in 1989 with the addition of federal Central Valley Project deliveries and the completion of the Santa Teresa Water Treatment Plant.

2.1.4 Santa Clara Plain Storage Capacity

The operational storage capacity of the Santa Clara Plain has been estimated to be 350,000 AF.[7] The operational storage capacity represents the volume of groundwater that can be stored while avoiding adverse impacts such as inelastic land subsidence and saltwater intrusion. The District is currently working to refine this estimate based on historically observed data.

2.1.5 Santa Clara Plain Water Budget

A water budget for the Santa Clara Plain for calendar years 2002 through 2011 is shown in Table 7. The water budget is based on the District groundwater flow model[8] for the Santa Clara Plain, and represents inflows and outflows for the principal aquifer. A majority of the inflow to the Santa Clara Plain is a result of managed recharge of local and imported supplies. Although the water budget can vary significantly from year to year, on average, there was a slight annual increase in storage for the Santa Clara Plain over this 10-year period.

[7] Santa Clara Valley Water District, 2012 Groundwater Management Plan

[8] The District uses MODFLOW to forecast groundwater supply and assess the annual water budget. Separate MODFLOW models are used for Santa Clara Plain, Coyote Valley, and the Llagas Subbasin.

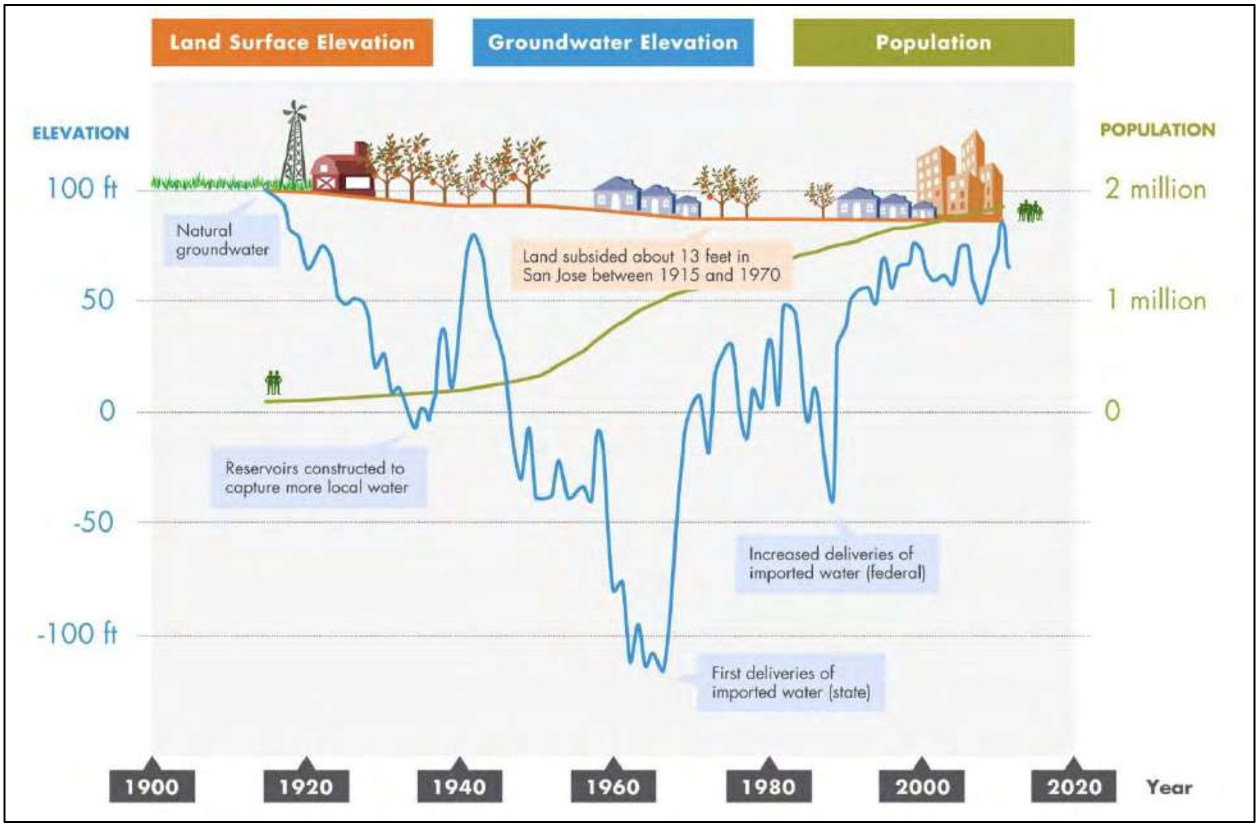


Figure 7 – Historical Water Levels, Land Subsidence, and Groundwater Recharge Milestones

2.1.6 Santa Clara Plain Groundwater Quality

The Santa Clara Plain generally produces water of excellent quality for municipal, irrigation, and domestic supply. Within the Santa Clara Plain calcium and magnesium constitute the principal cations, and bicarbonate as the most prevalent anion. The total dissolved solids (TDS) content is typically 200 to 500 mg/L, with the exception of localized areas including the Evergreen area of San Jose, and all of Palo Alto (see Figure 17). The median TDS content for the principal aquifer zone is 400 mg/L. The median is the preferred statistic to represent water quality because it represents the middle of the data set and is less affected by outliers and skewed data.

Some shallow aquifers adjacent to the San Francisco Bay have been affected by saltwater intrusion. High TDS is also noted in some wells close to the Bay. Very few wells sampled each year contain contaminants above primary MCLs.[9] A summary of the shallow and principal aquifer water quality from 2002 to 2011 is presented in Tables 8 and 9. Groundwater quality is discussed in more detail in section 2.5.

[9] Santa Clara Valley Water District, 2012 Groundwater Quality Report.

Table 8 – Santa Clara Plain Shallow Aquifer Zone[1] Groundwater Quality Summary Statistics

Parameter[2]	2002 – 2011 Results[3]			Population Median[4]		MCL[5]		n[6]
	25th Percentile	50th Percentile (Median)	75th Percentile	Lower	Upper	Primary	Secondary	
Nitrate as NO_3 (mg/L)	0.30	1.4	6.4	0.60	3.3	45	NE	35
Total Dissolved Solids (mg/L)	410	588	840	440	820	NE	500	31

Table 9 – Santa Clara Plain Principal Aquifer Zone[1] Groundwater Quality Summary Statistics

Parameter[2]	2002 – 2011 Results[3]			Population Median[4]		MCL[5]		n[6]
	25th Percentile	50th Percentile (Median)	75th Percentile	Lower	Upper	Primary	Secondary	
Nitrate as NO_3 (mg/L)	4.2	9.3	20.8	8.1	10.7	45	NE	288
Total Dissolved Solids (mg/L)	337	400	490	384	410	NE	500	273

Notes:

1. The shallow aquifer zone is represented by wells primarily drawing water from depths less than 150 feet, while the principal aquifer zone is represented by wells primarily drawing water from depths greater than 150 feet.
2. mg/L = milligrams per liter (or parts per million)
3. The percentile is the value below, which a certain percent of observations fall (e.g., the 50th percentile, or median, is the value below which half of the observations fall). For parameters with results reported at multiple reporting limits, the Maximum Likelihood Estimate (MLE) method is used.
4. The lower and upper estimates of the population median are determined using a 95% confidence interval (alpha = 0.05).
5. Primary and secondary MCLs are from the California Code of Regulations. Primary MCLs are health-based drinking water standards, while secondary MCLs are aesthetic-based standards. For secondary MCLs with a range, the lower, recommended threshold is shown. NE= Not Established
6. n represents the number of wells tested.

2.2 Coyote Valley Hydrogeology

The Coyote Valley is the southern extension of the Santa Clara Valley Groundwater Basin, covering a surface area of 17 square miles. The Coyote Valley is approximately 7 miles long, and ranges from 3 miles wide to about a half mile wide at the boundary with the Santa Clara Plain to the north. The alluvial sediments overlying the Santa Clara Formation vary in thickness from a few feet or less along the west side of the subbasin, to more than 400 feet along the east side. The alluvial sediments are mainly composed of thick sequences of alluvial sand and gravel with inter-bedded thin and discontinuous clays. The absence of a continuous horizon of clay limits the delineation of shallow and principal aquifers in Coyote Valley. Accordingly, the Coyote Valley alluvium is treated as a single unconfined aquifer. A generalized cross-section of the Coyote Valley is presented in Figure 8.

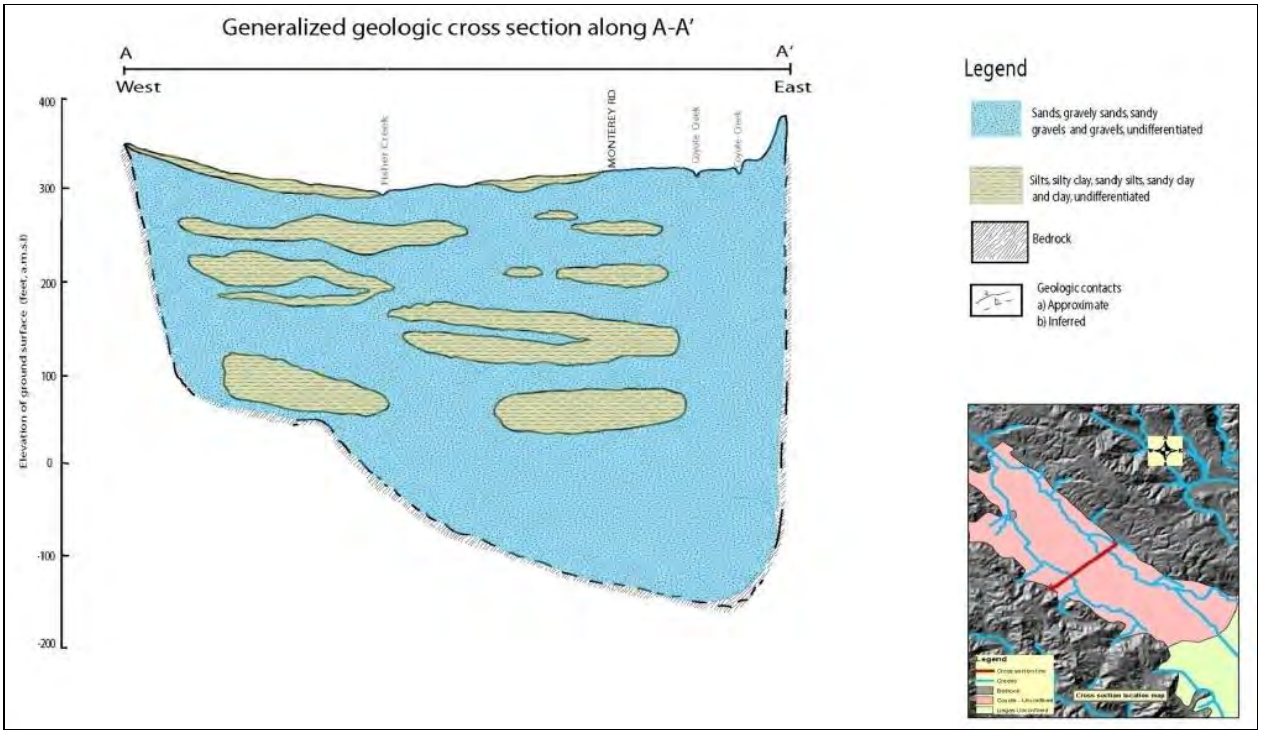


Figure 8 – Coyote Valley Generalized Cross Section

The Coyote Valley is generally unconfined and groundwater is typically encountered between 5 and 40 feet below ground surface. Groundwater movement follows surface water patterns, flowing to the northwest and draining into the Santa Clara Plain. Regional groundwater elevations in Coyote Valley range from 200 to 220 feet near the Coyote Narrows, to about 350 feet at Cochrane Road in Morgan Hill.

Groundwater levels in the Coyote Valley respond rapidly to changes in hydrology and pumping. Local groundwater moves toward areas of intense pumping, especially at the southeastern and northern parts of the subbasin where retailer groundwater production wells are located. Groundwater recharge occurs along Coyote Creek due to the District managed recharge releases from Anderson Reservoir and stream seepage. The District does not have off-stream managed groundwater recharge facilities in the Coyote Valley.

2.2.1 Coyote Valley Pumping

In 2010, groundwater pumping in the Coyote Valley was approximately 12,300 AF. As shown on Figure 9, 53% of groundwater pumped was for municipal and industrial uses (M&I), and 45% of groundwater pumped was used for agriculture. Only 2% of groundwater pumping was for domestic use. Pumping by water retailers accounted for over 60% of pumping in the Coyote Valley in 2010. Although there is some variation from year to year, this figure represents typical recent pumping patterns for the Coyote Valley.

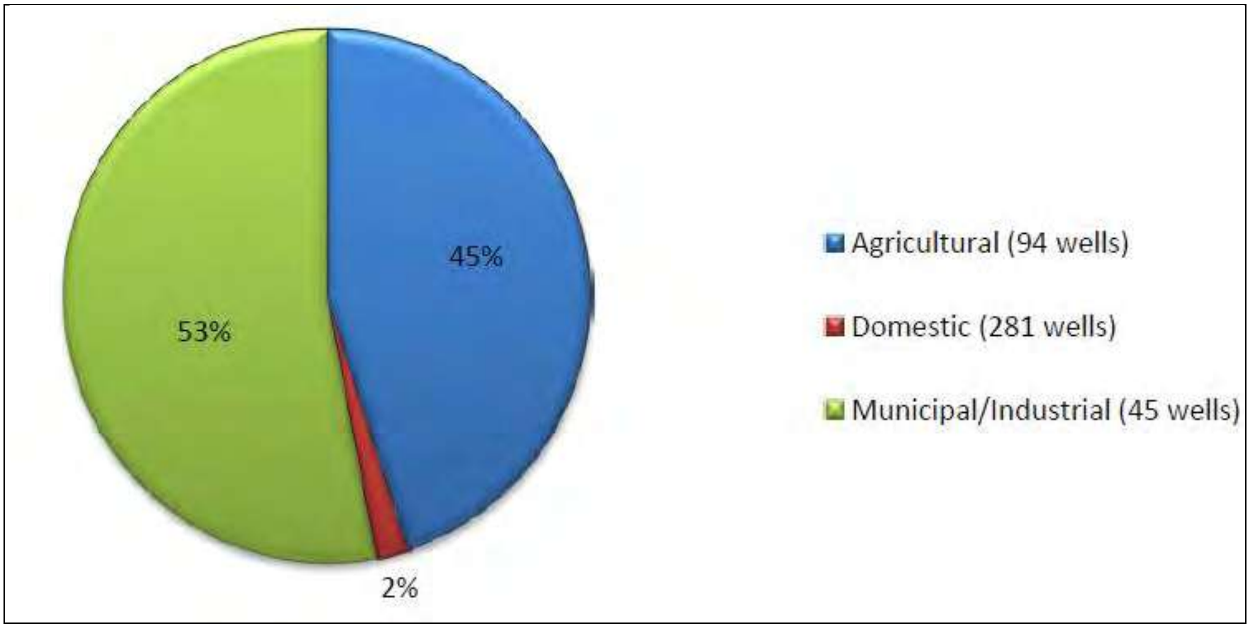


Figure 9 – Coyote Valley 2010 Groundwater Use

2.2.2 Coyote Valley Groundwater Pumping Trends

As shown in Figure 6, high production wells (500 to 4,000 AF/yr) are in the southern portion of the Coyote Valley. The District assumed management of the Coyote Valley and Llagas Subbasin in 1987; prior to that date, limited groundwater pumping data are available. Coyote Valley groundwater production remained fairly consistent until 2006, when new water retailer wells began pumping water to serve customers in the Santa Clara Plain. Managed recharge provides the majority of water available for groundwater production, as shown in Table 10 and Figure 10. Managed recharge in the Coyote Valley supports the maintenance of subsurface flows to the Santa Clara Plain.

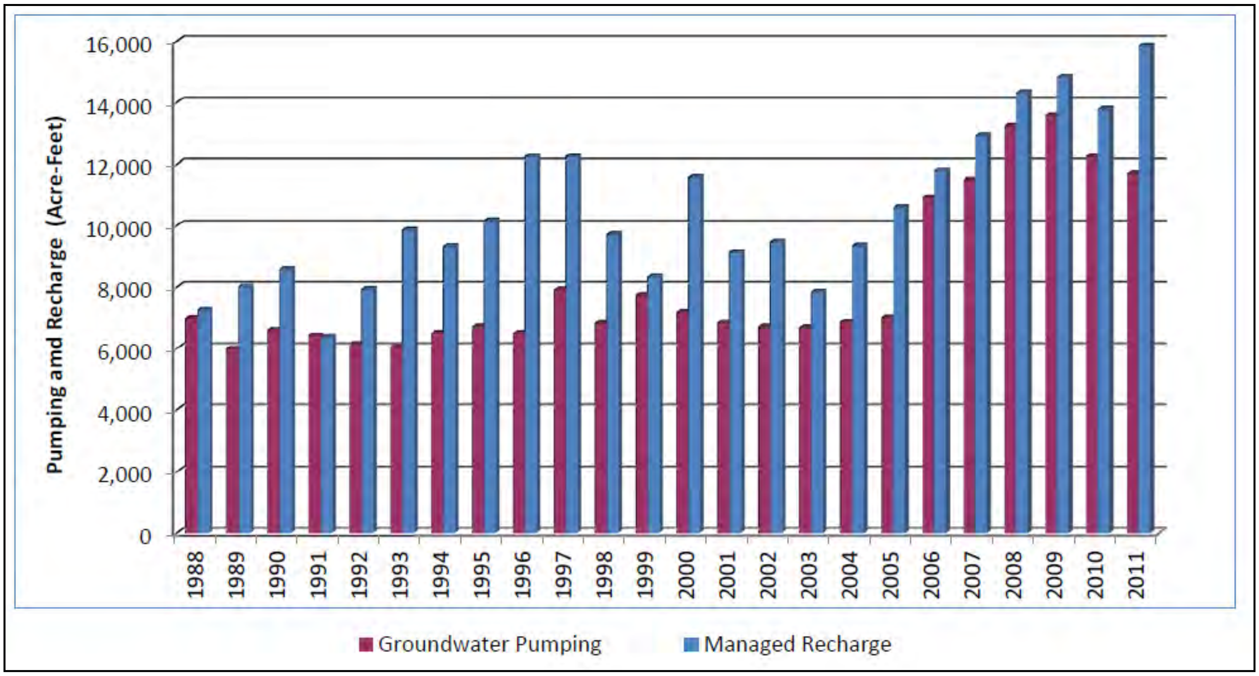


Figure 10 – Coyote Valley Groundwater Pumping and Managed Recharge

2.2.3 Coyote Valley Storage Capacity

The operational storage capacity of the Coyote Valley ranges between 23,000 and 33,000 AF.[10] The District is currently working to refine the operational storage capacity estimate based on historically observed data.

2.2.4 Coyote Valley Water Budget

Average Coyote Valley inflows and outflows for calendar years 2002 to 2011 are presented in Table 10. The Coyote Valley is dependent on Coyote Creek for its water supply, which is largely fed by releases from the Anderson-Coyote reservoir system. Imported water from the San Felipe Project can also be released to Coyote Creek. Natural recharge from rainfall and other sources typically account for less than 25% of the inflows to the Coyote Valley. Over the 10-year period evaluated, the Coyote Valley has seen a slight annual decrease in storage.

[10] Santa Clara Valley Water District, Operational Storage Capacity of the Coyote and Llagas Groundwater Subbasins, April 2002.

Table 10 – Coyote Valley Water Budget (2002 to 2011)

Water Budget Component	Acre-Feet
Inflow	
Managed Recharge	12,000
Natural Recharge	2,500
Subsurface Inflow	0
Total Inflow	14,500
Outflow	
Groundwater Pumping	10,000
Subsurface Outflow	5,000
Total Outflow	15,000
Change in Storage	- 500

Notes:

1. Managed recharge represents direct replenishment by the District using local and imported water.
2. Natural recharge includes all uncontrolled recharge, including rainfall, septic system and/or irrigation return flows, and natural seepage through creeks.
3. Subsurface inflow represents inflow from adjacent aquifer systems.
4. Groundwater pumping is based on pumping reported by water supply well owners.
5. Subsurface outflow represents outflow to adjacent aquifer systems.

2.2.5 Coyote Valley Groundwater Elevation Trends

Groundwater elevations are affected by natural and managed recharge and groundwater extraction, and are an indicator of how much groundwater is in storage at a particular time. Groundwater elevations have been relatively stable since about 1970, although there has been a slight decreasing trend since the late 1990’s. A typical hydrograph is shown in Figure 11.

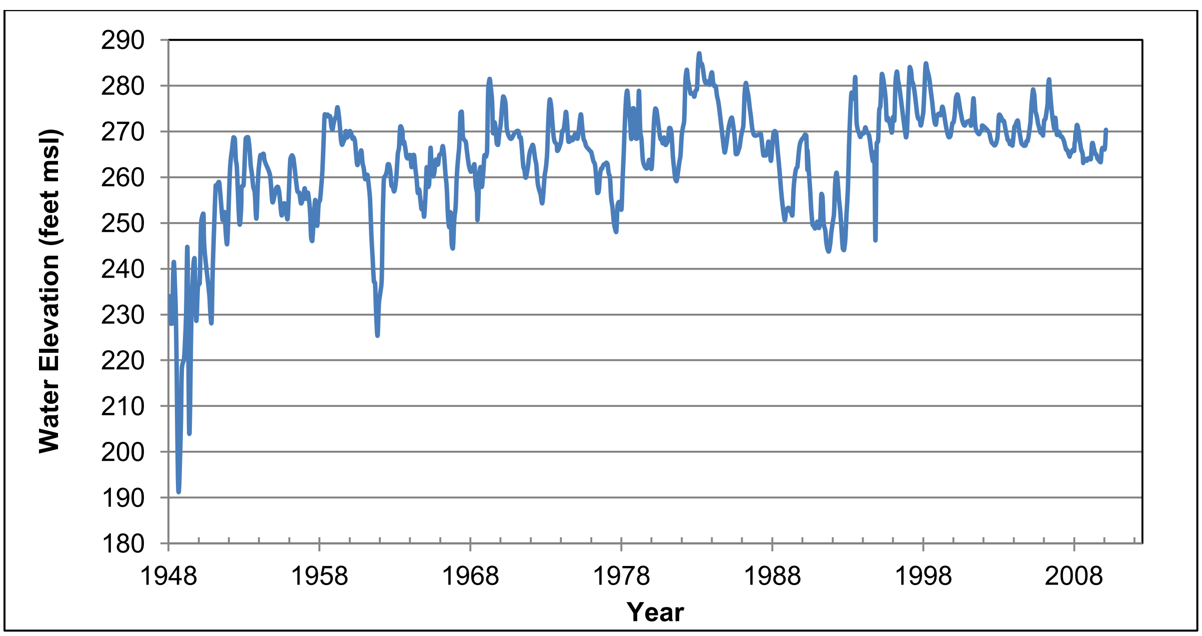


Figure 11 – Groundwater Elevation in Coyote Valley Well 09S02E02J002

2.2.6 Coyote Valley Groundwater Quality

The Coyote Valley produces water of good quality for municipal, irrigation, and domestic supply. The typical water type is dominated by calcium-magnesium and bicarbonate. The median TDS concentration is 368 mg/L, which is below the recommended secondary MCL of 500 mg/L. The median nitrate concentration is 15 mg/L, below the MCL of 45 mg/L. Typically, very few wells sampled each year contain contaminants above primary MCLs. A summary of Coyote Valley water quality data is presented in Table 11. Groundwater quality is discussed in more detail in section 2.5.

Table 11 – Coyote Valley Groundwater Quality Summary Statistics

Parameter[1]	2002 – 2011 Results[2]			Population Median[3]		MCL[4]		n[5]
	25th Percentile	50th Percentile (Median)	75th Percentile	Lower	Upper	Primary	Secondary	
Nitrate as NO_3 (mg/L)	3.7	15.0	43.0	4.5	29.8	45	NE	39
Total Dissolved Solids (mg/L)	320	368	414	328	405	NE	500	29

Notes:
1. mg/L= milligrams per liter (parts per million)
2. The percentile is the value below, which a certain percent of observations fall (e.g., the 5^{0th} percentile, or median, is the value below which half of the observations fall). For parameters with results reported at multiple reporting limits, the Maximum Likelihood Estimate (MLE) method is used.
3. The lower and upper estimates of the population median are determined using a 95% confidence interval (alpha = 0.05).
4. Primary and secondary MCLs are from the California Code of Regulations. Primary MCLs are health-based drinking water standards, while secondary MCLs are aesthetic-based standards. For secondary MCLs with a range, the lower, recommended threshold is shown. NE= Not Established
5. n represents the number of wells tested.

2.3 Sources of Supply

A majority of the inflow to the Santa Clara Plain is a result of artificial recharge of local and imported supplies. Even with supplemental recharge, groundwater alone provides insufficient water supply to support this heavily developed area. Treated surface water deliveries have been critical to the area for half a century – first with SFPUC Hetch-Hetchy delivery to local water retailers, and later with District treated water deliveries. The Los Gatos, Westside, Penitencia, Guadalupe, and the Coyote Valley recharge systems are operated to actively recharge the Santa Clara Plain using imported and local reservoir water.

The Coyote Valley is almost entirely dependent on Coyote Creek for its water supply, which is largely fed by releases from the Anderson-Coyote reservoir system. Imported water from the Federal Central Valley Project may also be released to Coyote Creek.

2.4 Santa Clara Groundwater Subbasin Water Budget

The water budget for the Santa Clara Groundwater Subbasin is summarized in Figure 12. Long-term groundwater pumping for the Santa Clara Plain averages about 95,000 AF per year based on data from 2002 to 2011. Historical pumping has been as high as 180,000 AF per year. The subsurface outflow from the Santa Clara Plain, which includes outflow to the San Francisco Bay, was 6,000 AF per year. Average recharge to the Santa Clara Plain is estimated to be 102,000 AF per year with sources including the District's managed recharge of local and imported water, deep percolation of rainfall, natural seepage from creeks, and subsurface inflow from surrounding hills (mountain front recharge). Two-thirds of recharge to the Santa Clara Plain comes from the District's managed recharge program. Subsurface inflow from adjacent aquifer systems is estimated to be 8,000 AF per year. The average annual change in groundwater storage between 2002 and 2011 is approximately 500 AF.

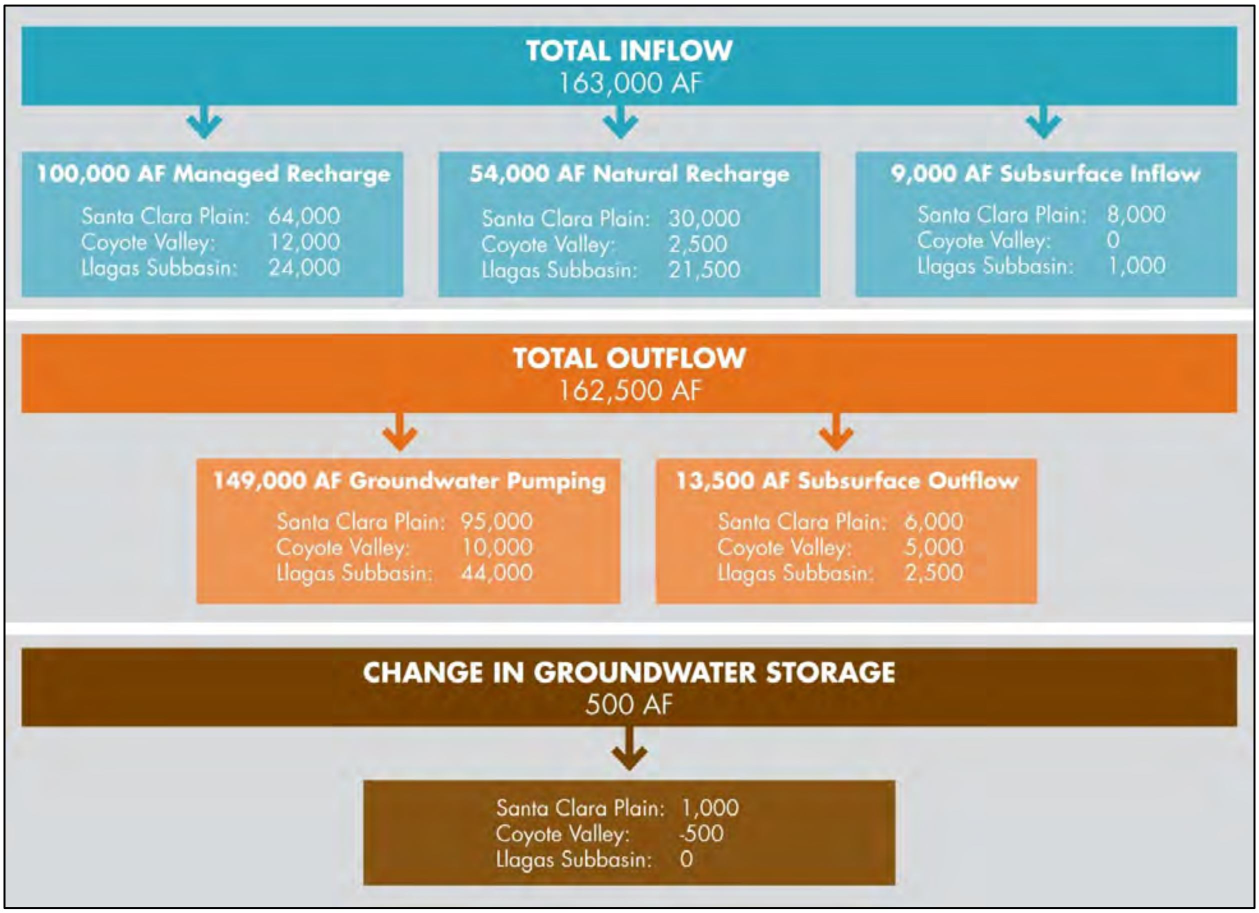


Figure 12 – 2002–2011 Average Groundwater Budget for the Santa Clara Plain and Coyote Valley

The Coyote Valley water budget is based on the District groundwater flow model for the Coyote Valley, and represents general inflows and outflows. The natural recharge term used in the budget is the sum of mountain front recharge, stream seepage, rainfall, septic return, and agricultural and landscape return. The net subbasin outflow term represents the combination of subsurface outflow to the Santa Clara Plain aquifers gaining reaches of streams and evapotranspiration.

2.5 Groundwater Quality – Salts and Nutrients

The District monitors groundwater quality throughout Santa Clara County to evaluate groundwater quality with respect to the RWQCB's Basin Plan Water Quality Objectives, and to provide data needed to support protection of the long-term reliability of the resource. Data on a variety of water quality constituents is collected and analyzed on an annual basis. The results of testing by the District and water suppliers are compared to drinking water standards and Basin Plan Agricultural Objectives. In addition, trends for key constituents are evaluated. This section focuses on water quality parameters pertinent to salt and nutrient management, including nitrate and total dissolved solids (TDS) in the Santa Clara Groundwater Subbasin and is based on the District's 2010 Groundwater Quality Report.[11]

2.5.1 Total Dissolved Solids

Total Dissolved Solids (TDS) is a measure of the combined content of all solutes in a water sample. It is a prime indicator of the general suitability of water, especially for domestic and municipal use. TDS is a comprehensive measure of all salts in groundwater, and is therefore used as the indicator parameter for salts in this SNMP. Tracking individual salts such as sodium, magnesium, or calcium is less informative for salt management because these solutes are subject to cationic exchange, which may decrease concentrations of one solute while increasing another. The relative proportions of calcium, sodium or magnesium may change from geochemical reactions, but the TDS stays relatively constant and is therefore a more robust measure of salts in groundwater. Limitations to TDS measurement accuracy can make comparison of TDS analyzed by different methods difficult. However, the consistent application of a single method employed for analysis of District samples makes TDS the best overall indicator of salt in groundwater.

Dissolved solids in groundwater are related to the interaction of water with the atmosphere, soil, and rock, as well as the quality of water entering the aquifer by managed and incidental recharge. Although not considered a "primary" contaminant associated with health effects, it is used as an indication of the aesthetic characteristic of drinking water. TDS in groundwater can be artificially elevated due to runoff, soil leaching, land use, recharge with high salinity water, or intrusion of saltwater from in the tidal reaches of creeks near the bay.

The Division of Drinking Water (DDW)[12] has adopted a SMCL, 500 mg/L for TDS, which is also the RWQCB's Basin Plan Objective. SMCLs address aesthetic issues related to taste, odor, or appearance of the water and are not related to health effects. The District compares concentrations of TDS to both the "recommended" and an "upper" SMCL as identified by DDW.

Table 2–6 summarizes 2012 data for TDS in the principal aquifer zones of the Santa Clara Groundwater Subbasin. Thirty-two of 101 wells (31.7%) tested in the Santa Clara Plain were found to contain TDS in excess of the "recommended" SMCL of 500 mg/L. When wells in the zone of saline intrusion are excluded from the count of wells with TDS in excess of the SMCL (4 wells), there are 27 of 96 wells (28%) with TDS greater than 500 mg/L. Two of the wells tested in the Santa Clara Plain principal aquifer exceeded the "upper" SMCL of 1,000 mg/L for TDS. Both wells with TDS greater than 1,000 mg/L are deep monitoring wells located in the same

---

[11] Additional information is available in the District's most recent annual groundwater report at http://www.valleywater.org/services/Groundwater.aspx.

[12] In July, 2014, the California Department of Public Health Division of Drinking Water was reorganized into the State Water Resources Control Board.

cluster in Palo Alto, where marine sediments contribute to elevated TDS (Metzger and Fio, 1997).

In the Coyote Valley, 2 of 20 wells (10%) tested contained TDS above the "recommended" SMCL. None of the wells tested in Coyote Valley exceeded the "upper" SMCL of 1,000 mg/L for TDS.

Table 12 – 2012 TDS Testing Results

Constituent	Units	SMCL[1]	Santa Clara Plain[2]		Coyote Valley	
			Median	Range	Median	Range
Total Dissolved Solids	mg/L	500 (1000)	395	174 – 2,520[3]	358	236 – 630

1. The lower recommended limit is listed and the upper limit is shown in parentheses. Source: 2012 Annual Groundwater Report.
2. Santa Clara Plain results are for the principal aquifer zone (wells with a total depth greater than 150 feet).
3. The well with elevated TDS is screened at 780 feet below ground in a zone of marine sediments (Metzger and Fio, 1997).

2.5.2 Nitrate

Nitrate is regulated with a MCL due to acute health effects (methemoglobinemia)[13] in infants exposed to elevated nitrate levels. Elevated nitrate concentrations have been an ongoing groundwater quality challenge in the Llagas Groundwater Subbasin in the southern part of the County.[14] Groundwater in the Santa Clara Plain and the Coyote Valley is generally well below the nitrate MCL with a few localized exceptions. The primary sources of nitrate added to the Santa Clara Plain include irrigated groundwater, sewer system exfiltration, and recycled water. The area overlying the Santa Clara Plain consists mostly of urban and suburban development. Almost all areas are served by municipal wastewater systems, and the use of individual septic systems is limited to the southern end of the Almaden Valley. While once prevalent, today only a few pockets of agricultural land remain in the Santa Clara Plain. Moderately elevated nitrate in the western portion of the Santa Clara Plain is likely due to past agricultural legacy land uses. Land use in the northern portion of the Coyote Valley is predominantly agricultural, and the southern portion contains both agricultural land use and residential development. Septic systems are common in much of the Coyote Valley because no municipal wastewater collection system exists. The primary sources of nitrate are agricultural fertilizers and septic tank leach fields (SCVWD, 1994).

Table 2–7 summarizes 2012 data for nitrate and other nitrogen constituents in the principal aquifer zones of the Santa Clara Plain and the Coyote Valley. One of 210 wells tested located in the Santa Clara Plain was found to contain nitrate in excess of the MCL (less than 1%). In Coyote Valley, 6 of 39 wells (15%) tested contained nitrate above the MCL.

The Basin Plan Agricultural Objective of 5 mg/L for nitrate + nitrite (as N) was also exceeded in several wells in the Santa Clara Groundwater Subbasin. Thirty seven of 210 wells (18%) in the

[13] Methemoglobinemia is the presence of methemoglobin in the blood due to conversion of part of the hemoglobin to this inactive form, and can be induced from consumption of excessive concentrations of nitrate in food or water.
[14] See the Llagas Subbasin SNMP for further details on nitrate and TDS in the Llagas Subbasin.

principal aquifer zone of the Santa Clara Plain exceeded the agricultural objective, and 22 wells (56%) in the Coyote Valley exceeded the agricultural objective for nitrate + nitrite.[15]

Table 13 – 2012 Nitrogen Constituent Testing Results

Constituent	Units	MCL	Santa Clara Plain[1]		Coyote Valley	
			Median	Range	Median	Range
Nitrate (as NO_3)	mg/L[2]	45	12.4	ND[3] – 45.6	10.6	ND – 58

1. Santa Clara Plain results are for the principal aquifer zone or wells with a total depth greater than 150 feet. Source: Santa Clara Valley Water District 2010 Groundwater Quality Report.
2. mg/L = milligrams per liter (parts per million).
3. ND = Not detected at testing limit.

2.5.3 Trends in TDS and Nitrate

Trends in TDS and nitrate were evaluated from 1998 to 2012, using the non-parametric, non–-seasonal Mann-Kendall trend test. This procedure was chosen due to its ability to handle non-detect data and ease of use. All trend tests were evaluated at the 95% confidence level (alpha = 0.05). Trends were tested at all wells having a minimum of 5 data points over the fifteen-year period. Table 14 provides a summary of nitrate and TDS trend results by area and aquifer zone. Maps showing the spatial distribution of TDS and nitrate concentration trends are shown in Figures 13 and 14.

Table 14 – 15-year TDS and Nitrate Concentration Trend Analysis Results (1998-2012)

Study Area Category	# wells w/ upward trend	# wells w/ downward trend	# wells w/ no trend	Total	Range of Change: upward rate of change (mg/L/yr)	Range of Change: downward rate (mg/L/yr)
Total Dissolved Solids						
Santa Clara Plain – principal zone	3	6	138	147	7.6–9.9	4.9–22.4
Santa Clara Plain – shallow zone	2	5	14	21	27.1–104.9	2.5–56.4
Coyote Valley	2	0	15	17	5.4–18	–
Total	**7**	**11**	**167**	**185**	**–**	**–**
Nitrate as NO_3						
Santa Clara Plain – principal zone	10	48	171	229	0.2 – 0.7	0.03 – 1.68
Santa Clara Plain – shallow zone	1	2	18	21	0.51	1.05 – 1.63

[15] Agricultural objective evaluated against nitrate data only, which are more abundant. If nitrate concentration exceeded agricultural objective, it was assumed that an analysis for nitrate + nitrate would also show exceedance of the agricultural objective.

Coyote Valley	2	8	18	28	1.07 – 1.15	0.04 – 1.44
Total	**13**	**58**	**207**	**278**	--	--

2.5.4 TDS Trends in Monitoring Wells, for 1998–2012

In the Santa Clara Plain shallow aquifer, TDS trends were tested on 21 wells, with upward trends detected in 2 wells, downward trends in 5 wells, and no trend in 14 wells (67%).

TDS trends were tested for 147 Santa Clara Plain principal aquifer wells. Upward trends were detected in 3 wells and downward trends were found in 6 wells. No trend was detected in the remaining 138 wells (94%). In the Santa Clara Groundwater Subbasin, wells having a downward trend in TDS are primarily located along or near Coyote Creek.

In the Coyote Valley, TDS was evaluated on 17 wells for 1998–2012. No trend was detected in 15 wells (88%) and an upward trend was detected in 2 wells (12%).

2.5.5 Nitrate Trends in Monitoring Wells, for 1998–2012

Nitrate trends were tested at 21 wells in the Santa Clara Plain shallow aquifer. An upward trend was detected in 1 well and downward trends were found in 2 wells, while no trends were detected in the remaining 18 wells (86%).

In the Santa Clara Plain principal aquifer, trends were tested for 147 wells, with an upward trend found in 3 wells and downward trend in 6 wells, and the remaining 138 wells displayed no trend (94%).

In the Coyote Valley, nitrate trends were tested on 28 wells. An upward trend was indicated in 2 wells and a downward trend in 8 wells, with 18 wells showing no trend (64%).

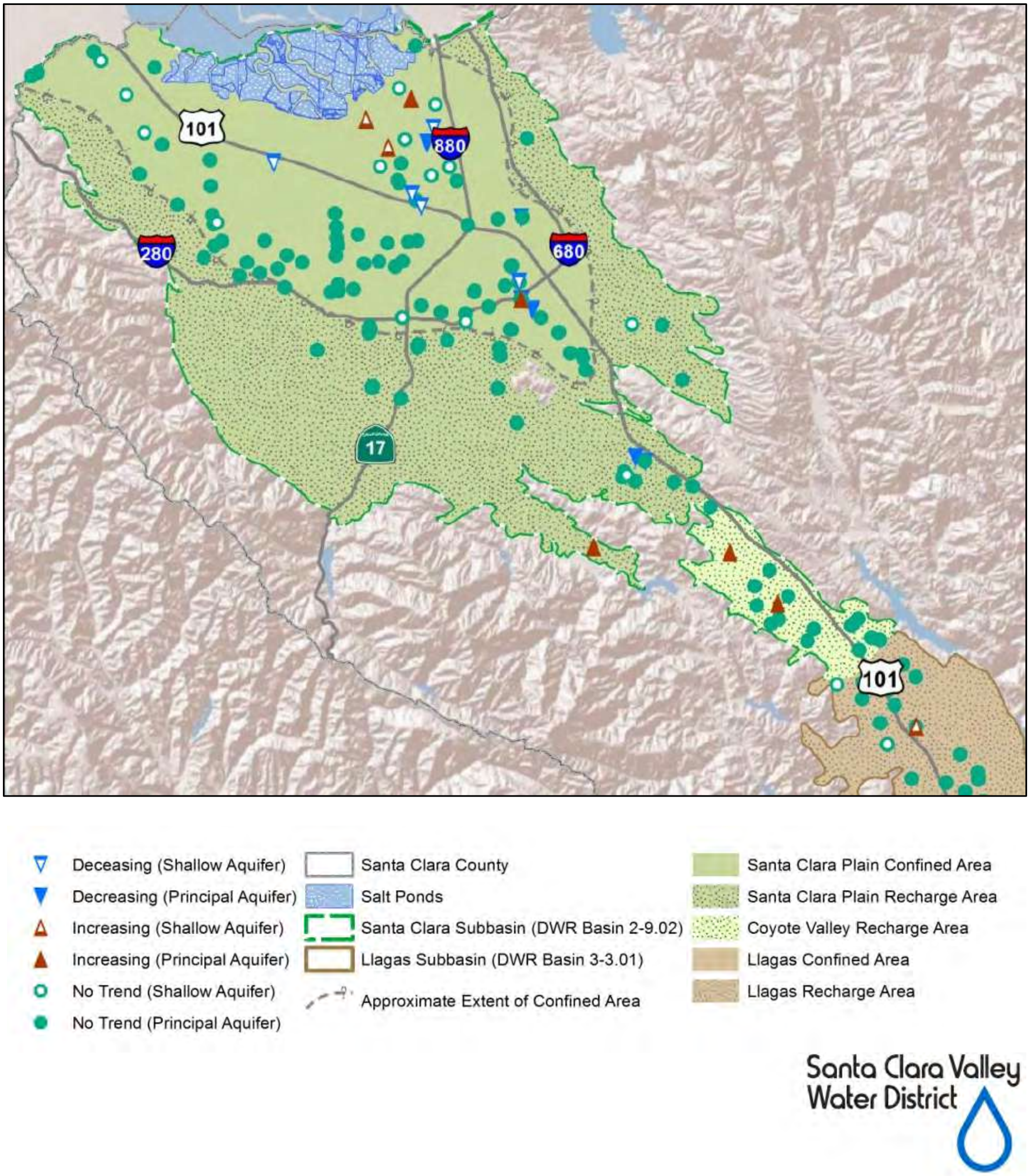


Figure 13 – 15-year TDS Trends in the Santa Clara Groundwater Subbasin (1998-2012)

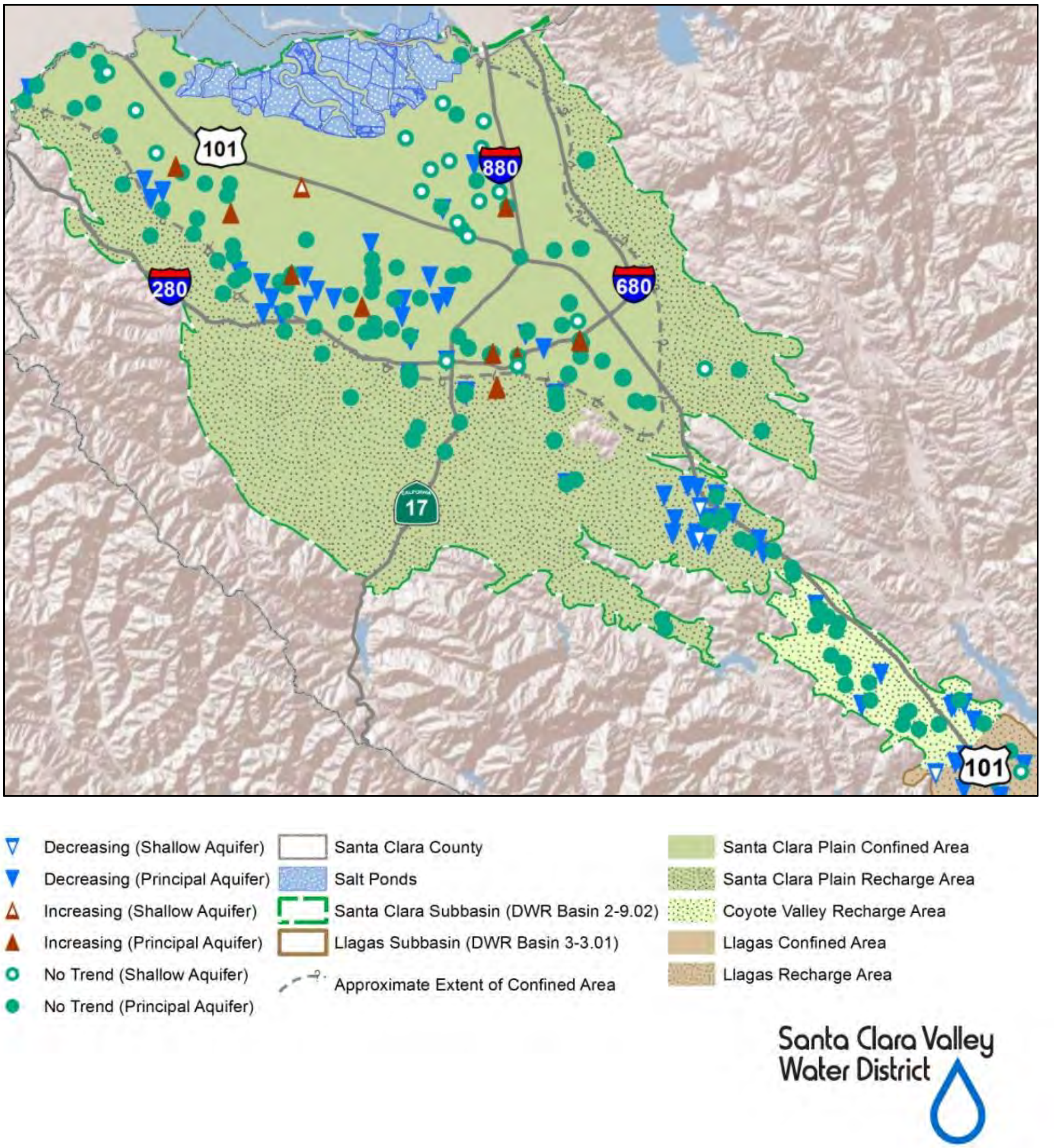


Figure 14 – 15-year Nitrate as NO3 Trends in the Santa Clara Groundwater Subbasin (1998-2012)

CHAPTER 3: ESTIMATING CURRENT AND FUTURE SALT AND NUTRIENT LOADING AND ASSIMILATIVE CAPACITY

The SWRCB Recycled Water Policy specifies that SNMPs include S/N source identification, basin/sub-basin assimilative capacity and loading estimates, and the fate and transport of salts and nutrients. This chapter summarizes the attributes of S/N loading, and current and future assimilative capacity.

3.1 Sources of Salts and Nutrients

Salts and nutrients are introduced to the subbasin by “wet loading” and “dry loading”. Wet loading includes the introduction of dissolved salts and nutrients through recharge from all sources of water, including rainfall, stream losses, irrigation, conveyance losses, drainage losses, basin inflow, mountain front recharge, and managed aquifer recharge. Dry loading includes dry fertilizer and soil amendments, and atmospheric deposition of particulate nitrogen, primarily from vehicle emissions. All known sources of salts and nutrients were reviewed and grouped to generate a comprehensive list of sources, summarized in Table 15. Avenues by which salts and nutrients are removed from the groundwater subbasin are also listed in Table 15.

Table 15 – Sources and Removal of Salts and Nutrients in the Santa Clara Groundwater Subbasin

Wet Sources	**Dry Sources**
Rainfall	Fertilizer
Basin In-flow and Saline Intrusion	Soil Amendments
Mountain Front Recharge	Atmospheric Deposition
Managed Recharge – Streams	
Managed Recharge – Ponds	**Removal**
Irrigation – Landscape/Municipal Supplies	Groundwater Pumping
Irrigation – Landscape/Recycled Water	Gaining Reaches of Streams
Irrigation – Landscape/Local Supply Wells	Basin Outflow
Irrigation – Agriculture	Sewer Line and Storm Drain Infiltration
Conveyance Losses – Pipeline Leaks	
Drainage Losses – Septic Tank Leach Fields	
Drainage Losses – Sewer Line Losses	
Drainage Losses – Storm Drain Losses	

Figure 15 demonstrates the relationship between the S/N loading sources in Table 15 and groundwater.

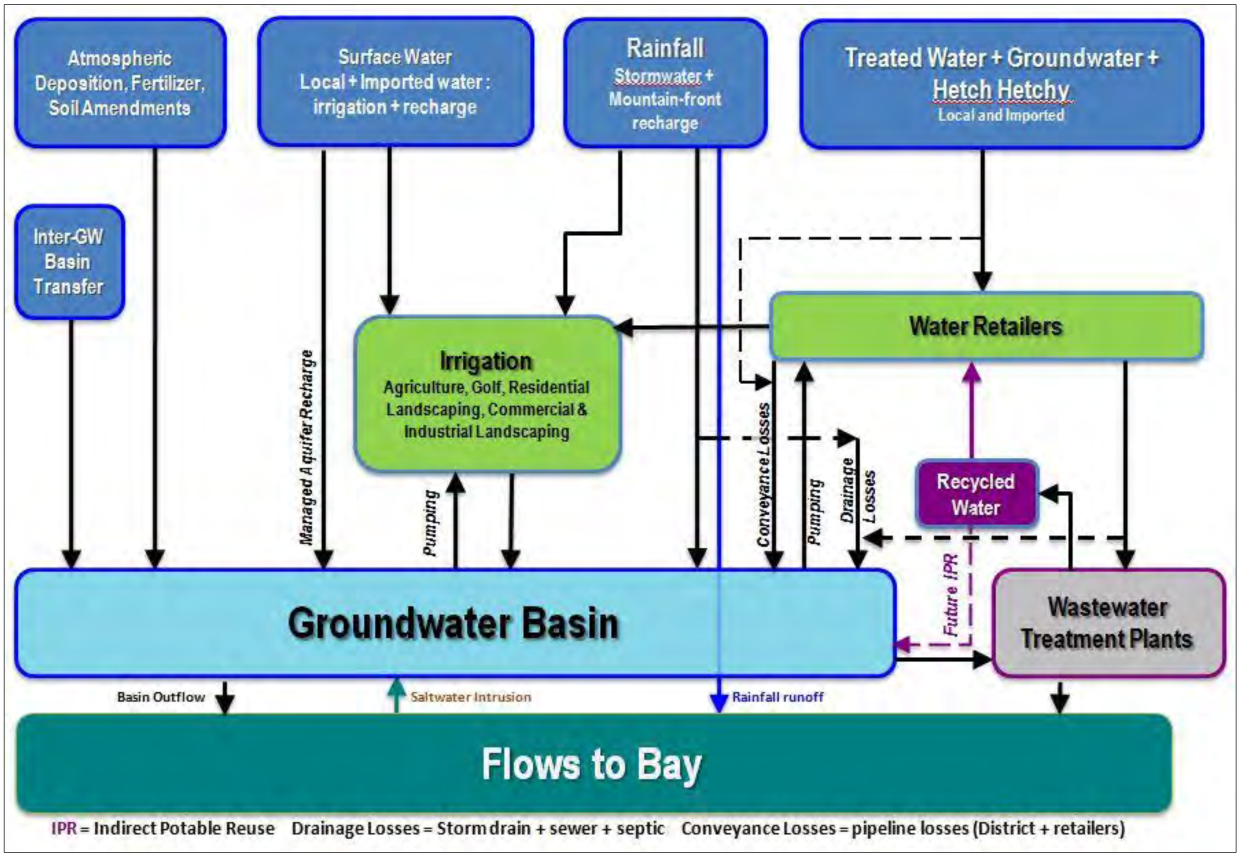


Figure 15 – Relationship of Salt and Nutrient Sources to Groundwater

3.2 Fate and Transport of Salts and Nutrients

Solutes (dissolved minerals) in irrigation water and dissolved from fertilizer and soil amendments may undergo physical and biological processes that affect their concentration and rate of migration. These processes are known as “fate and transport” processes, and contribute to removal of salt and nitrate as water percolates through the unsaturated zone to groundwater. Nitrate is prone to transformation and translocation by plants and microbes and may undergo volatilization, ammonification, nitrification and denitrification, adsorption or desorption, and fixation (Canter, 1997). Consequently, only a portion of the nitrate originally present in irrigation water or applied fertilizer will arrive at the water table and impact groundwater quality. The occurrence and rates of these processes depend on geochemical conditions such as the presence of soil organic matter or dissolved oxygen, soil moisture content, and temperature, all of which are highly variable. Rather than attempt to represent the geographic and seasonal variation in nitrate transformation processes, this SNMP estimates the fate and transport of salts and nitrates with a universal value that approximates the degree to which salts and nitrate leach to groundwater.

Mineral cations and anions excluding nitrate may also be involved in sorption and desorption and cationic exchange processes. A conservative assumption is made that salts in the unsaturated zone have attained steady-state, i.e., any salts added to the surface will produce an equivalent addition of salts to the water table. Uptake of salts in crops and other vegetation is considered to be negligible, but a salt uptake value is assigned to turf (see below). By contrast, nitrate can undergo substantial root uptake, volatilization, and denitrification. Therefore, attenuation factors are used to estimate nitrate loading to groundwater. To estimate an appropriate attenuation factor for nitrate, we reviewed the range of values reported in the literature and other SNMPs and settled upon 50% crop uptake, 15% denitrification and volatilization, and 35% leaching to groundwater. A few of the literature studies and agency reports reviewed are summarized here:

- The Santa Rosa Plain draft SNMP (RMC, July, 2012) uses 25% applied nitrogen as leachable, 10% is off-gassed, and the balance is "used". No technical citations are provided.

- The District Llagas Nitrate Source Area Identification Study (1994) used 30% as the leaching factor for a typical crop of strawberries.

- Malone et al., 2007, measured 29% of total applied nitrogen leaching to groundwater for fertilization of corn and soybeans.

- Reports indicate NO_3-N losses from crops amounting to 24 to 55% of the N applied at recommended rates. The apparent crop uptake of applied N is on the order of 40 to 80%, depending on the timing of fertilizer applications, crop type, irrigation management, and other factors (WDOE, 2000).

- Typical N uptake efficiencies of major agronomic crops range from 30 to 70% (WDOE, 2000).

- Observed range of nitrogen volatilization in applied fertilizer was 2 to 50% N-emissions for soil pH > 7 and 0 to 25% emissions for soil pH < 7. If the N source is mixed into an acid soil, the emissions are usually greatly reduced (0 to 4% lost) (Meisinger and Randall, 1991).

Selecting a leaching factor of 35% for nitrate dissolved from crop fertilizer and in irrigated water may overestimate the degree of nitrate leaching to groundwater in some settings, while underestimating it in others. Underestimation can occur where double-cropping or macropore flow through root channels occurs (Sidle and Kardos, 1979), and from underestimating the amount of post-harvest leaching due to lack of over-winter cover crops (McCracken et al., 1994).

Fertilizer applied to lawns has a considerably higher degree of nitrate attenuation due to the accumulation of thatch in the turf root zone. The following assumptions are made for nitrogen fertilizer applied to lawns:

- All applied nitrogen (N) is converted to nitrate.

- Total N application rate is 3.5 pounds per 1,000 ft² (~150 lbs N/acre) in 50% of the lawns per year (UCD, 2002).

- 80% of applied nitrogen is taken up by turf.

- 15% of applied nitrogen is volatilized.

- 5% of applied nitrogen is converted to nitrate and leached to groundwater (based on Kopp and Guillard, 2005).[16]

To estimate salt loading from lawn fertilizer, the following assumptions were made:

- Total fertilizer applied was taken as applied nitrogen divided by 33% to estimate salt loading.
- Total salt loading from fertilizer application to turf is 161 lbs/acre, using the ratio salt leaching to N-uptake (111%) from 11 varieties of hay (NCCE, 2008).

In the managed aquifer recharge setting, nitrate attenuation is assumed to be greater for in-stream recharge than for percolation ponds due to the greater presence of natural organic matter in stream sediments. Presence of readily available organic carbon and absence of oxygen are prerequisites for microbial denitrification of nitrate in recharge water (Canter, 1997). Percolation ponds are designed and maintained to optimize percolation rates and have less organic carbon and residence time in an anaerobic sediment zone than occurs in natural streams. Nitrate attenuation was assigned as 80% to in-stream recharge and 50% to percolation ponds (i.e., the amount of nitrate leached to groundwater is 20% and 50%, respectively).

A summary of the nitrate attenuation factors assigned for the loading analysis in this SNMP is provided in Table 16.

3.3 Methodology for Estimating Salt and Nutrient Loading and Removal

The approach for estimating S/N loading from wet sources involves obtaining measurements or estimates of the volumes of water in each wet loading category, and the S/N content of each wet source. The water quality parameters used to represent all salts and nutrients are total dissolved solids (TDS)[17] and nitrate (NO_3). The total annual loading is taken as the product of the estimated annual volume and average annual concentration of TDS or nitrate, and for nitrate, an attenuation factor:

Volume/year × Concentration × Attenuation Factor = Mass Loading/year

The attenuation factor represents the degree to which the nitrate concentration is reduced due to denitrification or other processes. For example, if 50% of nitrate is taken up by roots, and 15% is converted from nitrate to nitrogen gas by denitrification, then 35% of nitrate concentration leaches to groundwater, and the attenuation factor is 65%. Table 16 lists the nitrate attenuation factors assigned to each loading category. When groundwater is removed or leaves the basin, the nitrate in that groundwater is removed, i.e., there is no attenuation factor applied to groundwater removal.

Dissolved salts, represented as TDS, are considered conservative solutes because their concentrations are not substantially attenuated by processes such as root uptake, geochemical

[16] The UCD 2012 nitrate study recommends using 10 kg N/hectare leached to groundwater (39.5 lbs NO_3/acre). Using 3.5 lbs/1,000 ft² and 5% leaching (the figures shown above) produces an estimate of 34 lbs/acre NO_3/year for fertilized lawns.

[17] Total Dissolved Solids is commonly measured as Total Filterable Residue by Standard Method 2540 or EPA Method 160.1. In some instances, where TDS measurements are not available but specific conductance has been measured, an estimated value of TDS is used based on the basin-specific conversion factor from specific conductance to TDS.

conversion, sorption, or microbial processes. For most loading categories, TDS was assigned an attenuation factor of zero. For fertilizer applied to turf however, a larger amount of root uptake is assumed, as explained in Section 3.2. Because nitrate is a component of TDS, TDS loading from irrigation was adjusted to account for root uptake and denitrification of nitrate.

Table 16 – Nitrate Attenuation Factor Assumptions by Loading Category*

Loading Category	Root Uptake	Denitrification/ Volatilization	Leached to Groundwater
Crop Fertilizer	50%	15%	35%
Lawn Fertilizer (Dry)	80%	15%	5%
Irrigated Water	50%	15%	35%
Rainfall	50%	15%	35%
Conveyance Losses	0%	15%	85%
Mountain Front Recharge	0%	15%	85%
Drainage Losses	0%	15%	85%
Recycled Water	50%	15%	35%
Atmospheric Deposition	80%	15%	5%
Managed Recharge – Ponds	0%	50%	50%
Managed Recharge – Streams	0%	80%	20%

*The basis for these assumptions is detailed in Section 3.2

3.3.1 Wet Loading Categories

Volume estimates for wet loading categories were obtained primarily from the District's groundwater flow models for the Santa Clara Groundwater Subbasin, i.e., the Santa Clara Plain model ("SCPMOD"), and the Coyote Valley Model ("CVMOD"), and adjusted as described below for the 2001-2010 baseline period. The water balances for each of these subareas of the Santa Clara Subbasin are described in Section 2.1.4 (see Tables 7 and 10).

3.3.1.1 Rainfall Recharge

Rainfall contains only trace amounts of solutes and is allocated among three pathways relevant to the overall salt balance: runoff, infiltration with subsequent evapotranspiration, and infiltration with deep percolation. Only the water involved in deep percolation is added to groundwater, however, the salt and nitrate in rainfall remains in the soil profile. This salt will ultimately migrate to groundwater, whereas the nitrate added to soil from rainfall will be attenuated by root uptake and denitrification, with 35% assumed to migrate to groundwater.

The volume of rainfall that ends up as percolation, or infiltration with subsequent evapotranspiration, cannot be measured directly and must therefore be estimated. Many factors determine the volume of rainfall that infiltrates such as soil type, vegetative cover, slope, etc. Assessing the variability of rainfall infiltration by accounting for all these factors is a time-consuming undertaking that is beyond the scope of this analysis. Rainfall contributes only a minor amount of salt and nitrate compared to other loading categories. Total estimated volumes of rainfall were obtained from the Santa Clara Plain and the Coyote Valley groundwater flow models. Estimated rainfall infiltration was taken as 22% of total rainfall, which is the 10-year median rainfall net of evaporation divided by 10-year median of total rainfall for the Los Gatos rain gauge station. Deep percolation was estimated using formulas applied to seven rainfall zones in the Santa Clara Plain model, and four rainfall zones in the Coyote Valley Model. Deep percolation estimates range from 10 to 15% and are determined for each model cell based on empirical formulae applied to rainfall data from local rainfall gages. The estimated volumes of rainfall contributing salt and nitrate to groundwater through deep percolation and infiltration followed by evapotranspiration are 13,300 AF/yr in the Santa Clara Plain, and 5,000 AF/yr in the Coyote Valley. Appendix 4 provides details for the rainfall infiltration volume estimates.

Rainfall quality is highly variable. For example, TDS in rainfall measured at the US Geological Survey offices in Menlo Park ranged from 8.2 to 38 mg/L (Hem, 1985). The estimates of salt and nitrate loading from rainfall, 10 mg/L and 1.2 mg/L, respectively, were selected from literature values as representative concentrations to be applied uniformly to rainfall infiltration in both the Santa Clara Plain and Coyote Valley subareas (SWRCB, 2010; NADP, 2012).

The total estimated salt and nitrate loading from rainfall is given in Table 17. Calculation details are provided in Appendix 4.

Table 17 – Estimated Salt and Nitrate Loading from Rainfall Infiltration

	Santa Clara Plain	Coyote Valley	Total
Rainfall Infiltration, AF/yr	13,300	5,000	18,300
Salt Loading as TDS, tons/yr	180	29.9	210
Nitrate as NO_3 Loading, tons/yr	8.2	1.4	9.6

3.3.1.2 Mountain-front Recharge

Mountain-front recharge (MFR) accounts for subsurface inflows from bedrock in the hills surrounding the Santa Clara Plain, and for inflow from uncontrolled reaches of streams. The source for the MFR estimates is the Santa Clara Plain groundwater flow model (SCPMOD). For the Santa Clara Plain, a rainfall-runoff approach was used to estimate MFR (CH2M HILL, 1992), as shown in Table 18.

The SCPMOD model distributes MFR for each mountain range across all model cells bordering the mountain range, in proportion to the length of cell perpendicular to the mountains, as shown in Figure 16. For SCPMOD, MFR is treated as a groundwater gain (11,855 AF/yr), regardless of weather conditions.

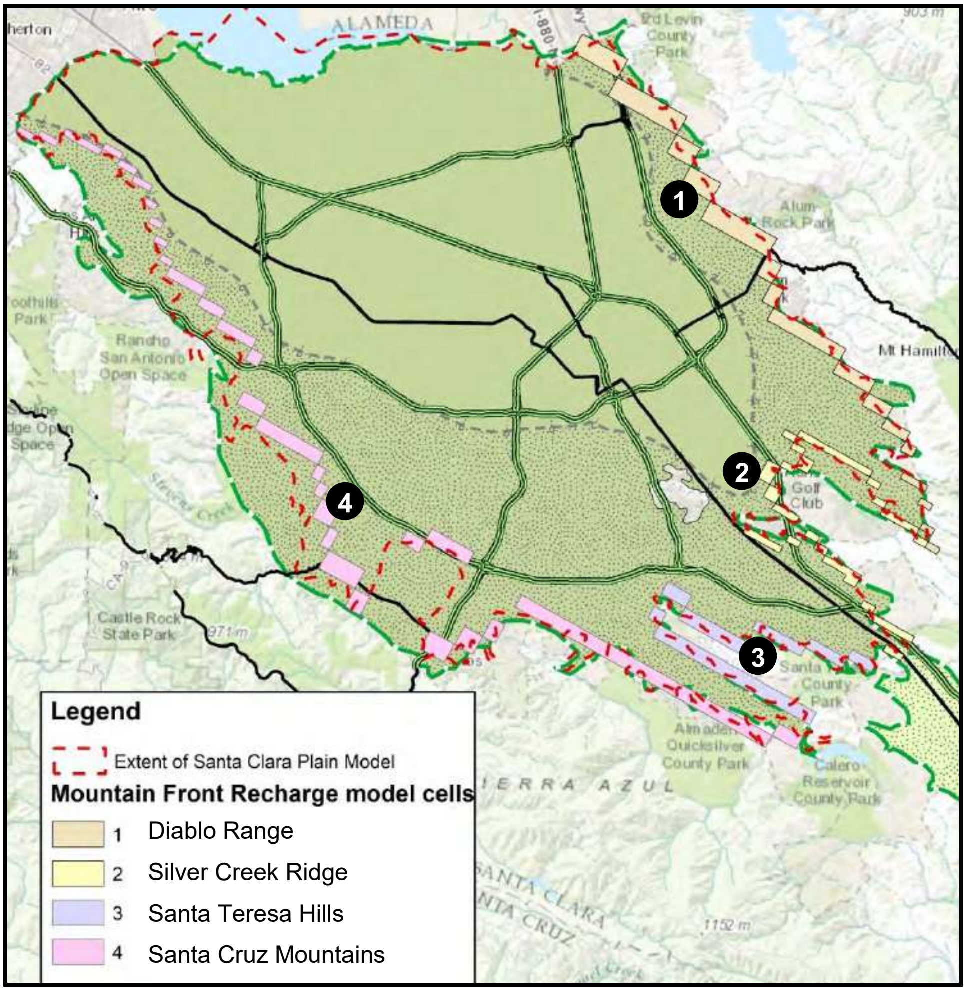


Figure 16 – Mountain-front Recharge Zones in Santa Clara Plain Groundwater Flow Model

Table 18- Santa Clara Plain Model Mountain-Front Recharge Estimates

Mountain-front recharge	Estimated recharge (inches/yr)	Estimated recharge (AF/yr)
Diablo Range ❶	1	2,900
Silver Creek Ridge ❷	.5	300
Santa Teresa Hills ❸	1	400
Santa Cruz Mountains ❹	1	8,255
Total		11,855

Recharge rates shown are for all years independent of hydrology.

MFR is considered negligible and is excluded in the Coyote Valley groundwater flow model. For SNMP, salt and nitrate loading from the minor amount of MFR is also excluded.

Salt and nitrate concentrations in groundwater in the bedrock hills are not monitored by the District. To estimate MFR water quality attributes, the values assigned to MFR are based on measured water quality in nearby streams and monitoring wells near the basin boundaries. The volume-weighted average of the TDS assigned to the four MFR zones is 286 mg/L, and for nitrate as NO_3, 3.2 mg/L. The resulting loading estimates from MFR are listed in Table 19.

Table 19 – Estimated Salt and Nutrient Loading from Mountain-Front Recharge

Mountain-front recharge zone	Representative Creeks	Composite Creek & Groundwater TDS*	Composite Creek & Groundwater NO_3*
❶ Diablo Range	Penitencia Creek-Upper; Silver Creek, Flint Creek	366	2.4
❷ Silver Creek Ridge	Coyote Creek	301	3.7
❸ Santa Teresa Hills	Alamitos Creek	314	4.1
❹ Santa Cruz Mountains	Stevens Creek, Saratoga Creek	256	3.5

* Assumed creek/groundwater mix for composite values is 80/20.

	Santa Clara Plain	Coyote Valley	Total
MFR Volume, AF/yr	11,855	0	11,855
MFR Salt Loading, tons/yr	4,600	0	4,600
MFR Nitrate as NO_3 Loading, tons/yr	44	0	44

3.3.1.3 Basin Inflow and Saline Intrusion

As described in section 2.1.1 and Figure 1, groundwater from the Coyote Valley flows into the Santa Clara Plain area, which adds salt and nitrate. The Coyote Valley is bounded by bedrock on its eastern and western edges, and abuts the Llagas Groundwater Subbasin on its southern edge. The boundary between the Coyote Valley area and the Llagas Groundwater Subbasin is a topographic high that is considered a hydrologic divide. Accordingly, Coyote Valley does not have basin inflow from the Llagas Groundwater Subbasin.

The basin inflow to the Santa Clara Plain from the Coyote Valley (8,200 AF/yr) is estimated using the groundwater flow models. Estimated loading from basin inflow is provided in Table 20.

Table 20 – Estimated Salt and Nitrate Loading from Basin Inflow to the Santa Clara Plain

Volume, acre-feet/yr	Coyote Valley TDS, mg/L	Coyote Valley NO_3, mg/L	TDS loading to Santa Clara Plain, tons/yr	NO_3 loading to Santa Clara Plain, tons/yr
8,200	376	24.6	4,140	230

Groundwater in the northern end of the Santa Clara Groundwater Subbasin is prone to saline intrusion due to the incursion of saline water from the San Francisco Bay in the lower reaches of creeks. The extent of saline intrusion in the shallow aquifer is limited and located primarily above the confined aquifer, i.e., the principal aquifer is not impacted by saline intrusion from the San Francisco Bay. Figure 17 displays the extent of saline intrusion in the shallow aquifer defined as chloride concentrations of 100 mg/L or more.

Saline intrusion is mapped from data obtained from annual groundwater sampling events. Net decrease in the chloride content is measured in wells monitored continuously over many years. The current mapped extent of saline intrusion is considerably smaller than the extent originally mapped in 1980. The decrease in the area impacted by saline intrusion may be due to a combination of reduced pumping near the bay, limited pumping in the shallow zone, and salt removal in gaining reaches of streams. Saline intrusion is considered to be limited to the shallow aquifer along the tidal reaches of streams and close to the bay or salt evaporation ponds. As detailed in Section 3.3, the Santa Clara Plain was not subdivided for analysis of S/N loading, therefore the salt load from saline intrusion was not included as a salt loading term because the areal extent of saline intrusion is limited and decreasing. The impact of saline intrusion on groundwater quality is incorporated into the determination of assimilative capacity (see Section 3.3).

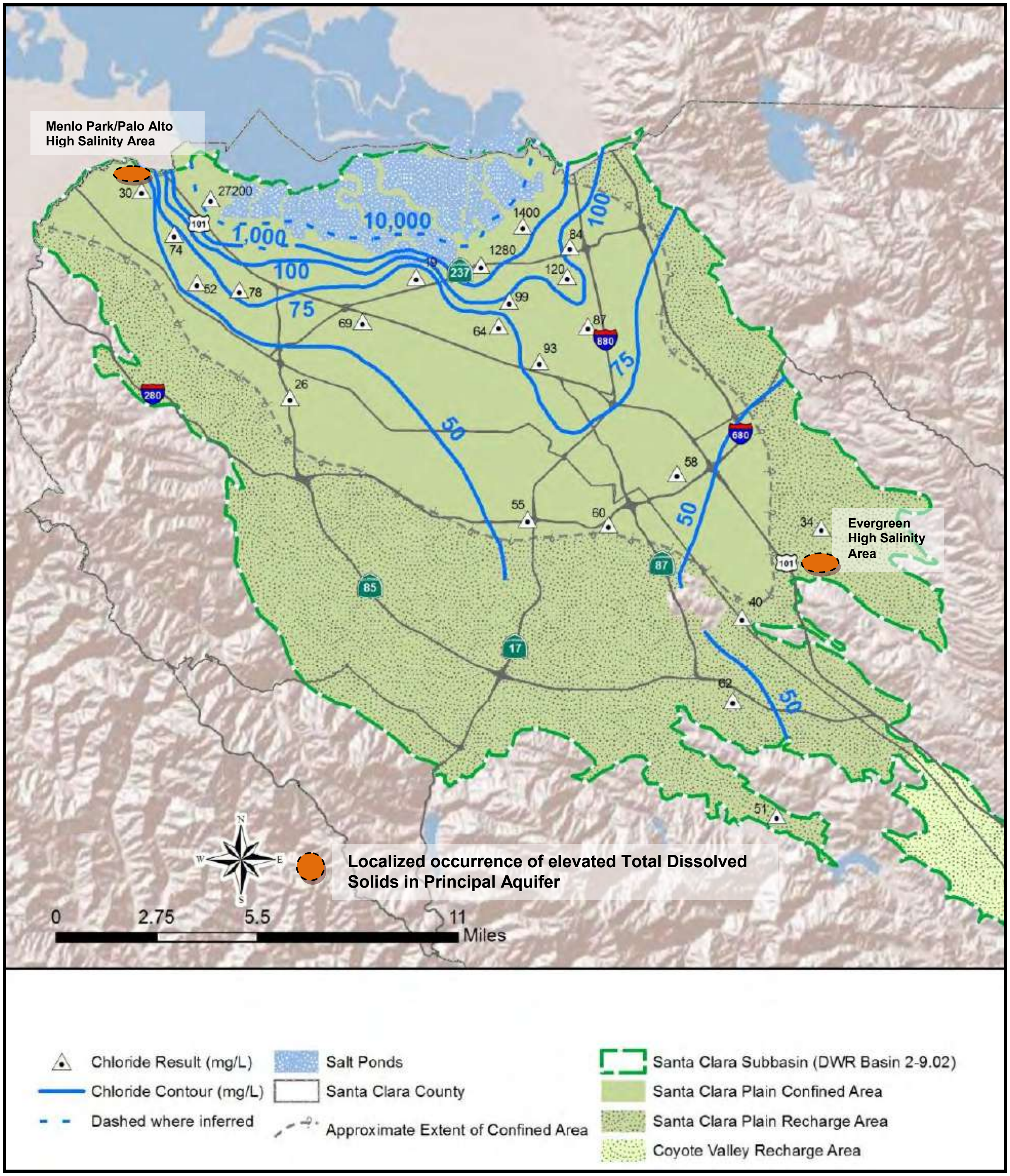


Figure 17 – Zone of Saline Intrusion into the Shallow Aquifer, Santa Clara Plain

Chloride contours: SCVWD, 2013; SE salinity zone: SCVWD, 1989; NW salinity zone: Metzger and Fio, 1997; see Section 3.4.1.

3.3.1.4 Managed Recharge in Streams

The District's recharge operations sustain groundwater supplies in the Santa Clara Groundwater Subbasin by percolating imported water and surface water from local reservoirs. Recharge operations include managed recharge in streams, profiled in this section, and managed recharge in percolation ponds discussed in the next section. The quality of water used for managed aquifer recharge in streams is better than ambient groundwater with respect to TDS and nitrate. Managed recharge in streams results in the addition of TDS and nitrate to the aquifers.

The volume of water in managed recharge in streams is tracked by stream gauging, by tracking the amount of water released at turnouts, and by periodic surface water balance. Managed recharge involves releasing water from upstream reservoirs or pipeline turnouts during summer and fall months. Natural recharge from rainfall runoff occurs during the winter and spring. The total volumes are given as ten-year medians in Table 21.

The quality of water used in managed recharge in streams varies depending on water source (reservoirs or imported water), time of year, discharges, and runoff. Managed recharge in streams involve local reservoir and imported water sources, so blended water quality was calculated from each source. The overall range, median, and volume-weighted average (VWA) concentration values for TDS and nitrate of water used in managed recharge in streams are given in Table 21.

While streams are used for managed recharge, they are natural features that host aquatic ecosystems. The sediments through which groundwater recharge occurs are rich in organic matter, which can create an anoxic environment conducive to denitrification. As shown in Table 16, a higher nitrate attenuation factor is assumed for streams, so only 20% of nitrate in stream water is assumed to migrate to groundwater.

Table 21 – Estimated 10-year Median Salt and Nitrate Loading from Managed Recharge in Streams

	Santa Clara Plain	Coyote Valley	Total
Stream Recharge Volume	36,680 AF/yr	14,470 AF/yr	51,150 AF/yr
TDS Concentration Statistics	Range = 227 – 460 mg/L Median = 286 mg/L VWA = 135 mg/L	Range = 186 – 320 mg/L Median = 238 mg/L VWA = 248 mg/L	
Nitrate as NO_3 Concentration Statistics	Range = .84 – 7.2 mg/L Median = 1.22 mg/L VWA = .38 mg/L	Range = .5 – 1.9 mg/L Median = .84 mg/L VWA = .96 mg/L	
Salt Loading as TDS	7,960 tons/year	4,680 tons/year	12,640. tons/year
Nitrate as NO_3 Loading	19 tons/year	3.3 tons/year	22.4 tons/year

VWA = volume-weighted average Volumes are 10-year medians of 2001-2010.

3.3.1.5 Managed Recharge in Percolation Ponds

Managed recharge in percolations ponds follows the same pattern as recharge in streams, except a greater degree of control is exerted over source water quality, as most facilities exclude runoff. Percolation ponds are also maintained to remove accumulated sediment. In addition, percolation ponds create aquatic ecosystems in which algae and plants contribute organic matter, enhancing denitrification. As listed in Table 16, percolation ponds are assigned an assumed nitrate attenuation factor of 50%. Because percolation rates far exceed evaporation rates by 20 to 110 times (summer vs. winter), evaporative concentration of salts and nitrate are considered negligible. As water quality samples from ponds used for this analysis reflect both dry season and wet season conditions, an evaporation factor was not included.

The volume of water recharged through percolation ponds is measured by gauging pond depths and reading flow meters. Source water and pond water quality is also monitored by the District so the salt and nitrate loading can be estimated. Table 22 summarizes quantities, quality, and salt and nitrate loading from managed recharge in percolation ponds in the Santa Clara Plain. There are no percolation ponds in the Coyote Valley.

Table 22 – Estimated Salt and Nitrate Loading from Managed Recharge in Percolation Ponds

	Santa Clara Plain
Percolation Pond Recharge Volume	24,810 AF/yr
TDS Concentration Statistics	Range = 190 – 306 mg/L Median = 251 mg/L VWA = 497 mg/L
Nitrate as NO_3 Concentration Statistics	Range = .78 – 9.93 mg/L Median = .84 mg/L VWA = .96 mg/L
Salt Loading as TDS	16,760 tons/yr
Nitrate as NO_3 Loading	20.3 tons/yr

3.3.1.6 Agricultural Irrigation

Irrigation of landscaping and crops leads to the addition of salts to aquifers because most of the water is taken up by plants or evaporated. Root uptake of salts is minimal due to semi-permeable membranes in root hairs that regulate solutes. Most of the mineral salts in irrigation water are excluded, while half the nitrate is taken up by roots. Consequently, while only 20% of irrigated water may percolate through the unsaturated zone to groundwater, nearly all of the mineral salt present in irrigated water is assumed to remain in the soil profile and will ultimately migrate to groundwater. Because nitrate is a constituent of TDS, the TDS load from irrigation water was reduced by the amount of nitrate attenuation to account for root uptake and denitrification.

Nitrate in irrigated water is needed by plants and is taken up by their roots. Rates of root uptake of nitrate in irrigation water will vary depending upon crop types, soil types, soil moisture, and many other factors. For the purposes of this plan, a single factor, 50% root uptake, is applied for nitrate in irrigated water, and 15% denitrification is assumed, so that 35% of nitrate in irrigated water is presumed to migrate to groundwater.

The volume of irrigated water is obtained from records of pumping which is classified as agricultural. A separate water rate for agricultural pumping facilitates an inventory of pumping for agricultural irrigation. Smaller agricultural water use, such as irrigating home orchards and gardens, is included in the assessment of outdoor irrigation loading from domestic wells and municipal water (Section 3.3.1.7).

In the Santa Clara Groundwater Subbasin, agricultural irrigation is concentrated in the Coyote Valley and supplied by locally pumped groundwater. The water quality for agricultural irrigation is assumed to be the volume-weighted average salt and nitrate concentration. Similarly, the minor amount of groundwater pumped from the wells classified as agricultural is assigned the volume-weighted average salt and nitrate concentration. Table 23 summarizes the volumes and quality of water used in irrigated agriculture in the Santa Clara Plain and the Coyote Valley and the resulting salt and nitrate loading.

Table 23 – Estimated Salt and Nitrate Loading from Agricultural Irrigation

	Santa Clara Plain	Coyote Valley	Total
Irrigation Water Volume, AF/yr*	660 AF/yr	4,300 AF/yr	4,960 AF/yr
Volume-weighted TDS Concentration *	425 mg/L	375 mg/L	
Volume Weighted Nitrate as NO_3 Concentration*	11 mg/L	25 mg/L	
Salt Loading as TDS, tons/yr*	320 tons	2,070 tons	2,390 tons
Nitrate as NO_3 Loading, tons/yr*	3 tons	49 tons	52 tons

* Ten-year median

3.3.1.7 Landscape Irrigation – Municipal and Domestic Water Sources

Outdoor water use for landscape irrigation comprises a large portion of water demand. A large amount of salt is included with this water use. Most of the water used for outdoor irrigation of residences, businesses, corporate, and municipal landscaping, is used by plants or evaporated. The majority of the salt carried by irrigation water is retained in the soil profile and ultimately leaches to groundwater. Nitrate in irrigation water is consumed by plants and subject to denitrification. For irrigated turf the nitrate attenuation factors in Table 16 apply i.e., 50% is taken up by roots, while 15% is lost to denitrification.

Water retailers serve a wide range of water types, each having its own nitrate and TDS concentrations that vary from year to year. For example, a city may serve a combination of treated surface water, groundwater, and water from the Hetch-Hetchy system. To assess the salt and nitrate loading from landscape irrigation, each water retailer service area was broken out into sub-areas by water type and by areas located within the subbasin vs. outside the subbasin. Volumes of each type of water were determined for each sub-area, and the amount of indoor vs. outdoor use was estimated using figures provided in each water retailer's Urban Water Management Plan (UWMP). The water use categories distinguish single-family homes from multi-family homes, and amounts of water used in applications that are mostly indoor (industrial) to mostly outdoor uses (municipal/parks). Estimates of the indoor/outdoor water use split for each water use category were obtained from the City of Santa Clara's UWMP. Table 24 lists the indoor/outdoor splits used for all water retailers. The overall indoor/outdoor split for each retailer's in-basin water use depends on the breakdown of water use categories. The indoor/outdoor split for the entire Santa Clara Groundwater Subbasin is 55.5%/44.5%, i.e., 44.5% of residential water use is outdoors.

Table 24 – Indoor-Outdoor Water Use Estimates by Water Use Category

Indoor vs. Outdoor (Landscape) Water Use	Indoor	Outdoor
Single Family	50.5%	49.5%
Multi Family	76.4%	23.6%
Industrial	77.3%	22.7%
Commercial	60.8%	39.2%
Institutional	35.9%	64.1%
Municipal	26.7%	73.3%

Water quality data used to estimate salt and nitrate loading was obtained for each water type for each of the ten baseline years (2001–2010).[18] Groundwater quality was taken as the ten-year median value of all the active wells within each water retailer service area. Loading was then determined by multiplying the salt and nitrate concentrations with the in-basin outdoor use volumes for each water type, for each year. The resulting median salt and nitrate loading estimates are summarized in Table 25.

The majority of salt and nitrate loading summarized in Table 24 is from outdoor water use. Landscape irrigation is also supplied by sources such as domestic wells and wells that supply cemeteries, golf courses, and other water users. These sources make up less than 1% of outdoor irrigation in the Santa Clara Plain, but in the Coyote Valley, where most of the residences are supplied by domestic wells, they comprise 87% of the non-agricultural outdoor irrigation.

Table 25 – Median Salt and Nitrate Loading from In-Basin Landscape Irrigation†

	Santa Clara Plain	Coyote Valley	Total
In-basin, Outdoor Irrigation Volume*	109,440 AF/yr	1,740 AF/yr	111,180 AF/yr
TDS Concentration**	284 mg/L	375 mg/L	
Nitrate as NO_3 Concentration**	2 mg/L	17 mg/L	
Salt Loading as TDS*	42,270 tons	840 tons	43,110 tons
Nitrate as NO_3 Loading*	322 tons	18 tons	340 tons

* Ten-year median
** Ten-year median of volume weighted averages for all water types.
† Includes residential outdoor irrigation supplied by water retailers, domestic well landscape irrigation, and non-retailer pumping for landscape irrigation uses (parks, golf courses, cemeteries, etc.).

[18] Water quality for SCVWD treated water and Hetch Hetchy water taken from retailer Consumer Confidence Reports and from District records.

3.3.1.8 Landscape Irrigation – Recycled Water

The three wastewater treatment plants operating in the Santa Clara Plain currently produce tertiary-treated recycled water used to irrigate parks, golf courses, street trees, and landscaping in corporate business parks, housing developments and industrial uses. Advanced treated recycled water is also produced at the Silicon Valley Advanced Water Purification Center. The advanced treated water is blended with tertiary treated recycled water from the South Bay Water Recycling system. Blending advanced treated recycled water with tertiary treated recycled water results in lower TDS and nitrate concentrations than current tertiary-treated recycled water.

In 2013, recycled water accounted for 5% of all water used in Santa Clara County. Locations of current and planned recycled water irrigation as of 2012 are shown in Figure 18. Recycled water used for irrigation contributes salt and nitrate to groundwater and has the potential to increase groundwater nitrate and TDS concentration because concentrations are higher in recycled water than in groundwater. The volume-weighted average TDS of recycled water from all three systems is 746 mg/L while the volume-weighted groundwater TDS concentration is 425 mg/L. Similarly, the volume weighted average nitrate (as NO_3) content in recycled water listed in Table 1 is 45.9 mg/L while the median groundwater nitrate concentration in the Santa Clara Plain is 10.8 mg/L.

Recycled water volumes and concentrations of TDS and nitrate were obtained from wastewater plant operators to estimate the total salt and nitrate loading. The nitrate attenuation factors, listed in Table 16, are the same as applied to irrigation (i.e., 50% root uptake, 15% denitrification, and 35% of nitrate leaches to groundwater).

Table 26 – Median Estimated Salt and Nitrate Loading from In-Basin Landscape Irrigation with Recycled Water

	Santa Clara Plain
In-basin, Outdoor Recycled Water Irrigation Volume*	6,640 AF/yr
TDS Recycled Water Concentration *	746 mg/L
Nitrate as NO_3 Recycled Water Concentration*	46 mg/L
Recycled Water Salt Loading as TDS*	6,725 tons/yr
Recycled Water Nitrate as NO_3 Loading*	141 tons/yr

* Ten-year median concentrations are volume weighted for all three recycled water producers. Recycled water is not used for irrigation in Coyote Valley.

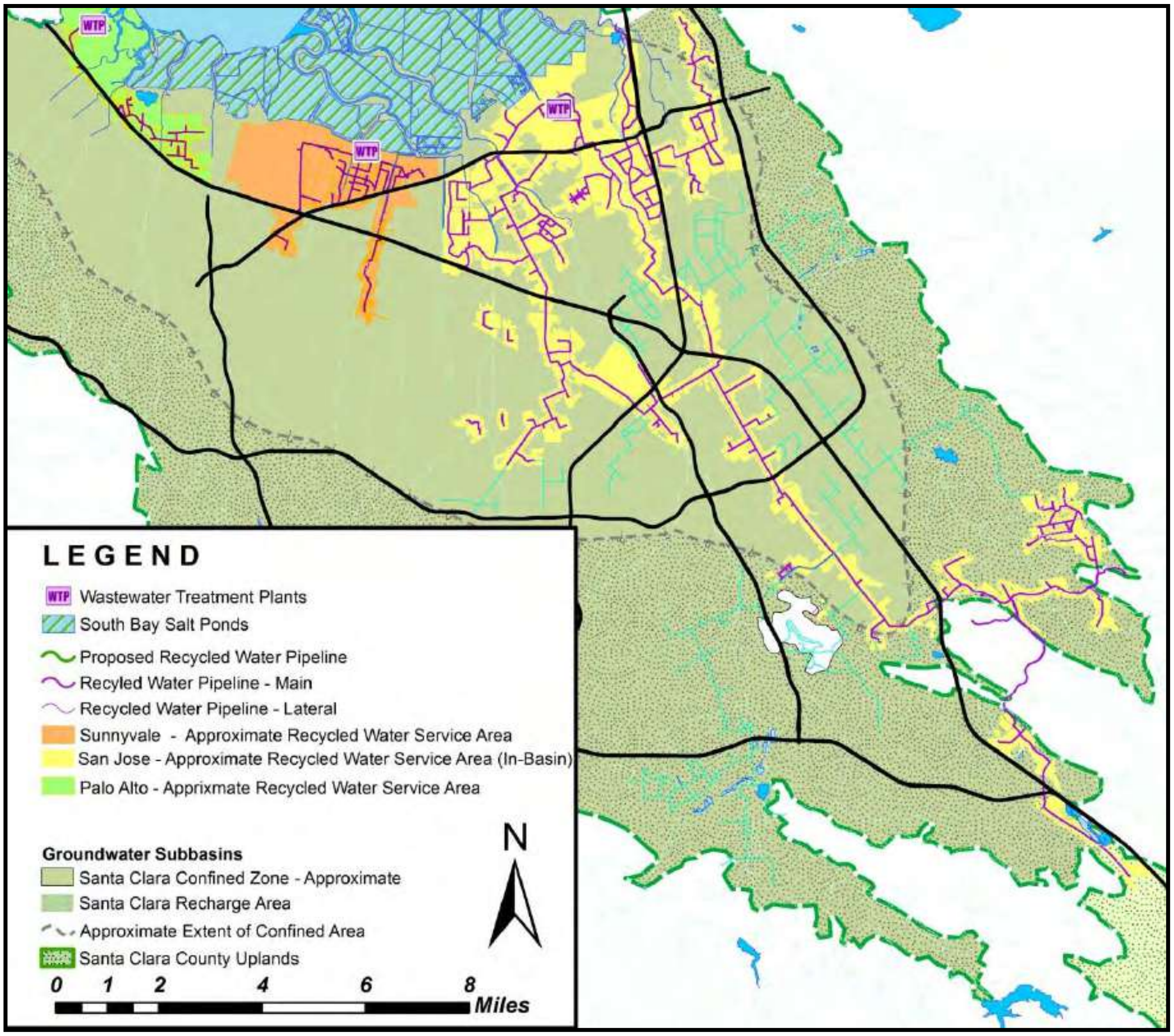


Figure 18 – Locations of Current and Proposed Recycled Water Irrigation as of 2012

3.3.1.9 Conveyance Losses

Losses from regional raw and treated water pipelines and losses from water utility local distribution networks are grouped together as conveyance losses. Conveyance losses occur below the root zone, so all the water moves to groundwater and contributes salt and nitrate to groundwater. Water lost from pipelines is treated drinking water, groundwater, or raw water en route to treatment plants, and contains salt and nitrate which is included in the overall salt balance.

An estimate of water utility distribution network loss rates was developed by taking the system losses reported by 9 water retailers as a percentage of total water supplied in the retailers Urban Water Management Plans. Based on data supplied by San Jose Water Company, we assumed half the system losses are "real" losses that result in salt and nitrate addition to groundwater, while the other half are losses attributable to hydrant testing, line flushing, and meter uncertainty. An assumed loss rate of 0.1% in regional raw water and treated water pipelines is based on the technical literature. District operators report that no losses are observed within the limits of measurement by flow meters.

The concentrations of TDS and nitrate in losses from District raw and treated water pipelines are similar and low, while the ten-year median of volume-weighted average TDS and nitrate concentrations for losses from retailer distribution systems, which include groundwater sources, are higher. Because losses occur below the root zone only denitrification plays a role in nitrate attenuation for which a 15% nitrate attenuation rate is assigned (see Table 16). Table 27 lists the volumes, concentrations, and mass of salt and nitrate contributed by conveyance losses.

There are no treated water pipelines in the Coyote Valley, and only a small area of residential development connected to the City of Morgan Hill water, so the volume of conveyance losses in the Coyote Valley is negligible.

Table 27 – Median Estimated Salt and Nitrate Loading from Conveyance Losses

	Santa Clara Plain	Coyote Valley	Total
Combined Conveyance Loss Volume*	10,050 AF/yr	40 AF/yr	10,100 AF/yr
Overall Conveyance Loss TDS Concentration *	256 mg/L	323 mg/L	
Overall Conveyance Loss Nitrate as NO_3 Concentration*	4 mg/L	8 mg/L	
Combined Salt Loading as TDS*	3,500 tons	20 tons	3,520 tons
Combined Nitrate as NO_3 Loading*	58 tons	0.45 tons	58 tons

* Ten-year median

3.3.1.10 Drainage Losses

Losses from storm drains, sewer laterals, and sewer mains loading from septic tank leach fields are grouped together as drainage losses. Because the quality and volumes of drainage losses are not directly measured, estimates from the technical literature are used for loading from this source. Sanitary system operators were also contacted to gain their perspectives and estimates of drainage loss volumes.

Exfiltration rates are considerably smaller than infiltration rates because wastewater causes soil clogging and sedimentation can plug sewer pipe defects (Karpf and Krebs, 2004). For most soil types, unsaturated soil transmits water less efficiently than the saturated conditions present during infiltration (i.e., unsaturated hydraulic conductivity is lower than saturated hydraulic conductivity). Leaks from sewers are self-sealing due to the rich organic content and microbial growth combining to form biofilms, called colmation layers which limit the volume of exfiltration (Ellis, J.B., 2001). However, colmation layers in sewers can be dislodged by flow surges caused by inflow during heavy rainfall events, sewer cleaning, or local increase in flow velocity following breakthrough of partial backup/blockages. It is therefore reasonable to assume some exfiltration and to assign S/N loading factors to exfiltration.

The rate of sewer line exfiltration was estimated based on pipe diameter and assumes 100 gallons per inch of internal diameter per mile of sewer over 24-hours (adapted from ASTM C 969). This method was applied for all parts of the sewer systems within the Santa Clara Plain and outside the zone where depth to water is 10 feet or less, i.e., where groundwater intrusion to sewer lines may occur. The resulting volume is about 1.8% of the average daily flow to all three wastewater treatment plants. This percentage is at the low end of the range of sewer system losses reported in the technical literature (Amick and Burgess, 2000).

A low estimate of sewer line exfiltration is appropriate for SNMP based on two considerations. First, sewer system management plans published for the sewer systems in the Santa Clara Plain identify specific preventive maintenance measures and vigilant inspection programs. Second, sewer line defects are often self-sealing as described above. To estimate loading we used the volume-weighted average of the TDS and nitrate measured on the influent to all three wastewater plants serving the Santa Clara Plain, based on 10-year medians for each plant.

Most of the Coyote Valley is not sewered. For this analysis, the residential section of Morgan Hill that is sewered and located within the Coyote Valley is ignored.

The estimated average volume of septic effluent is 99,000 gallons per septic system per year, based on literature data for per capita wastewater generation. There are only about 70 septic tanks in the Santa Clara Plain, located at the southern end of the Almaden Valley, while the Coyote Valley has about 600 septic tanks. Locations of areas served by septic tanks are shown in Figure 19.

The estimated volume of stormwater losses is based upon assumptions regarding the amount of rainfall that runs through storm drains to creeks, and an assumed exfiltration rate of 1.3%.

The quality of water in the drainage loss term was determined from measurements and from literature values. Wastewater quality measurement of specific conductance (electrical conductivity) and ammonia were converted to TDS and nitrate to obtain volume-weighted averages for all three wastewater plants. The quality of septic effluent was estimated as the median of values presented in 18 literature studies that measured septic effluent quality.[19] Stormwater quality is estimated based on creek samples reported by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP). Table 28 summarizes estimated volumes, concentrations, and salt and nitrate loading from drainage losses.

Table 28 – Median Estimated Salt and Nitrate Loading from Drainage Losses

	Santa Clara Plain	Coyote Valley	Total
Combined Drainage Loss Volume*	2,470 AF/yr	162 AF/yr	2,630 AF/yr
Overall Drainage Loss TDS Concentration*	824 mg/L	575 mg/L	
Overall Drainage Loss Nitrate as NO_3 Concentration*	33 mg/L	169 mg/L	
Combined Salt Loading as TDS*	2,770 tons/yr	127 tons/yr	2,900 tons/yr
Combined Nitrate as NO_3 Loading*	112 tons/yr	32 tons/yr	144 tons/yr

* Ten-year median

[19] Brown K.W., et al., 1978; Feth, J.H., 1966; Popkin, R.A., and Bendixen, T.W., 1968; Brown and Caldwell, 1981; Biggar, J. W., and Coney, R.B., 1969; Taylor, J., 2003; Zhan & Mackay, 1998 (citing Canter & Knox); Effert, D., et al., 1985; Dudley, J .G., and Stephenson, D.A., 1973; Otis R.J., et al., 1975; Metcalf & Eddy, 1972; Hansel, M.J., and Machmeier, R.E., 1980; Bicki, T.J., et al., 1984; Brooks J.L., et al., 1984; Lowe, K., et al., 2007 SCVWD, 1994; Alhajjar, et al., 1989; Canter, L.W., and Knox, R.C., 1985; Conn, K.E., and Siegrist, R.L., 2007; Panno, S.V., et al., 2005; Kaplan, O.B., 1991.

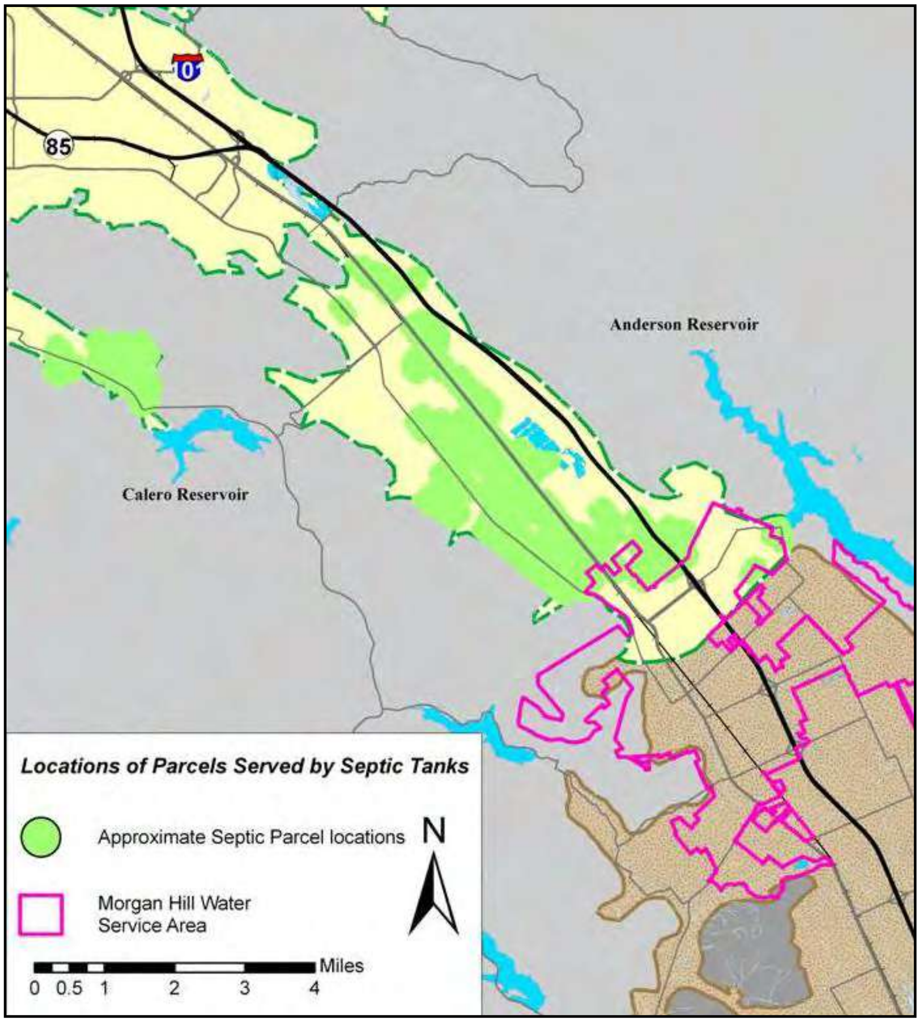


Figure 19- Locations of Areas Served by Septic Tanks

3.3.2 Dry Loading

Dry loading refers to the salt and nitrate loading from dry sources such as fertilizer, soil amendments, and atmospheric deposition. Salt and nitrate loading from dry sources is not directly measured, so estimates were developed from 2011 crop data and University of California Cooperative Extension guidance of fertilizer application rates, from literature on lawn fertilizer, and from published model results of regional atmospheric deposition rates for nitrogen.

3.3.2.1 Agricultural Fertilizer and Lawn Fertilizer

Fertilizers applied to crops and turf at parks and on residential lawns contribute salt and nitrate to groundwater where conditions favor leaching. To estimate nitrate and salt loading from agricultural fertilizer use, 2011 cropping patterns were obtained from the County Agricultural Commissioner's office. Crop fertilizer application rates by type were compiled from University of California Cooperative Extension agriculture technical literature. Rates of fertilizer application vary by crop type, and cropping patterns vary over time. For the purposes of this SNMP, the 2011 crop acreages are considered representative of a typical year, and loading rates developed for 2011 were applied to 2001–2010. Fertilizer adds mineral salts in addition to nitrogen. The rate of salt loading from agricultural fertilizer application was estimated from the typical fertilizer application rates for the crops grown in the Santa Clara Groundwater Subbasin, and the common composition of each fertilizer type.

The area of parks and residential lawns where fertilizers may be applied was estimated from the LAMS GIS raster.[20] No local data on the frequency and rate of fertilizer application on residential lawns and municipal parks was available. To render an estimate, the assumption is made that half the lawns and parks apply fertilizer in a given year. The rate of application was taken as 3.5 lbs nitrogen per 1,000 square feet, i.e., about 150 lbs per acre (UCD, 2002). The rate of nitrate attenuation for dry lawn fertilizer, listed in Table 16 (95%), was determined from a review of the technical literature. Only 5% of nitrogen in lawn fertilizer is assumed to leach to groundwater as nitrate. Because nitrate is 4.43 times heavier than nitrogen, the effective leaching rate for nitrate to groundwater from lawn fertilizer is 34 lbs NO_3/acre. Tables 29 and 30 list the estimated salt and nitrate loading rates from agricultural and lawn fertilizer.

Table 29 – Estimated Salt and Nitrate Loading from Agricultural Fertilizer

	Santa Clara Plain	Coyote Valley	Total
Acres fertilized	1,007 acres	1,273 acres	2,280 acres
Average fertilizer nitrate leaching rate – per acre	155 lbs NO_3	184 lbs NO_3	171 lbs NO_3
Fertilizer salt loading as TDS	40 tons/year	56 tons/year	96 tons/year
Fertilizer Nitrate as NO_3 Loading (leached to groundwater /year)	78 tons NO_3	117 tons NO_3	195 tons NO_3

Table 30 – Estimated Salt and Nitrate Loading from Lawn Fertilizer

	Santa Clara Plain	Coyote Valley	Total
Acres fertilized/year*	4,475 acres	175 acres	4,650 acres
Average application rate, pounds NO_3 per acre (includes 95% attenuation)	34 lbs NO_3 leached to groundwater per fertilized acre	34 lbs NO_3 leached to groundwater per fertilized acre	34 lbs NO_3 leached to groundwater per fertilized acre
Average application rate, pounds salt per acre	161 lbs TDS per acre	160 lbs N per acre	160 lbs N/acre
Fertilizer salt loading as TDS	360 tons/year	15 tons/year	375 tons/year
Fertilizer Nitrate as NO_3 Loading	76 tons/year	3 tons/year	79 tons/year

*Assumes 50% of lawns and parks are fertilized in a given year.

[20] LAMS = Large Area Mosaicing Software, a high-resolution infrared-band imagery coverage from which irrigated land uses can be differentiated.

3.3.2.2 Atmospheric Deposition

Atmospheric deposition refers to particles, aerosols, and gases that move from the atmosphere to ground surface.[21] Dry deposition originates from a variety of natural and air pollution sources that contribute nitrate and salt to groundwater. Dry deposition is difficult to measure so estimates of dry deposition rely on models that combine measured concentrations of nitrogen species with calculated deposition velocities. Uncertainties in dry deposition estimates are between 30 to 50%. Dry deposition data were obtained from US EPA, which maps deposition patterns nationally, based on modeled interpolation of a sparse regional network of non-urban atmospheric deposition monitoring stations. The monitoring stations are located primarily in national parks. The nearest available dry deposition data for total nitrogen (Fremont) was obtained from the California Air Resources Board. An interpolated grid of nitrogen dry deposition model estimates was obtained from California Energy Commission reports and interpreted following the approach used in a local study by Weiss (1999). Applying a series of scaling factors based on relationships among air pollution factors, the estimated total N dry deposition rate for open grassland or cultivated areas in Coyote Valley is calculated to be on the order of 11 to 15 kg nitrogen/hectare/year (N/ha/yr) (Weiss, 1999). For this calculation, the low end of the range was used (11 kg N/ha/yr) for the Coyote Valley. For the Santa Clara Plain, the modeled estimates of atmospheric depositions range from 3.9 to 8.4 kg N/ha/yr (Tonnesen et al., 2007).

Vehicle emissions represent the primary source of atmospheric nitrogen deposition in close proximity to high-traffic freeways and roads (Collins, 1998). Land within 100 meters of high-traffic corridors (freeways, highways, and expressways/arterial roads) was assigned a higher nitrogen flux value and added to the grid of modeled nitrogen loading to account for the Bay Area funnel effect that directs smog from San Francisco, San Mateo, and Alameda counties into the Santa Clara Valley. Nitrogen deposition in Santa Clara County is dominated by dry deposition due to the pattern of long dry summers and winter rains, and often exceeds wet deposition by 10 to 30 times (Blanchard, et al., 1996). For land within 100 meters of high-traffic corridors, 11 kg N/ha yr was used. Traffic corridors in Coyote Valley are included with the 11 kg N/ha/yr estimate.

The properties of the surfaces upon which nitrogen is deposited determine whether nitrate is added to the groundwater basin. Impervious surfaces such as roofs, roads, and parking lots, transfer nitrogen of atmospheric origin to stormwater, and ultimately to the Bay. Land areas that are cultivated, landscaped, or undeveloped facilitate deep percolation of a portion of the atmospheric nitrogen to groundwater.

Once deposited to vegetated ground surfaces, nitrogen of atmospheric origin may volatilize, be taken up by plants (through the root zone or through leaf stomata), or become dissolved in water, some of which will run off as surface water, and some of which will contribute to deep percolation of nitrate to underlying groundwater. Dissolved nitrate may further undergo denitrification in the subsurface. The following assumptions regarding nitrate fate and transport are made (as listed in Table 16):

- 80% of the nitrogen is taken up by plants (primarily grasses).
- 15% is volatilized or denitrified to gaseous nitrogen.
- 5% is converted to nitrate and percolates to groundwater.

[21] Atmospheric deposition also refers to wet precipitation (rain and snow), which also contribute salt and nitrate to groundwater, and are addressed in Section 3.3.1.1.

Inspecting the LAMS image data and the MRLC[22] cover imagery in GIS, the average ratio of irrigated and vegetated area to total area in the Santa Clara Plain area of the Santa Clara Groundwater Subbasin is 24%. Therefore, 76% of the atmospheric deposition of nitrogen is likely removed by rainfall runoff.

Table 31 – Estimated Salt and Nitrate Loading from Atmospheric Deposition

Category	Total N kg/ha/yr	Annual Nitrate as NO_3 Loading, tons/yr [1]		
		Santa Clara Plain	**Coyote Valley**	**Subbasin Total**
Areal Deposition on Santa Clara Plain from CMAQ[2] modeled estimate	3.9–8.4	10	1.25	11.25
High-Traffic Corridors + Coyote Valley	11	11.5	0.3	11.8
Total Nitrate		**21.5**	**1.55**	**23**
Salt as Dry Deposition of TDS [4]	**5 yr range kg/ha/yr**	**Santa Clara Plain [3]**	**Coyote Valley**	**Subbasin Total**
	0.22 – 1.29	30	1.8	32

[1]Total N-deposition converted to nitrate as NO_3 (multiply by stoichiometric conversion factor 4.43) subject to deep percolation to groundwater (5%).
[2] CMAQ: Congestion Mitigation and Air Quality Improvement model. See Tonneson et al, 2007.
[3] On average 76% of Santa Clara Plain ground surface is impervious and assumed to facilitate removal of atmospheric salt and nitrate deposits to stormwater, which removes it from the groundwater subbasin.
[4] TDS is taken as the sum of US EPA's Clean Air Status and Trends Network (CASTNET) data for sulfate, chloride, calcium, magnesium, sodium, and potassium.

3.3.3 Salt and Nutrient Removal

Groundwater leaving the Santa Clara Groundwater Subbasin aquifers carries salt and nitrate and comprises a removal term in the overall salt balance. Groundwater removal occurs naturally through basin outflow and in gaining reaches of streams. Groundwater removal also occurs through groundwater pumping and through groundwater infiltration into sewer pipes and storm drains located beneath the water table. This section inventories the volumes of groundwater leaving the subbasin and the associated salt and nitrate removal. Table 32 summarizes salt and nitrate removal from all of these removal categories following their descriptions in the next sections.

3.3.3.1 Groundwater Pumping

The District meters pumping from major production wells and uses reported production from other wells to account for a detailed and accurate inventory of groundwater pumping. Pumping categories include municipal and industrial, environmental, domestic, and agricultural wells. For each category, reported volumes were multiplied by groundwater concentrations of nitrate and salt. The largest volume of pumping is from municipal supply wells. S/N removal from municipal supply wells was calculated by multiplying metered volumes and S/N concentrations corresponding to the retailer service areas, using water quality data supplied by retailers to

[22] Multi-Resolution Land Characteristics Consortium – www.MRLC.gov

DDW. No attenuation is assigned for pumping, which removes S/N already dissolved in groundwater. For industrial, environmental, domestic, and agricultural wells, the groundwater basin average concentrations were used. Some of the salt and nitrate in groundwater is returned to the basin, which is accounted for in the wet loading terms described in Section 3.3.1. Table 32 summarizes S/N removal by groundwater pumping.

3.3.3.2 Basin Outflow

The volume of groundwater leaving the subbasin by flowing into aquifers north of the Santa Clara Plain or from the Coyote Valley into the Santa Clara Plain is not measured directly. Groundwater flow models are used to estimate basin outflow volumes, which are multiplied by volume-weighted average concentrations for TDS and nitrate. Estimates of S/N removal attributable to basin outflow are provided in Table 32.

3.3.3.3 Gaining Reaches of Streams

Where groundwater elevations are higher than the stream bottom[23] groundwater may discharge into the stream. Groundwater discharge to streams generally occurs in sections of streams located near the Bay called gaining reaches of streams. Gaining reaches of streams also occur in Fisher and Coyote Creeks at the northern end of the Coyote Valley, where decreasing depth to bedrock causes a shallow groundwater condition. The volume of groundwater discharging to streams was estimated by stream gauging and calibration of groundwater flow models. The estimated removal of S/N from Coyote Valley that is attributable to gaining reaches of streams was obtained by multiplying this volume by the volume-weighted average concentrations of TDS and nitrate in Coyote Valley. The Santa Clara Plain groundwater flow model was calibrated without including a module for gaining reaches of streams, so an estimate of groundwater discharge to streams is not available. Stream gauging to estimate groundwater discharge to streams in the Santa Clara Plain is made difficult by tidal fluctuations in the lower reaches of streams. Table 32 summarizes S/N removal by gaining reaches of streams in Coyote Valley.

3.3.3.4 Groundwater Infiltration into Sewer Lines and Storm Drains

Where sewer mains and storm drains are buried below the water table, groundwater may enter under hydrostatic pressure through defective joints, cracks, or other openings. A detailed review of Groundwater Infiltration (GWI) estimation methods and estimates of the mass of S/N removed by GWI is provided as Appendix 5. Results of these estimates are included in Table 32.

3.3.3.5 Storm Drain Infiltration

Storm drains in both the Santa Clara Plain and the Coyote Valley may remove groundwater where they are submerged year-round or seasonally. In the lower reaches of the Guadalupe River, Coyote Creek, and other creeks, stormwater is discharged through flood control levees using stormwater pumps. The occasional operation of these pumps during the summer is due to storm drain conveyance of infiltrated groundwater. While the volumes pumped during summer are not measured, the discharges are regular and move a substantial volume of groundwater. To estimate the magnitude of groundwater infiltration into storm drains, an estimate of exfiltration was developed and the ten-fold infiltration estimation factor described in

[23] The “stream bottom” is the thalweg, i.e., the deepest point in the stream channel cross-section – akin to the invert in an engineered channel. Discharge into the stream may be impeded by clay layers.

3.3.1.10 was applied. The analysis of groundwater infiltration into storm drains is presented in Appendix 5, and results are included in Table 32.

Table 32 – Salt and Nutrient Removal

Category		Santa Clara Plain	Coyote Valley
10-year Median Volume-weighted TDS concentration †		Shallow: 536 mg/L Overall: 427 mg/L	376 mg/L
10-year Median Volume-weighted NO_3 concentration †		Shallow: 9 mg/L Overall: 11 mg/L	20 mg/L
1. Groundwater Pumping	Volume	91,800 AF/yr	13,600 AF/yr
	Salt Removal	49,000 tons/yr	6,700 tons/yr
	Nitrate Removal	730 tons/yr	400 tons/yr
2. Basin Outflow	Volume	6,000 AF/yr	4,870 AF/yr
	Salt Removal	3,360 tons/yr	2,490 tons/yr
	Nitrate Removal	90 tons/yr	160 tons/yr
3. Gaining Reaches of Streams	Volume	-	3,280 AF/yr
	Salt Removal	-	1,670 tons/yr
	Nitrate Removal	-	110 tons/yr
4. Infiltration into Sewer Lines	Volume	2,930 AF/yr	-
	Salt Removal	2,520 tons/yr	-
	Nitrate Removal	28 tons/yr	-
5. Infiltration to Storm Drains	Volume	4,380 AF/yr	-
	Salt Removal	3,200 tons/yr	-
	Nitrate Removal	46 tons/yr	-
TOTALS	Volume	**105,100 AF/yr**	**21,750 AF/yr**
	Salt Removal	**58,080 tons/yr**	**10,860 tons/yr**
	Nitrate Removal	**890 tons/yr**	**670 tons/yr**

† In the Santa Clara Plain, shallow concentrations were applied for sewer line and storm drain infiltration, and total basin concentrations were applied to basin outflow and gaining reaches of streams. Shallow and deep aquifers are not differentiated in the Coyote Valley.

3.3.4 Overall Salt and Nitrate Balance

The sum of all the individual salt and nitrate loading and removal categories provides the overall salt balance for the Santa Clara Plain and for the Coyote Valley. Table 33 provides the overall salt balance.

Table 33 – Overall Salt and Nitrate Balance

Salt and Nutrient Loading	Santa Clara Plain				Coyote Valley			
	TDS, tons/yr	%	Nitrate as NO_3, tons/yr	%	TDS, tons/yr	%	Nitrate as NO_3, tons/yr	%
Rainfall Recharge	180	0.2%	8.2	0.7%	29.9	0.38%	1.4	0.6%
Mountain-front Recharge	4,600	5.1%	44	3.9%	-	-	-	-
Basin Inflow	4,140	4.6%	230	20.4%	-	-	-	-
Managed Recharge†	24,720	27.6%	39	3.5%	4,684	60%	3	1.5%
Agricultural Irrigation	320	0.4%	3	0.3%	2,070	26%	49	21.7%
Landscape Irrigation	42,270	47.1%	322	28.5%	844	10.8%	18.2	8.1%
Landscape Irrigation with Recycled Water	6,725	7.5%	141	12.5%	-	-	-	-
Conveyance Losses	3,500	3.9%	58	5.1%	20	0.25%	0.45	0.2%
Drainage Losses	2,770	3.1%	112	9.9%	127	1.6%	32	14.1%
Agricultural Fertilizer	40	0.04%	78	6.9%	56	0.71%	117	52%
Lawn Fertilizer	360	0.4%	76	6.7%	15	0.19%	3.1	1.4%
Atmospheric Deposition	30	0.03%	21.5	1.9%	1.8	0.02%	1.5	0.7%
TOTAL LOADING	**89,660**	**100%**	**1,130**	**100%**	**7,850**	**100%**	**226**	**100%**
Salt and Nutrient Removal	**Santa Clara Plain**				**Coyote Valley**			
	TDS, tons/yr	**%**	**Nitrate as NO_3, tons/yr**	**%**	**TDS, tons/yr**	**%**	**Nitrate as NO_3, tons/yr**	**%**
Groundwater Pumping	49,000	84.4%	730	82%	6,700	62%	400	60%
Basin Outflow	3,360	5.8%	90	10%	2,490	23%	164	24%
Gaining Reaches of Streams	-	-	-	-	1,670	15%	110	16%
Infiltration into Sewer Lines	2,520	4.3%	28	3%	-	-	-	-
Infiltration into Storm Drains	3,200	5.5%	46	5%	-	-	-	-

TOTAL REMOVAL	**58,080**	**100%**	**890**	**100%**	**10,860**	**100%**	**670**	**100%**
NET LOADING	**31,520**	**tons/yr**	**240**	**tons/yr**	**- 3,010**	**tons/yr**	**- 444**	**tons/yr**

† The value listed is the median of the 10-year sums of creek and pond recharge, which differs from the sum of the 10-year medians of creek and pond recharge listed in Tables 21and 22, because the median is not a distributive property.

3.4 Assimilative Capacity

Assimilative capacity is the difference between the ambient groundwater quality and the Basin Plan Objective. For example, if measured TDS averaged over the groundwater basin is 300 mg/L, and the Basin Plan Objective is 500 mg/L, assimilative capacity is 200 mg/L. The SWRCB Recycled Water Policy stipulates that the available assimilative capacity should be calculated using the most recent five years of available data or a time period approved by the RWQCB. This SNMP uses data from 2008 through 2012 to calculate assimilative capacity.

3.4.1 Ambient Groundwater Quality

Data for the two indicator parameters, TDS and nitrate as NO_3, were obtained from the District's regional groundwater monitoring program and from data reported by water retailers to the DDW. Where multiple analyses are available for a given well in the same year, the average of all the sample results was used for that year.

The Santa Clara Plain has a zone of saline intrusion in the Baylands as described in Section 3.3.1.3. A regional aquitard separates the shallow aquifer from the principal aquifer as described in Section 2.1. There are two areas where TDS is high in the principal aquifer due to mineral salts of geogenic origin. The two areas with elevated TDS are located in Palo Alto and in a portion of the Evergreen area (see Figure 17). Sediments of marine origin may contain salts of the original seawater that may be the source of these higher dissolved solids (Metzger and Fio, 1997). The areas in question are of limited extent; however they were included in the determination of volume-weighted average concentration.

Figure 20 shows the locations of wells used to determine the basin average TDS concentrations in the Santa Clara Plain, and wells used to determine basin average nitrate concentration are shown in Figure 21.

In general, shallow monitoring wells have higher TDS than the wells completed in the principal aquifer below the confined zone. Therefore, averages for TDS and nitrate as NO_3 were determined separately for the shallow and deep aquifers. A single volume-weighted average was determined for both the Santa Clara Plain and Coyote Valley.

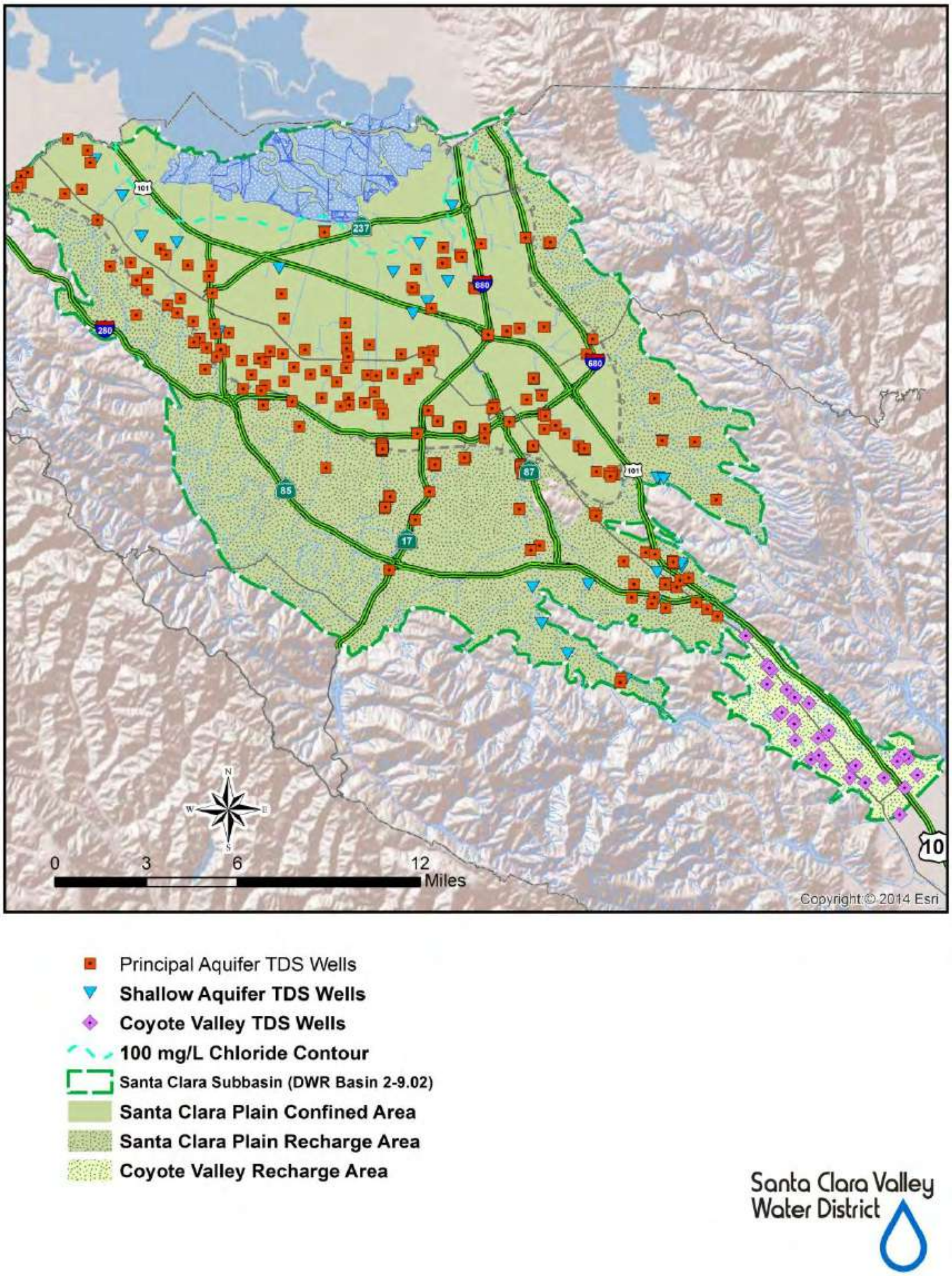


Figure 20 – Locations of Wells used to Determine Volume Weighted Average Concentration of Total Dissolved Solids in the Santa Clara Plain and Coyote Valley

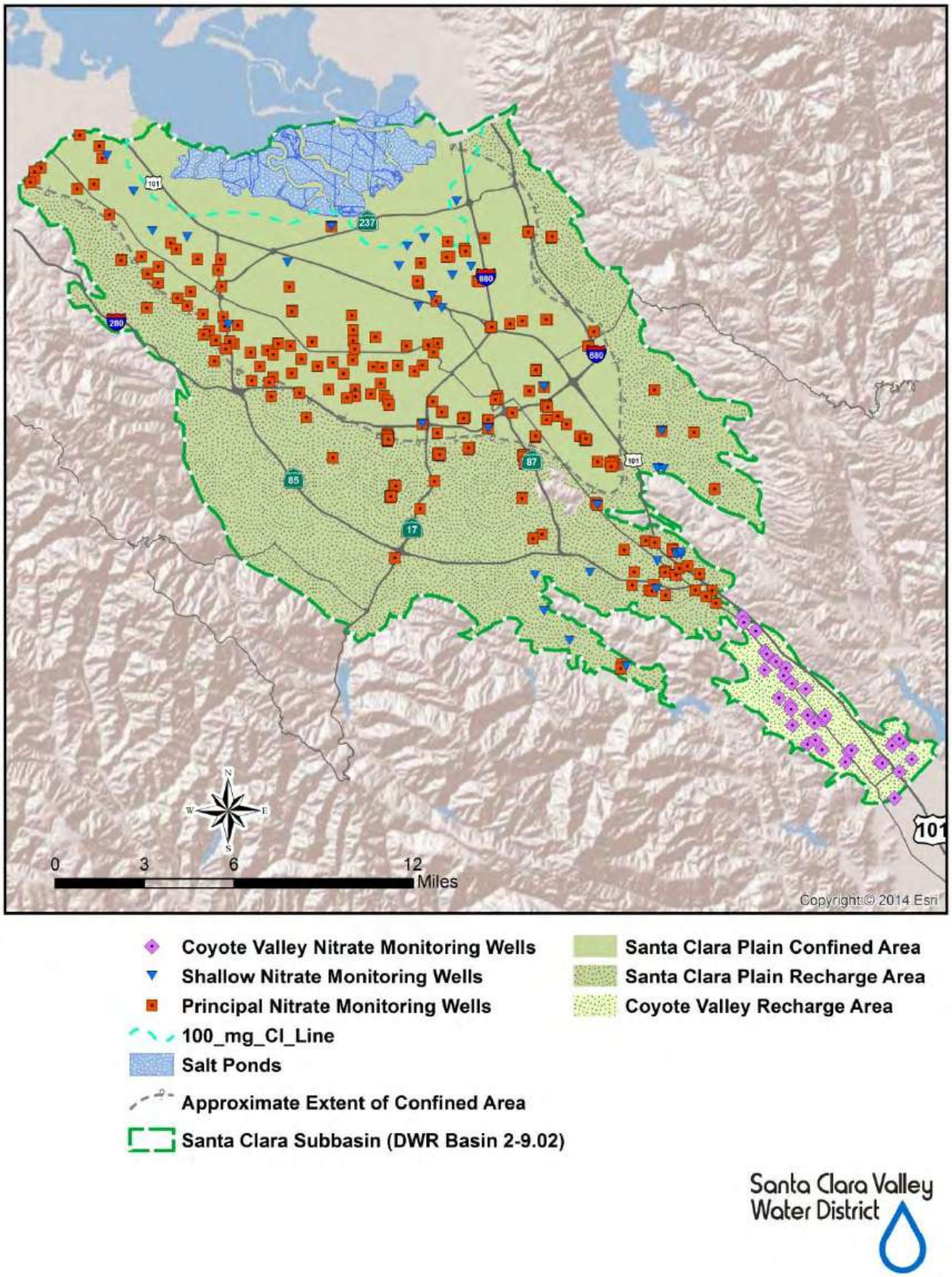


Figure 21 – Locations of Wells used to Determine Volume Weighted Average Concentration of Nitrate as NO3 in the Santa Clara Plain and Coyote Valley

3.4.2 Volume-Weighted Average Basin Concentrations

Volume-weighted averages were developed for yearly data from 2008 through 2012 for the saturated thickness of the shallow and principal aquifers. MODFLOW model grid cells and depth to water data were used to estimate saturated aquifer volume, and the wells were assigned to shallow or principal aquifers based on their depths. Concentration data from wells corresponding to each model layer were gridded using Surfer Software's universal kriging option. Gridded values were averaged over the model cells, and the concentrations assigned to each model cell were multiplied by the cell volume and the estimated porosity. The mass of TDS or nitrate as NO_3 was summed for each model layer, and the totals from each layer were summed to obtain the overall mass in the Santa Clara Plain. The overall mass was divided by the overall volume to obtain volume-weighted averages for the shallow and principle aquifers, and for a single average, as summarized in Table 34. For the Coyote Valley, available water quality data was interpolated using Thiessen polygons[24] ArcGIS software. Values in the Thiessen polygons were assigned to model grid cells to estimate mass, and divided by the total volume in the Coyote Valley, to yield a volume-weighted average concentration. The resulting concentrations for both subareas are contrasted with the Basin Plan Objectives to determine assimilative capacity in Table 34.

To determine the basin volume available for mixing, a specific yield was considered representative of the volume involved with active, short-term mixing. Nitrate and the solutes measured in TDS analysis participate in diffusion over the long term, which includes the total effective porosity. Therefore, porosity was used instead of specific yield. Staff considered the estimated porosities of basin aquifer materials, and used a porosity of 30% for the shallow aquifer and 25% for the principal aquifer in the Santa Clara Plain, and 30% for all of the Coyote Valley.

Table 34- Factors Used to Determine Volume-Weighted Average Concentrations

SANTA CLARA PLAIN			**Available Mixing Volume, AF**	**Vol-Wt. Avg. Conc. 2008 – 2012**	
Aquifer	**Saturated Volume, AF**	**Porosity**		**TDS, mg/L**	**Nitrate as NO_3, mg/L**
Shallow	10,790,700	30%	3,237,200	528	9.1
Principal	86,682,200	25%	22,509,700	410	11.0
Overall	97,472,900	25%	25,746,900	425	10.7
COYOTE VALLEY				**Vol-Wt. Avg. Conc. 2008 – 2012**	
				TDS, mg/L	**Nitrate as NO_3, mg/L**
Overall	644,650	30%	644,650	377	20.0

[24] Thiessen Polygons, also called Voronoi Cells, are a method for subdividing an area based on locations of data points (e.g., wells or rain gages). Polygons are formed by line segments perpendicular to the midpoints of lines formed by connecting adjacent points. Thiessen polygons are used to develop an area-weighted distribution of data across a spatial domain to lessen the effect of clustered data or data gaps.

Table 35 – Assimilative Capacity in the Santa Clara Plain and Coyote Valley

Sub-Area/Aquifer	Vol-Wt. Avg TDS, mg/L	TDS Assimilative Capacity	Vol-Wt. Avg Nitrate as NO_3	NO_3 Assimilative Capacity
Basin Plan Objective	***500***		***45***	
Santa Clara Plain – Shallow	528	**-28**	9.1	**35.9**
Santa Clara Plain – Principal	410	**90**	11.0	**34.0**
Santa Clara Plain – Overall	425	**75**	10.7	**34.3**
Coyote Valley	377	**123**	20.0	**25.0**

3.4.3 Estimated Basin Assimilative Capacity

The assimilative capacities listed in Table 34 show that for the Santa Clara Plain overall, there is an assimilative capacity of 75 mg/L for TDS and 34.3 mg/L for nitrate as NO_3. The Coyote Valley has lower average TDS concentration, with an assimilative capacity of 123 mg/L. Nitrate as NO_3 concentrations in the Coyote Valley are higher with an assimilative capacity of 25 mg/L.

3.4.4 Projecting Future Assimilative Capacity

Future assimilative capacity can change with variation in salt loading and removal and associated changes in TDS and nitrate concentrations. The approach used for projecting future concentrations involves projecting changes to TDS and nitrate loading and removal. This section discusses the basis for the assumptions applied to make these projections, and explains the results of calculations of future assimilative capacity.

3.4.4.1 Assumptions for Future Loading

The Recycled Water Policy stipulates that SNMPs should calculate S/N loading impacts for no less than a ten-year time frame. In order to coincide with the planning period for the 2010 Urban Water Management Plan, the planning horizon selected is 2010 through 2035. In this timeframe, a number of anticipated changes will impact water use and quantities of salt and nitrate in groundwater. These anticipated changes are based on projections for water demand and water conservation detailed in the Urban Water Management Plans published every five years. Future actions that can affect (increase or decrease) the salt and nitrate loading include the following:

- Improved recycled water quality from advanced treatment.
- Planned increases in recycled water use.
- Planned indirect potable reuse using advanced-treated recycled water.
- Planned rehabilitation of known problems with infiltration of saline water into sewer lines.

- Decreasing trends in pumping for environmental remediation.
- Planned outdoor water conservation initiatives.
- Planned capital improvements to increase recharge system capacity.
- Anticipated increases in drainage losses due to increased sewer flows and storm drain losses (septic component is assumed to be constant).
- Anticipated increases in conveyance losses associated with increases in water use.

While there are many forecasts for long-term variation in rainfall, evapotranspiration, and sea level rise in response to climate change (i.e., in 50 to 100+ years), there are only a few studies available that estimate local conditions in the near term (i.e., in the next 25 years). For the SNMP planning horizon, there are not sufficient local studies of rainfall and evapotranspiration changes to render a projection, so these factors were held constant. Similarly, the possible effects from sea level rise on delta water quality and local saline incursion of streams over the next 25 years is not considered for these projections due to lack of a reliable short-term forecasts. Table 35 lists the numeric factors used to forecast changes to salt and nitrate loading to groundwater.

Table 36 – Basis of Future Loading Projections by Category

LOADING Landscape Irrigation	Tied to Urban Water Management Plan water demand and water conservation projections; assumes 45% outdoor water use overall. About 90% of SJWC's projected 7,000 AF new recycled water irrigation is retrofit displacing existing landscape irrigation with potable water. Increased loading from irrigating with higher TDS recycled water is included in the Recycled Water Category.
Other Irrigation	Held constant. Includes domestic well outdoor irrigation parks, golf course irrigation, and agricultural irrigation.
Managed Recharge	20,000 AF/yr of advanced treated recycled water is forecasted to be available for additional groundwater recharge by 2030. Future loading includes the IPR scenario (20,000 AF/yr by 2030), and new recharge from upgrade of the Kirk Diversion Dam (920 AF/yr by 2015), Alamitos Diversion Dam (440 AF/yr by 2018), and the Coyote Diversion Dam (1,000 AF/yr by 2020) per the 5- year Capital Improvements Program report. In addition, the Water Supply Infrastructure Master Plan includes a new recharge facility in the west part of the Santa Clara Plain with a 3,300 AF/yr capacity, for which 1,650 AF/yr recharge is projected (total of all new recharge = 4,000 AF/yr).
Natural Recharge	Held constant.
Recycled Water	Non-potable recycled water used for irrigation is projected to increase from about 7,000 AF in 2010 to 26,500 AF in 2035. Advanced treated recycled water will be blended with tertiary-treated recycled water to achieve a TDS of 500 mg/L. Sunnyvale plans long term addition of 2,061 AF/yr and forecasts improved TDS at 760 mg/L. Palo Alto achieved a TDS reduction from 950 mg/L to 770 mg/L in 2013 and forecasts achieving 600 mg/L by 2018 if identified projects are funded and completed (included in the forecast).
Drainage Losses	Drainage losses will increase from 2,100 tons TDS/year to 2,600 tons per year according to projected increases in wastewater and stormwater volumes, and the resulting loading will increase slightly based on projected water quality changes in response to water conservation.
Conveyance Losses	Increases proportional to projected increases in demand.
Fertilizer	Held constant.
Atmospheric Deposition	Held constant – assumes increased number of vehicles is offset by improved emissions controls and increased use of alternative fuel vehicles.
REMOVAL Saline Infiltration of Sewer Lines	In 2013, Palo Alto sleeved Mountain View Trunk Line reducing TDS from 950 to 775 mg/L. This trunk line contributes 31% of the 21.7 MGD total flow to the plant. The reduction in annual removal from saline infiltration of sewer lines is 732 tons per year in 2013, and 2,240 by 2022 (included in the forecast).[B]
Retailer pumping	Increases per 2010 UWMP Projections.
Non-Retailer Pumping	Agricultural pumping decreases in both the Coyote Valley and the Santa Clara Plain per the projection in Urban Water Management Plan. [C] Overall, the Santa Clara Plain non-retailer pumping decreases due to the continuing trend of declining environmental pumping.
Basin outflow/gaining streams	Held constant.

Definitions: Other Irrigation = agricultural irrigation, irrigation from domestic wells, irrigation of parks, golf courses, cemeteries, etc.; Managed Recharge = combined recharge from percolation ponds and in-stream recharge (includes Indirect Potable Reuse, which is not counted in the Recycled Water Category); Natural Recharge = mountain front, rainfall, and losing reaches of streams; Drainage Losses = sewer line exfiltration, storm drain exfiltration, and septic tank leach field effluent; Conveyance Losses = real losses from retailer distribution systems and regional transmission losses; Fertilizer = combined agricultural and lawn and garden fertilizer; Atmospheric Deposition = dry deposition of nitrogen exclusive of rainfall. **References:** A) RMC, 20 13 B) City of Palo Alto, 2013 C) SCVWD, 2010

3.4.4.2 Methodology and Assumptions for Mixing Calculation

The procedure used to determine the change in concentration resulting from loading and removal of salts and nitrate is a basic mixing equation, in which the following assumptions are made:

- Mixing occurs within the year that the loading occurs, i.e., mixing is considered to be instantaneous.
- Mixing involves the entire saturated volume, including both the shallow and principal aquifers. Accordingly, the geographic locations of different loading sources (e.g., recycled water vs. septic tanks) are inconsequential for determining a change in basin-wide average concentration for the combined shallow and principal aquifers.
- The role of the confining clay layer (aquitard) in isolating the principal aquifer can be ignored for the purposes of determining changes in overall basin concentration.
- The effects of changes in rates of loading or removal are instantaneous.
- The unsaturated zone is in steady state with respect to sorption therefore, transit of salt and nitrate through the unsaturated zone is taken as instantaneous.
- Attenuation of nitrate due to root uptake and denitrification does not delay its transit across the unsaturated zone.
- The volume of water in the groundwater basin remains constant.
- The relevant time step for determining changes in concentration is one year.

These assumptions allow for a simplified calculation of basin concentrations. Some of these assumptions exaggerate the effects of salt and nitrate loading and are therefore conservative. For example, the residence time of nitrate in the unsaturated zone may span 40 to 80 years, causing long-term delayed effects from present-day loading (Sebiloa et al., 2013). By assuming a single mixing volume, local variations in rates of concentration changes are not considered. This approach to forecasting future changes in concentrations cannot be applied to estimating salt and nitrate concentration changes in individual wells or specific areas. This simplified approach allows determination of basin-wide concentration changes that match available data for groundwater and source-water quality.

Subdividing the basin for salt and nitrate loading analysis based on hydrologic, geologic, and land-use characteristics was not pursued because data limitations would make the analysis of sub-areas less reliable. The number of available monitoring data points varies substantially from year-to-year within smaller areas. Moreover, the variation of land use throughout the subbasin subareas is relatively small. For example, the Santa Clara Plain is primarily suburban/urban with no substantial agricultural areas. The most pronounced variation in land use is between the Coyote Valley, which is primarily rural/suburban, and the Santa Clara Plain, which is primarily suburban/urban; therefore, these two subareas were evaluated separately.

The mixing equation used to evaluate future groundwater salt and nitrate concentrations (S/N) can be stated verbally and symbolically as follows:

New Concentration = [Mass S/N Added + Mass S/N already in groundwater – Mass S/N removed]÷ groundwater volume

$$C_{n+1} = \left(\frac{M_{Ln} - M_{Rn} + (C_n \times V)}{V}\right)$$

where C_{n+1} is the new concentration, M_{Ln} is the mass of salt/nitrate loaded in year n, M_{Rn} is the mass of salt/nitrate removed in year n, C_n is the groundwater salt/nitrate concentration in year n, and V is the subarea aquifer saturated porosity volume.

The calculated new basin concentration is applied to groundwater sources of loading for the next year, setting up a feedback loop that accounts for salt accumulation or depletion due to successive net loading or net removal. Where the quantity of S/N loaded exceeds the quantity of S/N removed, the mixing equation will result in concentrations that are larger than the prior years, resulting in an upward trend. While measured concentrations in individual wells show flat or very slightly increasing or decreasing trends in salt and nitrate over the past fifteen years, the mixing equation predicts trends in the basin-wide averages that increase or decrease more rapidly. This departure in trend is attributable to the assumptions of instantaneous mixing, which does not reflect the relatively slow movement of groundwater. Accordingly, the projections provided for 2011–2035 are by nature, inflated because the concentrations changes will take much longer than 25 years to manifest.

3.4.5 Future Assimilative Capacity Projections

Long–term changes in basin–wide groundwater quality are typically slow and gradual because of the large volume of groundwater in storage. In order to account for variable hydrologic conditions, the starting concentration used to forecast future groundwater quality is taken as the median concentration in the 10–year baseline period (2001–2010). The Recycled Water Policy requires that groundwater quality be estimated a minimum of 10 years into the future. This SNMP includes projections from 2010 through 2035 – the planning horizon for the Urban Water Management Plans – to evaluate long-range changes to current trends that may result from planned changes to land and water use. To estimate future loading and removal for factors that are not expected to change loading and removal, rates were held constant at the median value from the 2001–2010 baseline period. Other loading and removal factors were systematically adjusted to reflect future changes in land use and water use, and are included in Urban Water Management Plans, Master Plans, and other planning documents, as noted in Table 35. Ongoing programs and policies that achieve groundwater quality management to mitigate S/N loading are described in Appendix 4.

The primary determinant of future changes in loading is forecasts of increased water use, including landscape irrigation with potable and recycled water. The Urban Water Management Plans (UWMP) prepared by each water retailer and the District's 2010 UWMP forecasts demand increase in response to population growth and planned developments, as well as conservation goals mandated by California's 20x2020 Water Conservation Plan and District water conservation efforts. Table 36 summarizes the changes in overall water use anticipated in the 2010 UWMPs.

Table 37 – Retailer Demand Projections after Conservation Savings(1) (AF/year)

Retailer	2015	2020	2025	2030	2035
Cal Water Service Co.	14,060	12,710	12,920	13,120	13,330
Great Oaks Water Co.[(3)]	13,260	13,420	13,830	14,250	14,660
Milpitas, City of[(4)]	15,280	16,240	17,220	18,240	19,320
Morgan Hill, City of[(4)]	8,970	8,520	8,990	9,580	10,160
Mountain View, City of[(5)]	14,280	14,860	15,430	16,000	16,750
Palo Alto, City of[(2)]	14,190	14,460	14,690	15,500	16,310
Purissima Hills Water District[(5)]	3,130	3,320	3,490	3,660	3,830
San José Municipal Water[(6)]	32,140	35,230	38,460	42,120	45,780
San José Water Company	143,790	147,860	150,930	154,080	157,290
Santa Clara, City of	31,260	33,050	34,610	36,070	37,430
Stanford University[(2)]	5,100	5,740	6,250	6,860	7,470
Sunnyvale, City of[(5)]	27,480	27,900	28,390	28,920	29,800
Independent Groundwater Pumping[(7)]	15,600	15,600	15,600	15,600	15,600
Totals	**338,540**	**348,910**	**360,810**	**374,000**	**387,730**
County-wide Agricultural Demand Projection[(8)]	**29,110**	**28,140**	**27,160**	**26,180**	**25,250**

(1) Includes conservation savings goal for both urban and agricultural conservation.
See Table 43 for total District water conservation program water savings goal with 1992 base year.
(2) 2035 values are a linear extrapolation of retailer provided data.
(3) From District developed demand projections based on ABAG Projections 2009 calibrated with actual use data.
(4) Figures shown are total demand for Morgan Hill. This SNMP accounts for Morgan Hill wells pumping in Coyote Valley and commercial/residential use north of Cochrane Road.
(5) Projections are based on the BAWSCA Long-Term Reliable Water Supply Strategy Phase I Scoping Report (Table A-2, May, 2010) with adjustments for active conservation.
(6) Projections are consistent with the City of San Jose Envision 2040 Draft General Plan Update Preferred Alternative. Includes all of San Jose Municipal's service areas and portions of Coyote Valley where the actual retailer to serve this area has not yet been defined.
(7) Demands for independent pumpers were assumed to continue at the same average level observed in the historical pumping record (2000 – 2009).
(8) Calculated from estimates of projected total agricultural acreage and a water use factor (1.7 AF/yr).

3.4.5.1 Future Loading from Landscape and Agricultural Irrigation

To determine future loading from landscape and agricultural irrigation, the retailer demand projections listed in Table 36 were apportioned to each retailer according to the in-basin/out-basin use splits, indoor-outdoor use splits, and water sources splits (groundwater, treated imported water, SFPUC water, and/or local reservoir water) described in Section 3.3.1.7. The period from 2010–2015 is not addressed in the UWMP projections shown in Table 36. The large increase in loading from 2010–2015 shown in Figure 22 is due to extrapolating from the 2010 measured values to the volume for the projected 2015 retailer demand. This suggests that the retailer demand projected in the 2010 UWMP for 2015 and possibly subsequent years is overestimated. During the 2013-2014 drought, landscape irrigation has declined, rather than increased. Drought conservation measures are not reflected in the projections because the analysis was based on the 2010 UWMP projections.

Agricultural water demand projections shown in Table 36 apply primarily to the Llagas Groundwater Subbasin. The percent change for each five-year interval was applied to the agricultural acreages in the Santa Clara Plain and Coyote Valley. Figures 22-25 chart the projected loading from landscape irrigation by retailer water and agricultural wells, domestic wells and other supply wells used to irrigate parks, golf courses, cemeteries, etc. (non-retailer irrigation).

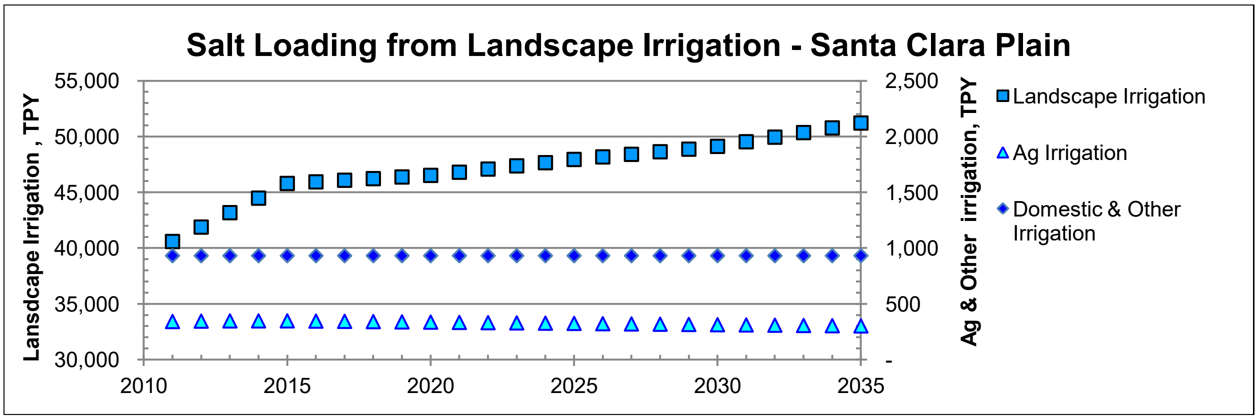


Figure 22 – Salt Loading from Landscape and Agricultural Irrigation in the Santa Clara Plain

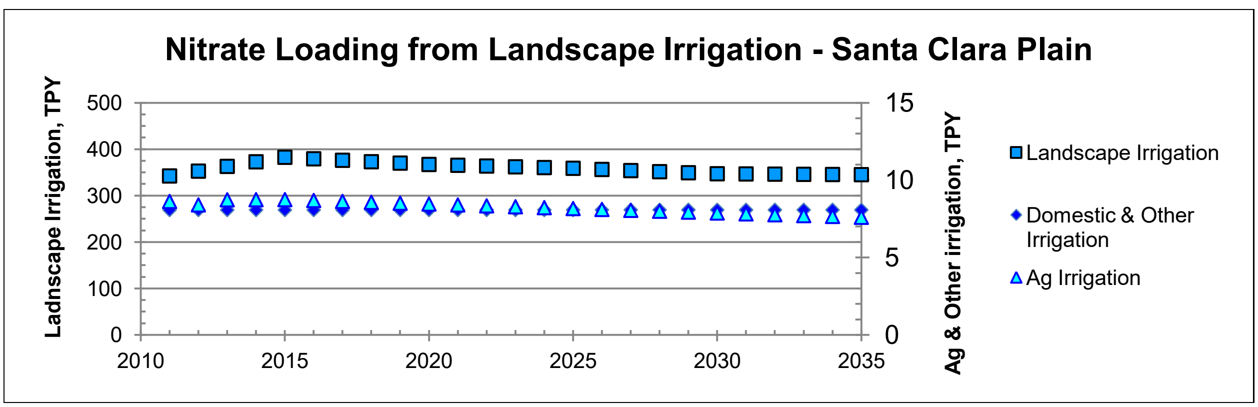


Figure 23 – Nitrate Loading from Landscape and Agricultural Irrigation in the Santa Clara Plain

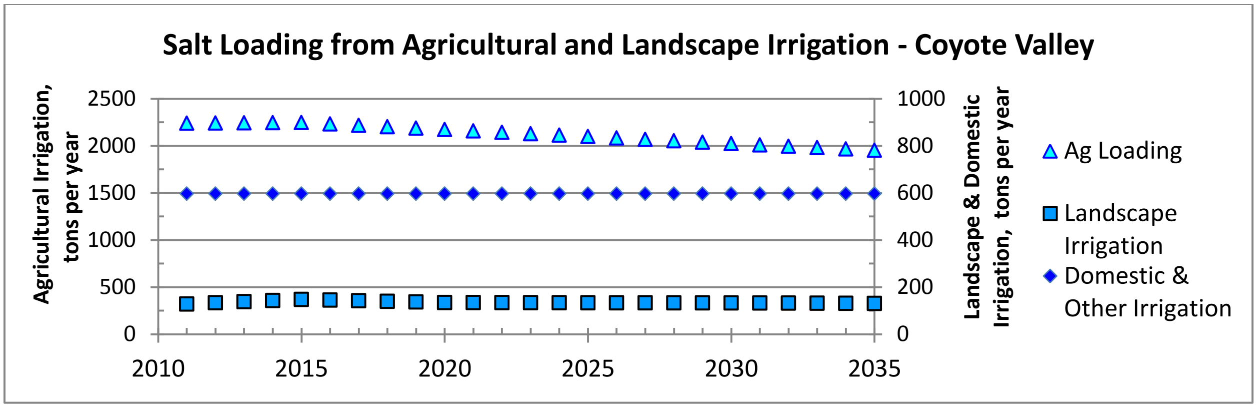


Figure 24 – Salt Loading from Landscape and Agricultural Irrigation in the Coyote Valley

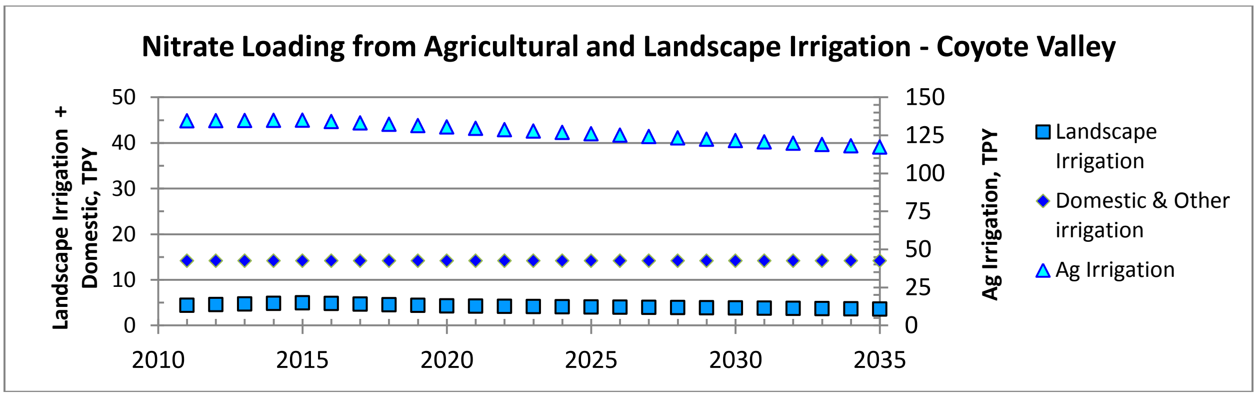


Figure 25 – Nitrate Loading from Landscape and Agricultural Irrigation in the Coyote Valley

3.4.5.2 Future Loading from Natural and Managed Recharge

Projections for natural recharge are held constant for the planning horizon as mountain-front recharge and basin inflow are assumed to remain the same. Projected increases in managed recharge are based on capital projects included in the District's 5-year Capital Improvements Projects Plan that will increase operational recharge capacity to the extent that water supply is available. The 2012 Water Supply Infrastructure Master Plan also identifies a new recharge facility in the western Santa Clara Plain. For the purposes of this SNMP, the capacities of the improvements and increased recharge volumes assumed to come on-line according to the schedule are shown in Table 38.

Table 38 – Schedule and Capacity of Recharge Capital Improvement Projects

Project	Average Yield Increase Capacity, AF/yr	Assumed Increase in Recharge, AF/yr	Estimated Completion Date
Alamitos Diversion Dam	2,200	440	2018
Coyote Diversion Dam	5,000	1,000	2020
Kirk Diversion Dam	4,600	920	2015
New Recharge Facility	3,300	1,650	2026
TOTALS	**15,100**	**4,010**	

Managed recharge is also projected to increase as Indirect Potable Reuse (IPR) projects come on-line. IPR projects take advanced treated recycled water blended with current sources of recharge to provide lower TDS water for recharging the subbasin. The assumed quality of water supplied with IPR projects is 168 mg/L TDS and 2 mg/L nitrate as NO_3. Actual quality of water used for IPR may have higher or lower concentrations depending on operational constraints and other factors. The assumed schedule of increased recharge volumes from IPR projects is as follows:

Table 39 – Schedule and Capacity of Indirect Potable Reuse Recharge Projects

Project	Average Yield Increase (AF/yr)	Estimated Completion Date
Los Gatos Recharge System	20,000 AF/yr	2032

Schedule and volumes included in the 2012 Water Supply Infrastructure Master Plan (SCVWD, 2012).

Water supply for recharge projects is highly variable due to its dependency on available imported water and rainfall-supplied local reservoirs. The baseline volumes for managed recharge are based on the sum of recharge facility 10-year median volumes. The range of managed recharge volumes from 2001 through 2010 is from 64,629 to 88,507 AF/yr. The projected salt and nitrate loading from managed recharge shown below in Figures 26-29 includes managed recharge in percolation ponds and creeks.

A significant source of variability in recharge water quality is the quality of water imported from the state and federal water projects and used in recharge operations. Depending on how current and/or future pumping facilities in the Sacramento/San Joaquin delta are operated, overall salinity (TDS) of imported water may decrease between 50 and 100 mg/L. If no changes are made to delta operations and severe climate change scenarios are realized, imported water salinity may increase substantially. Because both scenarios (improved or deteriorated delta water quality) are highly uncertain, the projections for SNMP have held imported water TDS and nitrate constant by water source.

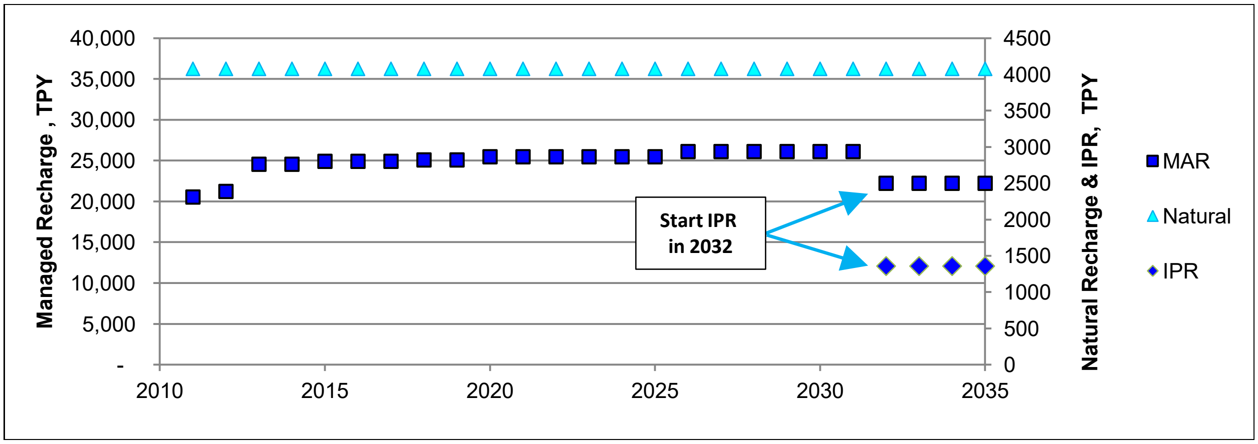


Figure 26 – Salt Loading from Managed Recharge, Natural Recharge, and Indirect Potable Reuse in the Santa Clara Plain

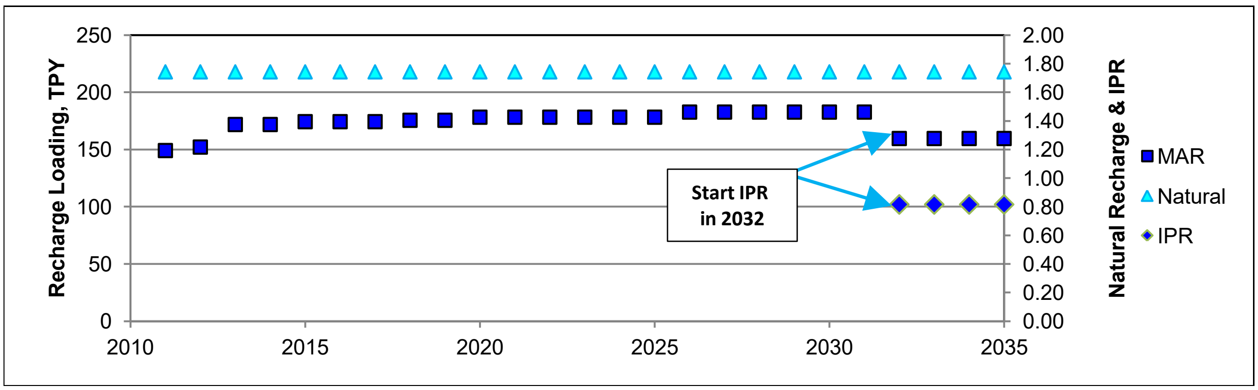


Figure 27 – Nitrate Loading from Managed Recharge, Natural Recharge, and Indirect Potable Reuse in the Santa Clara Plain

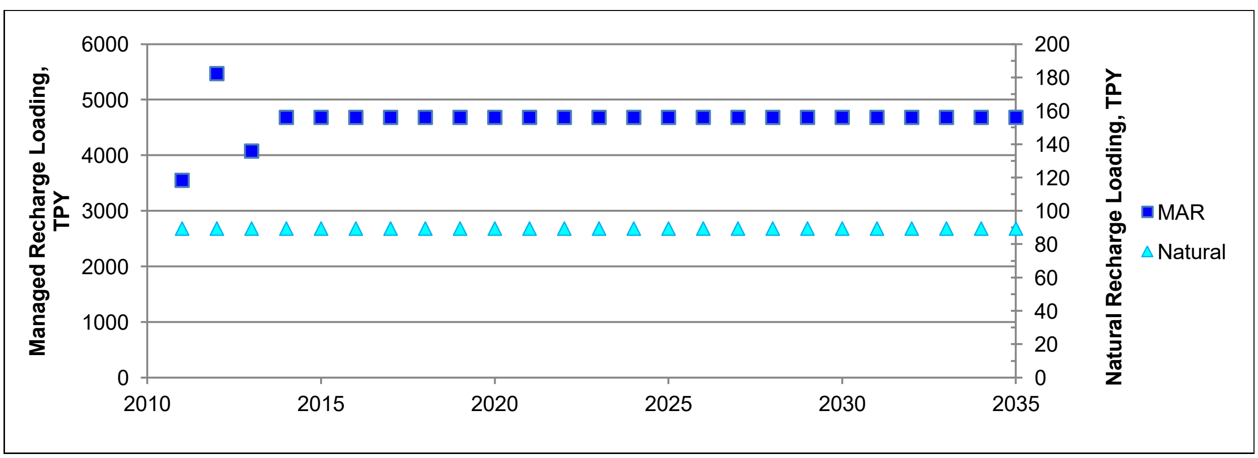


Figure 28 – Salt Loading from Natural and Managed Recharge in the Coyote Valley

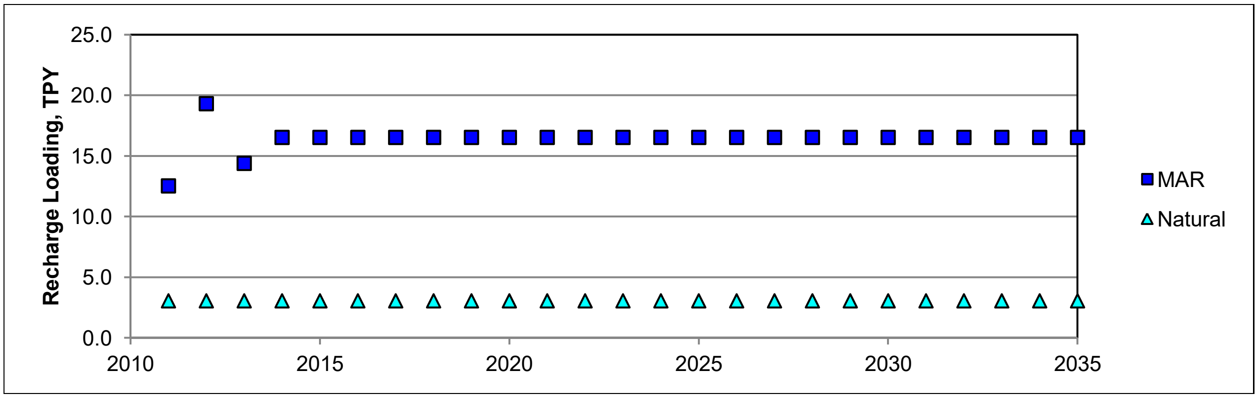


Figure 29 – Nitrate Loading from Natural and Managed Recharge in the Coyote Valley

3.4.5.3 Future Loading from Recycled Water

Future loading projections for recycled water include improved water quality from advanced treatment of recycled water, sewer line rehabilitation, and increased utilization of recycled water. Recycled water master plans were reviewed for each of the three producers (South Bay Water Recycling (SBWR), Sunnyvale Water Pollution Control Plant (WPCP), and Palo Alto Regional Water Quality Control Plant (PARWQP). The planned schedule of improvements and expansion used for SNMP projections are listed in Table 40.

Table 40 – Recycled Water Master Plans: Expansion and Water Quality Improvements

System	Volume Increases	Future TDS	Starting Year	Notes
SBWR	0	500 mg/L	2014 – 2017	Silicon Valley Advanced Water Purification Center comes on-line; tertiary treated recycled water blended with purified water to lower TDS from 725 mg/L to 500 mg/L, phased in system-wide by 2017; assume linear change.
SBWR	4,850	500 mg/L	2015 – 2035	SJWC UWMP baseline + projected 4,850 AF/yr new SJWC projects in next 25 yrs; add 970 AF/yr every 5 yrs.
SBWR	3,300	500 mg/L	2020 – 2035	SJ UWMP baseline + projected 3,300 AF/yr new RW SJ Muni. RW projects; adding 825 AF/yr every 5 yrs in 2020.
SBWR	100	500 mg/L	2020	Adds 100 AF/yr for Milpitas BART Station development in 2020.
SVWPCP	1,885	760 mg/L	2020 – 2033	Treatment improves TDS from 856 mg/L TDS to 760 mg/L in 2023. Increased volume from Apple and other expansion; 495 AF/yr by 2020; 764 AF/yr by 2025; 140 AF/yr by 2030; 486 AF/yr by 2030.
PARWQCP	0	770 mg/L – 600 mg/L	2013 – 2018	PARWQCB resleeved a sewer main in Mtn. View producing immediate improvement to TDS by eliminating saline groundwater intrusion. Additional resleeving projects are planned to bring TDS to 600 mg/L by 2018.
PARWQCP	5,500	600 mg/L	2027	Palo Alto Phase III recycled water expansion projects 5,500 AF/yr increase by 2027. Up to 915 AF/yr additional expansion may occur in current Phase II, which is not yet serving at full capacity.

The quality of source water before it becomes wastewater and recycled water varies significantly under different scenarios. As mentioned in 3.3.5.2, TDS in imported water may increase or decrease, depending on whether improvements are made to managing delta pumping and whether climate change scenarios are realized. Changes to source water quality can shift the quality of recycled water, depending on the type and degree of treatment. The future projections for recycled water reflect planning scenarios only, and exclude delta conveyance improvements and climate change scenarios. Groundwater quality also changes in response to loading and removal, so the source water that becomes recycled water may change as groundwater quality changes or as the blend of supplies shifts. These potential variations in recycled water quality are not incorporated into the future planning scenarios evaluated here.

The schedule of planned improvements is also subject to change. For example, the PARWQCP Long Range Facilities Plan calls for addition of reverse osmosis and micro-filtration by 2050, but changing conditions could lead to bringing advanced treatment online sooner, possibly within the SNMP planning horizon. Similarly, planned improvements for SBWR and Sunnyvale WPCP could come on-line earlier or later than the SNMP planning scenarios. Figures 22 and 23 display the projected loading from recycled water in the scenario outlined in Table 40.

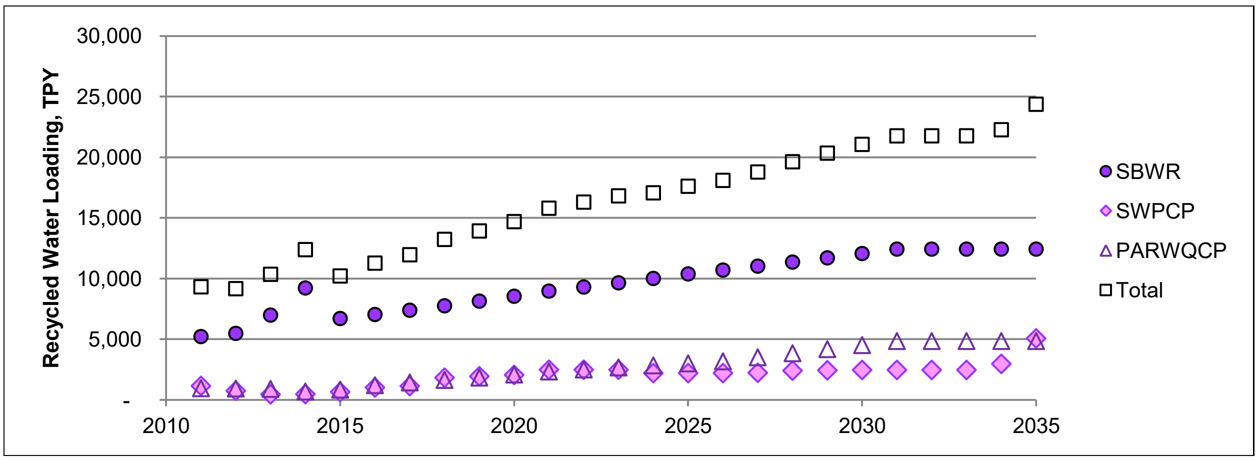


Figure 30 – Salt Loading from Recycled Water in the Santa Clara Plain

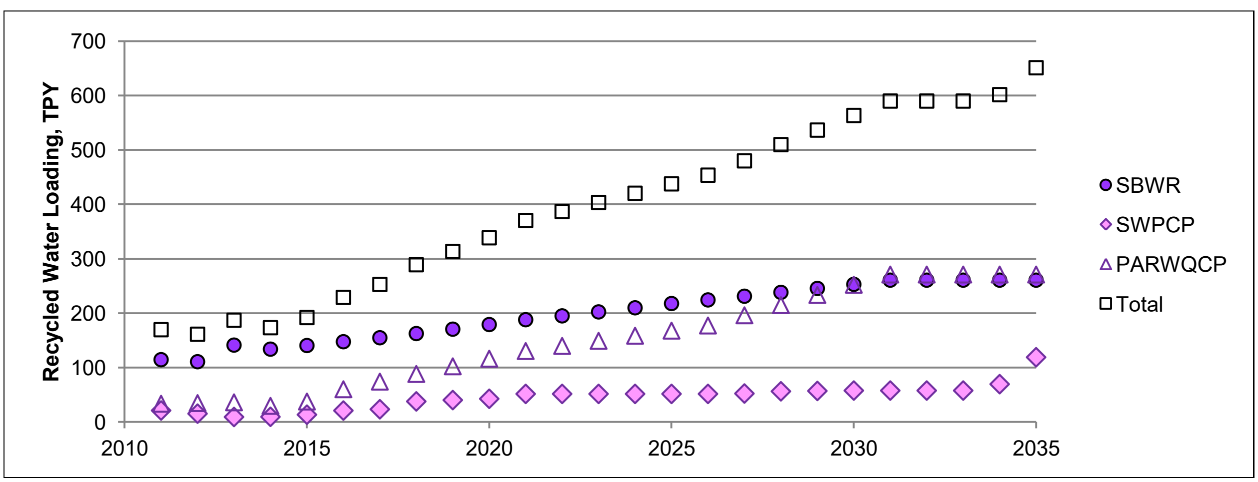


Figure 31 – Nitrate Loading from Recycled Water in the Santa Clara Plain

Notes: SBWR = South Bay Water Recycling; SWPCP = Sunnyvale Water Pollution Control Plant; PARWQCP = Palo Alto Water Pollution Control Plant.

3.4.5.4 Future Loading from Conveyance and Drainage Losses

As described in 3.3.1.9 and 3.3.1.10, conveyance losses include that portion of water distribution system losses that ultimately recharge groundwater. Similarly, drainage losses are losses from storm drains, sewer lines, and septic leachfield effluent that recharge groundwater. Conveyance losses are treated as proportional to the volume of water served, and indexed to projected changes in annual total volume of water served by water retailers inside the Santa Clara Plain or inside the Coyote Valley (including the portion of Morgan Hill that is in Coyote Valley).

Storm drain losses are proportional to future volumes of runoff. To make an approximation, storm drain losses are indexed to population growth, which is taken as an indicator of the increase in impervious surfaces. Assuming that most new development is multi-family housing, the percent increase in impervious surface area was taken as the percentage of population increase.

Septic leachfield volumes are assumed to remain constant. The County's new Onsite Wastewater Treatment System (OWTS) Ordinance could lead to some improvements in septic tank management, potentially decreasing loading from this source. The impacts of the ordinance are subject to many variables that are not easily assessed, so a constant value was used.

Sewer line losses are indexed to the SCVWD 2010 Urban Water Management Plan projections for wastewater treatment flows to obtain volume increases. Wastewater concentration is indexed to measured values from 2010, which increase as a result of water conservation. Indoor water conservation results in increased TDS concentration of influent at wastewater treatment plants which can negatively impact the quality and quantity of recycled water. The degree to which wastewater concentration changes in response to water conservation is unknown; however this effect is widely observed (Wistrom, et al., 2006). An assumption is made that wastewater TDS concentration increases by $1/10^{th}$ the amount of projected increases in water conservation volumes. Table 41 summarizes the assumptions made for sewer line loss projections. Figure 32 displays loading projections from conveyance losses in the Santa Clara Plain, and Figures 33 and 34 provide loading projections for drainage losses in the Santa Clara Plain. Both conveyance losses and drainage losses in Coyote Valley are small and fixed at constant values throughout the 25-year period evaluated.

Table 41 – Factors Used to Project Future Sewer Line Losses

Year	2015	2020	2025	2030	2035
Wastewater Volume, MGD	169	177	184	192	194
Percent WW Volume change	4.5%	4.7%	4.0%	4.3%	1.0%
Conservation Goal, AF/yr	63,100	76,100	86,700	98,800	98,800
Concentration Increase % (assumed)	2.47%	2.06%	1.39%	1.36%	0.0%

Source: SCVWD 2010 Urban Water Management Plan

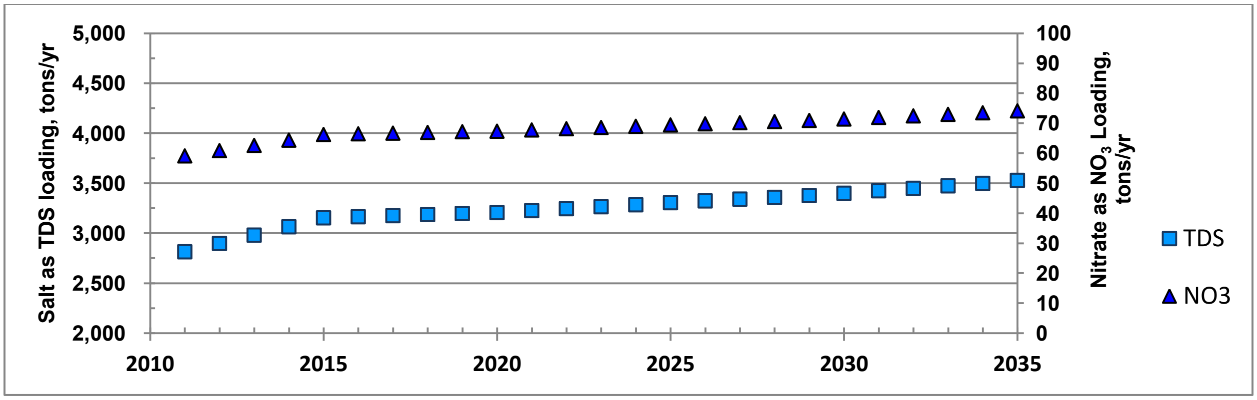


Figure 32 – TDS and Nitrate Loading from Conveyance Losses in the Santa Clara Plain

Note: conveyance losses in Coyote Valley are small (ranging from 12 to 15 tons per year TDS and 0.4 to 0.5 tons per year nitrate), and are therefore not displayed. Nitrate as NO_3 is displayed on the right axis.

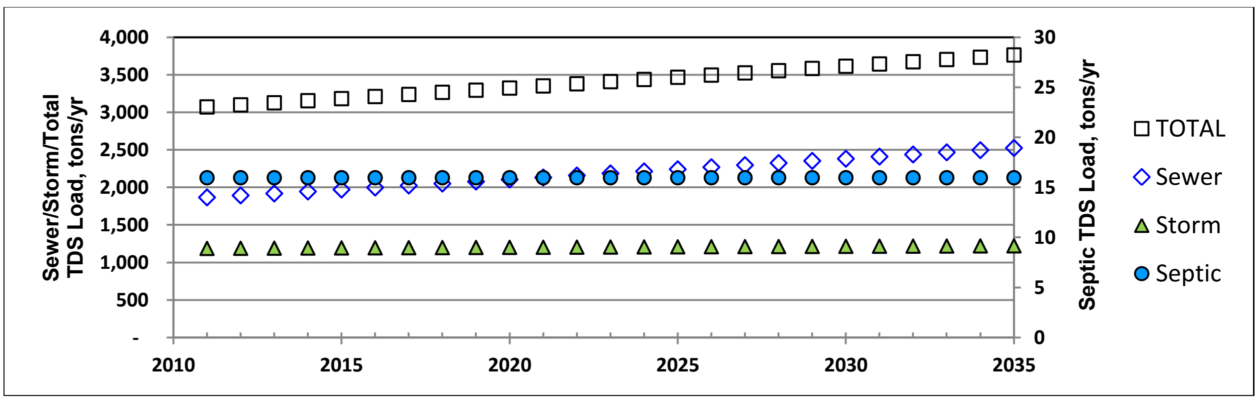


Figure 33 – TDS Loading from Drainage Losses in the Santa Clara Plain

Note: Nitrate as NO3 loading from drainage losses (septic tanks) in Coyote Valley are held constant throughout the planning period (127 tons TDS per year), and are therefore not displayed.

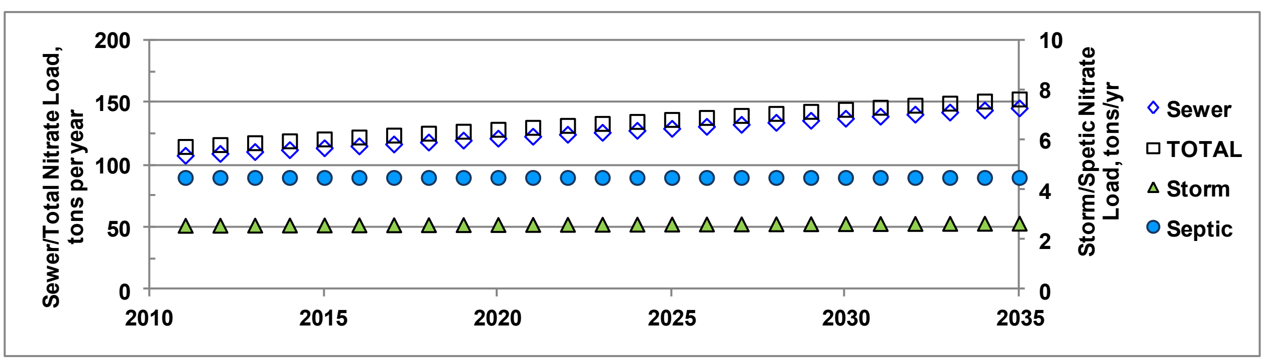


Figure 34 – Nitrate as NO3 Loading from Drainage Losses in the Santa Clara Plain

Note: Nitrate as NO3 loading from drainage losses (septic tanks) in Coyote Valley are held constant throughout the planning period (79 tons nitrate as NO_3 per year), and are therefore not displayed.

3.4.5.5 Future Loading from Dry Loading Sources

Dry loading includes fertilizer, soil amendment application, and atmospheric deposition. Combined, these categories contribute only minor amounts of salt and nitrate. The factors that could change rates of fertilizer use or rates of atmospheric deposition are not quantified. Atmospheric deposition could decrease in response to more alternative fuel vehicles and improved emissions controls, and fertilizer application could decrease with land use changes. Because these changes are not easily predicted, for SNMP analysis, they were left as fixed values equal to the 2001-2010 median loading rates.

3.4.5.6 Salt and Nitrate Removal Projections

As listed in Table 15 and shown in Figure 15, salt and nitrate are removed when groundwater is removed by pumping, basin outflow, gaining reaches of streams, and groundwater infiltration into sewer lines and storm drains. The primary variable in salt and nitrate removal is the rate of groundwater pumping. Projected demand by water source was obtained from the Urban Water Management Plans and pro-rated to annual increments to project rates of salt and nitrate removal due to groundwater pumping. Infiltration of saline groundwater to sewer lines has been reduced in Palo Alto and additional projects will further reduce infiltration. Gaining reaches of streams in the Santa Clara Plain have not been quantified; though there might be some groundwater discharging to streams in the northern reaches of streams. Figures 35-38 summarize the projected rates of salt and nitrate removal.

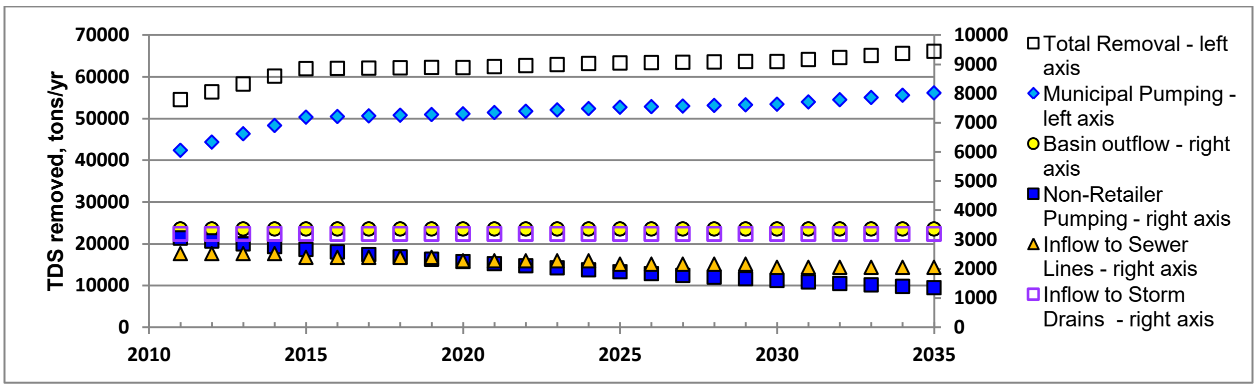


Figure 35 – TDS Removal in the Santa Clara Plain

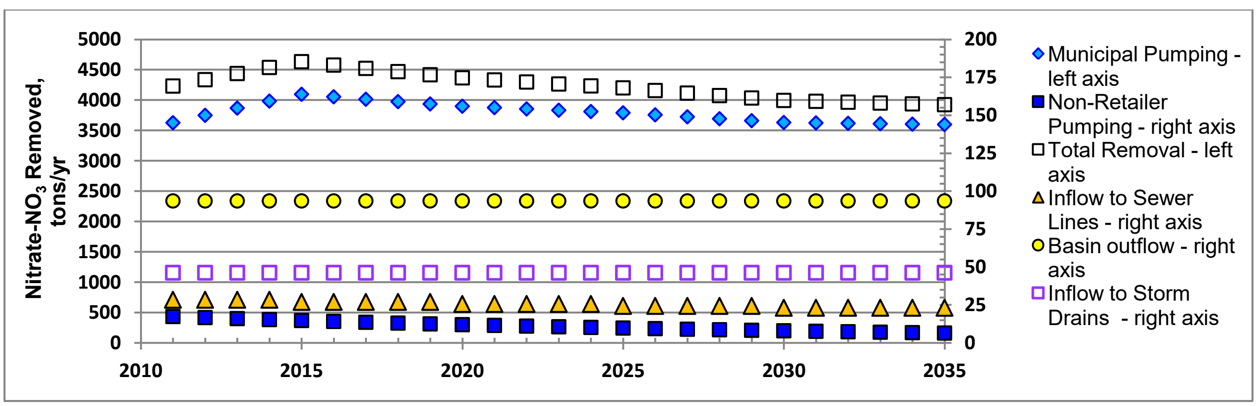


Figure 36 – Nitrate as NO3 Removal in the Santa Clara Plain

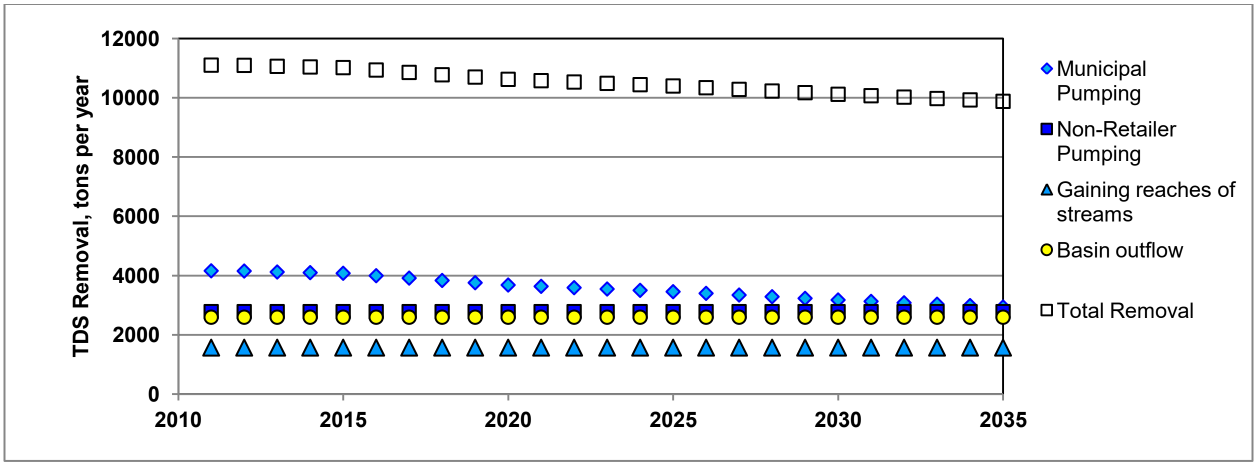


Figure 37 – TDS Removal in the Coyote Valley

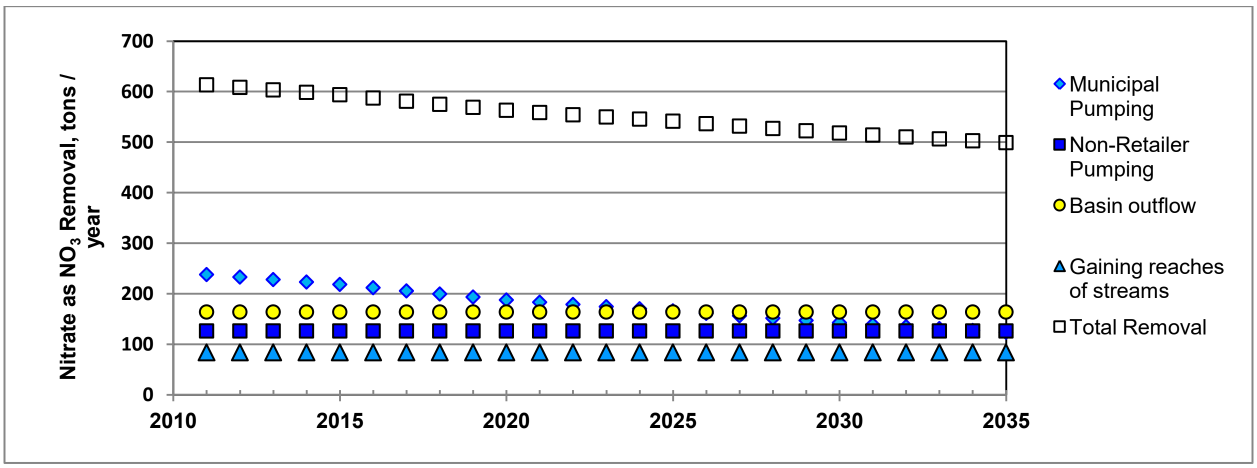


Figure 38 – Nitrate as NO_3 Removal in the Coyote Valley

3.4.5.7 Net Loading/Removal and Assimilative Capacity

The sum of all loading projections, minus the sum of all removal projections, gives the net loading or removal. In the Santa Clara Plain, net loading of TDS is projected to start at 25,000 tons per year and grow to 47,000 tons per year by 2035. The primary causes of the net loading are outdoor irrigation, imported water used for groundwater recharge, and increasing irrigation with recycled water. Currently, about 90,000 AF of water is imported and used in the Santa Clara Groundwater Subbasin for outdoor irrigation and managed aquifer recharge. Imported water used outdoors or for recharge represents about 26,000 tons of new salt per year (TDS), with about 7,000 tons salt added to groundwater through recharge, and about 19,000 tons salt added through landscape irrigation.[25] Nitrate addition from imported water is low due to the low concentration of nitrate found in imported water. Concurrent with the addition of 26,000 tons of salt to groundwater per year from imported water, groundwater is removed from the subbasin via groundwater pumping and basin outflow. Pumping and basin outflow remove a combined 49,000 tons of salt per year. The TDS in water served by municipal retailers is returned to the

[25] These figures exclude imported water used for outdoor irrigation at homes and businesses located in the foothills outside the groundwater Subbasin. Imported Water refers to State Water Project, Federal Water Project water from the San Luis Division, and Hetch-Hetchy water from the San Francisco Public Utilities Commission.

groundwater basin at an average rate of about 45% (the percentage of municipal water used for outdoor irrigation), while about 55% of the salt goes to the wastewater treatment plants and to the Bay, with a small fraction getting processed as recycled water. The nitrate in imported water is much lower than in groundwater, so groundwater pumping combined with root uptake and denitrification, cause a net removal of nitrate from the groundwater basin.

While the amount of new salt introduced to the subbasin each year is large, the volume of water into which the salt is mixed in this analysis is also large. Table 34 presents the mixing volume – 25,746,900 AF. The starting net loading amount in 2011, tons per year when divided by the mixing volume equates to a net change in TDS concentration of 0.88 mg/L per year. By 2035, the net loading is projected to increase to 47,000 tons per year, producing a net change in TDS concentration of 1.31 mg/L/yr.

To determine future estimated basin concentrations, the net loading is added to the mass of salt already dissolved in groundwater at ambient concentrations. The overall basin average TDS concentration calculated in Section 3.3.2 is 425 mg/L. The existing mass of salt dissolved in groundwater is 17,260,184 tons. The net loading forecasted for each year is added to the prior year's total salt mass and divided by the basin saturated porosity volume to get the next year's concentration. The new concentration is used to determine net removal from groundwater pumping and net loading from landscape irrigation with groundwater. Figures 39-42 show the net loading, future TDS and nitrate concentrations, and corresponding assimilative capacity. The fluctuation in net loading is due to use of actual recharge volumes for 2010–2012 and projected 2013 based on January-October data.

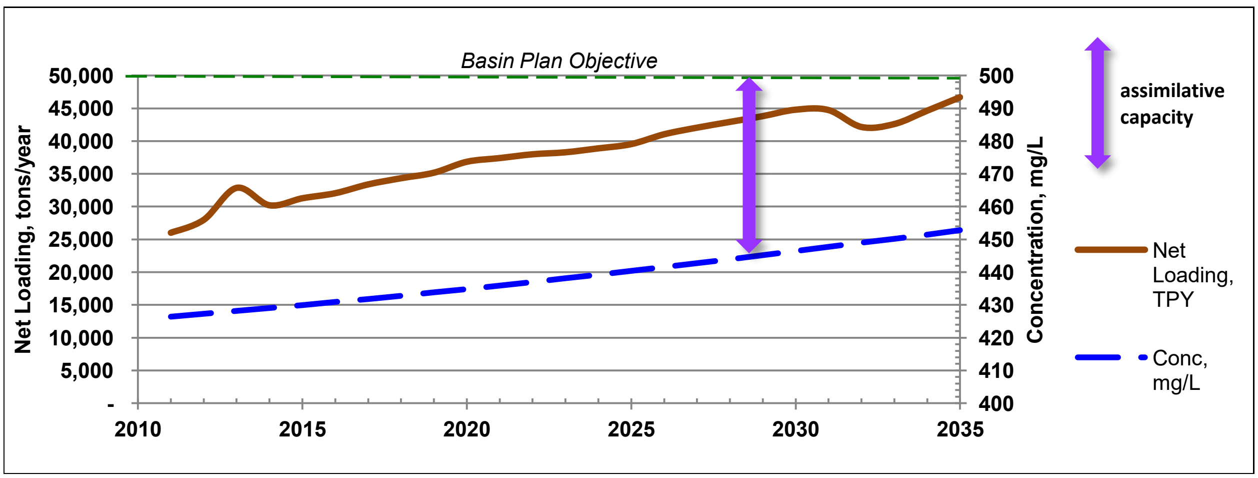


Figure 39 – Net TDS Loading and Projected Average TDS Concentrations in the Santa Clara Plain

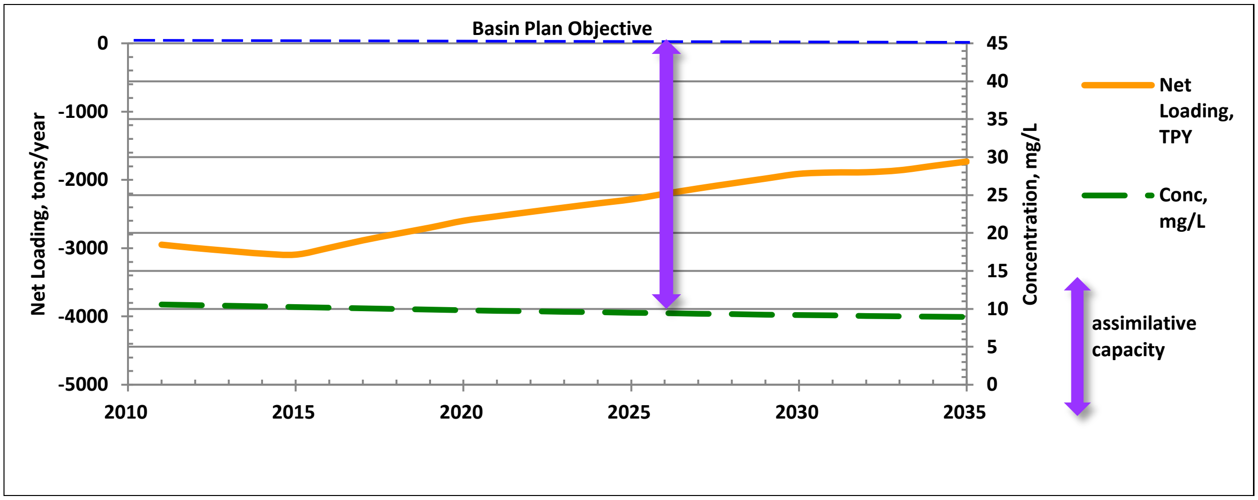


Figure 40 – Net Nitrate as NO3 Loading and Projected Average NO3 Concentrations in the Santa Clara Plain

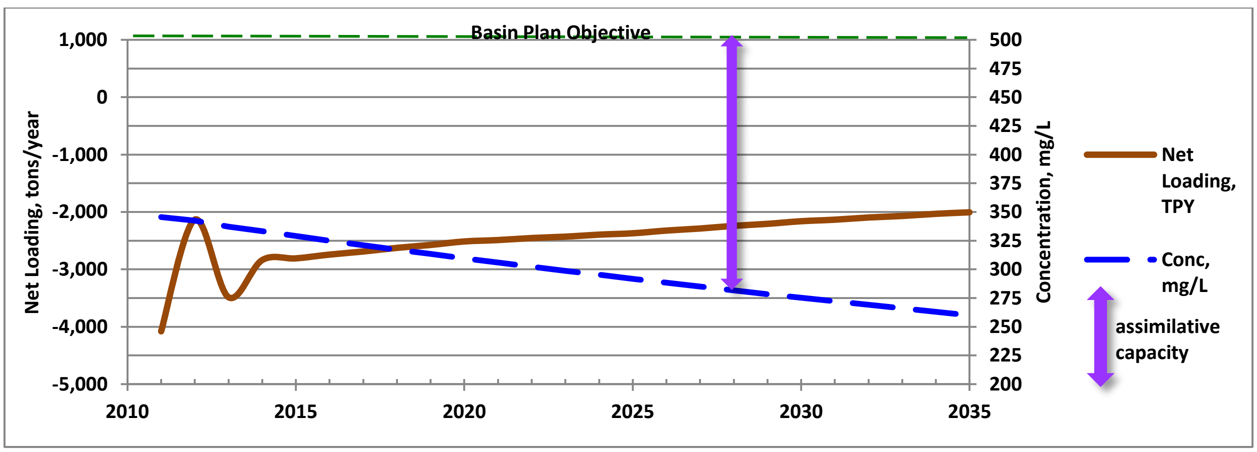


Figure 41 – Net TDS Loading and Projected Average TDS Concentrations in the Coyote Valley

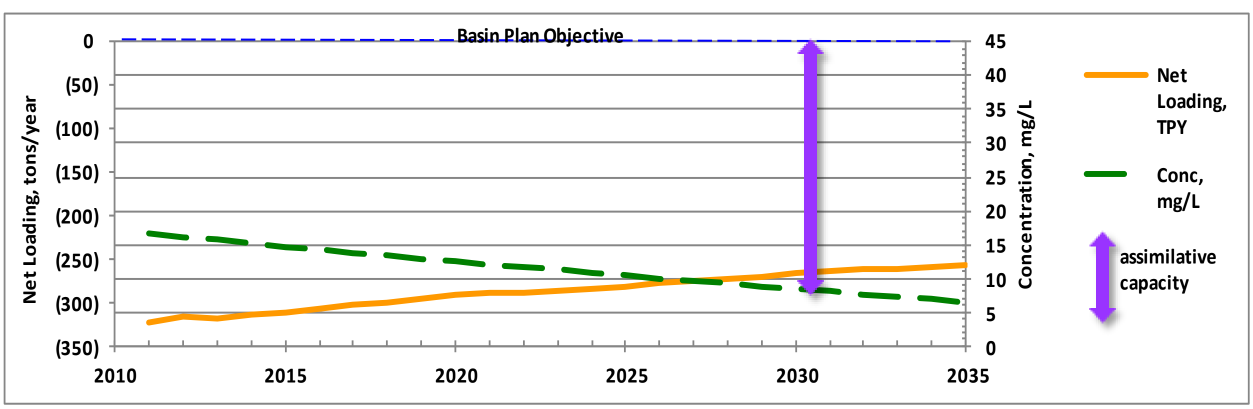


Figure 42 – Net Nitrate as NO3 Loading and Projected Average NO3 Concentrations in the Coyote Valley

The net removal of both TDS and nitrate in Coyote Valley is partly attributable to pumping that supplies water to consumers in the Santa Clara Plain, i.e., the water is moved from one subarea to the other (about 3,100 tons per year TDS and 86 tons per year nitrate as NO_3). There is also a net basin outflow from Coyote Valley, about 2,500 tons per year TDS and 160 tons per year nitrate. In addition, Coyote Valley has gaining reaches of streams that remove about 1,700 tons per year TDS and about 110 tons per year nitrate. The net removal of salt and nitrate produces a steady decrease in estimated concentrations as shown in Figures 41 and 42, above.

3.4.5.8 Allocation of Future Assimilative Capacity

The allocation of future assimilative capacity consumption by loading category is listed in Table 42. The sum of all planned recycled water irrigation and groundwater recharge projects in the Santa Clara Plain consumes 9.2% of the TDS assimilative capacity in the 25 year planning timeframe ending in 2035. The assimilative capacity of nitrate as NO_3 is projected to increase due to net nitrate removal from groundwater pumping, basin outflow, and sewer line infiltration; therefore, recycled water projects do not consume any assimilative capacity for nitrate as NO_3.

At the end of the 25 year evaluation period in 2035, 41% of the 75 mg/L TDS assimilative capacity is projected to be consumed overall (30.75 mg/L), with 44.25 mg/L TDS assimilative capacity remaining. The TDS assimilative capacity consumed by all planned Santa Clara Plain recycled water projects (including landscape irrigation and indirect potable reuse), 6.3%, is below the Recycled Water Policy 20% threshold for multiple projects.

Table 42 – Annual Consumption of TDS Assimilative Capacity (AC) by Loading Categories

	% AC Consumed overall	% AC by Recycled Water	% AC by Managed Recharge	% AC by Indirect Potable Reuse	% AC by Irrigation (excludes recycled water)	% AC by Natural Recharge Drainage + Conveyance & Dry Loading
2011	1.29%	0.12%	0.33%		0.67%	0.17%
2012	1.25%	0.12%	0.32%		0.64%	0.16%
2013	1.43%	0.16%	0.39%		0.70%	0.18%
2014	1.41%	0.16%	0.38%		0.70%	0.17%
2015	1.42%	0.16%	0.38%		0.71%	0.17%
2016	1.42%	0.16%	0.38%		0.71%	0.17%
2017	1.42%	0.16%	0.38%		0.71%	0.17%
2018	1.46%	0.17%	0.38%		0.72%	0.18%
2019	1.49%	0.19%	0.39%		0.73%	0.18%
2020	1.54%	0.20%	0.40%		0.75%	0.18%
2021	1.57%	0.22%	0.41%		0.76%	0.18%
2022	1.59%	0.23%	0.41%		0.77%	0.19%
2023	1.61%	0.24%	0.41%		0.77%	0.19%
2024	1.64%	0.25%	0.41%		0.78%	0.19%
2025	1.67%	0.26%	0.42%		0.79%	0.19%
2026	1.72%	0.28%	0.43%		0.81%	0.19%
2027	1.76%	0.29%	0.44%		0.82%	0.20%
2028	1.79%	0.31%	0.44%		0.83%	0.20%
2029	1.82%	0.32%	0.45%		0.85%	0.20%
2030	1.86%	0.34%	0.45%		0.86%	0.20%
2031	1.85%	0.34%	0.45%		0.86%	0.20%
2032	1.76%	0.35%	0.37%	0.023%	0.84%	0.20%
2033	1.75%	0.35%	0.37%	0.022%	0.84%	0.20%
2034	1.75%	0.34%	0.36%	0.022%	0.84%	0.20%
2035	1.75%	0.34%	0.36%	0.022%	0.84%	0.20%
TOTAL	**41.3%**	**6.2%**	**10.2%**	**0.1%**	**20%**	**4.8%**

CHAPTER 4: SALT AND NUTRIENT MONITORING PLAN

The Recycled Water Policy requires development of a SNMP Monitoring Plan for each groundwater basin in California. The District is the groundwater management agency for Santa Clara County, which includes the Santa Clara Groundwater Subbasin. For many years the District has conducted regular comprehensive monitoring that includes TDS and nitrate, as well as other water quality parameters. The District also analyzes data from municipal wells reported to DDW. The District prepares annual water quality reports that document the monitoring results and provides trend analyses for TDS and nitrate, and a comparison of detections with WQOs. District monitoring reports are made available on its website.

The proposed SNMP Monitoring Program includes the District's voluntary subbasin monitoring and reporting for TDS and nitrate. The District currently conducts monitoring for selected CECs at a recycled water irrigation site. CEC monitoring is not a required component of the Recycled Water Policy for basins where recycled water reuse is limited to irrigation (there are currently no active recycled water recharge projects). The District's ongoing groundwater monitoring and reporting is voluntary and relies on monitoring District monitoring wells and private wells under agreements with the well owners.

The Salt and Nutrient Monitoring Plan, provided as Appendix 3, is a subset of the District's regional monitoring program, which covers more water quality parameters than are required by the Recycled Water Policy. The goals established in the Recycled Water Policy for the Salt and Nutrient Monitoring Plan are met by the District's annual sampling. Monitoring well locations coincide with recharge locations, recycled water operations, and groundwater production. The plan presented in Appendix 3 fulfills the objectives set forth in the Recycled Water Policy.

CHAPTER 5: ANTI-DEGRADATION ANALYSIS

The regional and cumulative impacts analysis presented in Chapter 3 of this SNMP demonstrates that multiple recycled water projects in the Santa Clara Groundwater Subbasin use a minor amount of the available TDS assimilative capacity. The analysis shows that assimilative capacity is expected to increase (i.e., concentrations are projected to decline) for both nitrate and TDS in the Coyote Valley, and for nitrate in the Santa Clara Plain. Groundwater TDS concentrations are projected to increase in the Santa Clara Plain by 2035, but are not projected to exceed the Basin Plan objective. Chapter 3 demonstrates that the minority of the projected Santa Clara Plain TDS increase is attributable to recycled water irrigation.

As noted in Chapter 3, the simplifying assumptions made for this SNMP (e.g., instantaneous mixing, no attenuation of salts in the unsaturated zone) have the effect of overstating the rate of salt accumulation. For example, the concentration trends associated with future projections are not mirrored in observed trends from the last 15 years, yet the same S/N loading and removal processes have been ongoing.

The District has invested in the Silicon Valley Advanced Water Purification Center (SVAWPC) to substantially improve recycled water quality. The District and water retailers are engaged in a continuous effort to increase water conservation, which can further reduce the amount of salt loading. The Bay Delta Conservation Plan, if implemented, could also play a major role in reducing the importation and accumulation of salt. As improvements are made to limit conveyance losses and drainage losses and to increase outdoor water conservation, the rate of salt accumulation will slow. Similarly, employing micro-irrigation technologies and limiting fertilizer use to agronomic demands will help to reduce S/N loading.

The Recycled Water Policy and other statewide planning documents recognize the tremendous need for and benefits of increased recycled water use in California. As stated in the Recycled Water Policy, *"The collapse of the Bay-Delta ecosystem, climate change, and continuing population growth have combined with a severe drought on the Colorado River and failing levees in the Delta to create a new reality that challenges California's ability to provide the clean water needed for a healthy environment, a healthy population and a healthy economy, both now and in the future."* As the policy notes, *"We strongly encourage local and regional water agencies to move toward clean, abundant, local water for California by emphasizing appropriate water recycling, water conservation, and maintenance of supply infrastructure and the use of stormwater (including dry-weather urban runoff) in these plans; these sources of supply are drought-proof, reliable, and minimize our carbon footprint and can be sustained over the long-term."* With the current severe drought, the benefits of recycled water use in terms of sustainability and reliability cannot be overstated. Use of recycled water in the Santa Clara Groundwater Subbasin is consistent with the maximum benefit of the people of Santa Clara County.

The SNMP analysis finds that recycled water use can be increased while still protecting groundwater quality for beneficial uses. Table 43 provides an explanation of why recycled projects are in compliance with SWRCB Resolution No. 68-16.

Table 43 – Anti-Degradation Assessment

SWRCB Resolution No. 68-16 Component	Anti-Degradation Assessment
Water quality changes associated with proposed recycled water project(s) are consistent with the maximum benefit of the people of the State.	• The Basin Plan Water Quality Objectives are being met in average ambient groundwater and will continue to be met in the future • Recycled water irrigation project(s) and other S/N loading sources will not cause average groundwater quality to exceed the SMCL for TDS or the primary MCL for nitrate-NO_3. • Use of recycled water for irrigation to replace groundwater is consistent with the SWRCB Recycled Water Policy, which encourages increased reliance on local, drought-resistant water supplies.
The water quality changes associated with proposed recycled water project(s) will not unreasonably affect present and anticipated beneficial uses.	
The water quality changes will not result in water quality less than prescribed in the Basin Plan.	
The projects are consistent with the use of best practicable treatment or control to avoid pollution or nuisance and maintain the highest water quality consistent with maximum benefit to the people of the State.	• The recycled water used for irrigation is tertiary-treated water that meets California's Title 22 unrestricted use classification. • The District is now producing up to 8 MGD advanced treated water from the SVAWPC. The City of Sunnyvale Plans to improve recycled water quality, and the City of Palo Alto has resleeved some sewer mains resulting in lower TDS recycled water.
The proposed project(s) is necessary to accommodate important economic or social development.	• The recycled water projects are an integral part of water and wastewater master plans for the subbasin.
Groundwater management programs are being or will be implemented to continue attaining WQOs.	• The Santa Clara Groundwater Subbasin is actively managed with numerous programs, projects, and plans to manage groundwater, as described in Appendix 4.

CHAPTER 6: SUMMARY AND RECOMMENDATIONS

This SNMP tracks the addition and removal of salts and nutrients to and from the groundwater basin, revealing a dynamic interplay between water uses and salt accumulation and dilution. In the Coyote Valley, concentrations of both TDS and nitrate are found to decrease over time. In the Santa Clara Plain, nitrate concentrations are projected to decrease while TDS concentration is projected to increase, without exceeding basin water quality objectives. The rate of increase in TDS concentration does not correspond closely with the individual well TDS concentration trends analyzed in the District's annual groundwater reports. This suggests that the simplifying assumptions used to make the projections may be too aggressive, such that the projected rate of accumulation exceeds the measured concentration trends.

The categories contributing the greatest amount of S/N loading (outdoor irrigation of landscaping by potable water and managed recharge) are also linked to the largest means of S/N removal (groundwater extraction, consumptive uses of water, and basin outflow). Nevertheless, salt accumulation is indicated for the Santa Clara Plain, which warrants consideration of the following recommendations for additional salt and nutrient management measures:

1. New and continuing initiatives for outdoor water conservation will continue to diminish the quantities of S/N loading from outdoor irrigation with potable water.

2. New and continuing advanced treatment of recycled water will further reduce the minor amount of salt loading from this category.

3. If adopted and implemented, future indirect potable reuse with low TDS, advanced-treated recycled water can diminish the demand for imported water for managed recharge. Similarly, contingent on funding and approval, direct potable reuse of low TDS, advanced-treated recycled water finished at the District's drinking water plants can displace higher salinity groundwater and imported water currently distributed for indoor and outdoor water uses.

4. Adoption of the Bay Delta Conservation Plan is likely to significantly reduce the salinity of imported water used for both managed recharge and outdoor irrigation with potable water.

5. New and continuing city initiatives to improve sewer lines to prevent intrusion of saline groundwater will decrease salt loading from tertiary-treated recycled water used for irrigation.

6. Continued District monitoring and analysis of groundwater quality data will be useful for observing any changes to the long-term trends in TDS and nitrate in the Santa Clara Plain and Coyote Valley.

REFERENCES

Alhajjar, B.J., Chesters, G., and Harkin, J.M., 1990. Indicators of Chemical Pollution from Septic Systems. Ground Water 28(4): 550–568.

Amick, R.S., and Burgess, E.H., 2000. Exfiltration in Sewer Systems. U.S. Environmental Protection Agency National Risk Management Research Laboratory, Office of Research and Development, Cincinnati, Ohio 45268. EPA/600/R-01/034.

Aquacue, 2011. Uncovering Leaks and Other Mysteries, Faster than Traditional Methods, with New Real-Time Technology http://www.icwt.net/wtc/p12/u-330.pdf

ASTM, 2009. ASTM C969 – 02 Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines. http://www.astm.org/Standards/C969.htm

Bicki, T.J., R.B. Brown, M.S. Collins, R.S. Mansell, and D.F. Rothwell, 1984. Impact of On-site Sewage Disposal Systems on Surface and Ground Water Quality. Report to Florida Department of Health and Rehabilitative Services under Contract Number LC-170.

Biggar, J. W., and Coney, R. B., 1969. Agricultural Drainage and Eutrophication. In Eutrophication: Causes, Consequences, and Correctives. National Academy of Sciences, Washington, D.C., 1969.

Blanchard, C.L., Michaels, H. and Tannenbaum, S., 1996. Regional Estimates of Acid Deposition Fluxes in California for 1985-1994. California Air Resources Board Contract No. 93-332.

Brooks, J.L., Rock, C.A., and Struchtemeyer, R.A.,1984. Use of peat for on-site wastewater treatment: II. Field studies. J. Environ. Qual. 13: 524-530.

Brown and Caldwell and Geotechnical Consultants Inc., 1981. San Martin Water Quality Study – Phase 1 report. Prepared for Santa Clara County.

Brown, K.W. and Thomas, J.C., 1978. Uptake of N by grass from septic fields in three soils. Agronomy Journal. 70: 1,037–1,040.

Canter, L.W., and Knox, R.C., 1985. Septic tank system effects on ground water quality. Lewis Publishers, Chelsea, Michigan.

Canter, L.W., 1997. Nitrates in Groundwater. CRC Press, Boca Raton, Florida.

CH2MHill, 1992, Santa Clara Valley Groundwater Model Project, Hydrogeologic Interpretation

CH2MHill, 2005, Llagas Basin Numerical Groundwater Model

City of Palo Alto, 2012. Long Range Facilities Plan for the Regional Water Quality Control Plant. Prepared by Carollo Engineers, May, 2012.

City of Palo Alto, 2013. Clean Bay Pollution Prevention Plan, 2013: The Pollution Prevention Plan for the City of Palo Alto's Regional Water Quality Control Plant. http://www.cityofpaloalto.org/civicax/filebank/documents/33315

City of Santa Clara, 2010. Sewer System Management Plan.

Collins, S., 1998. Modeling Spatial Variations in Air Quality Using GIS. In: GIS and Health. Taylor and Francis Group, LLC, London, United Kingdom.

Conn, K.E., and Siegrist, R.L., 2007. Occurrence and Fate of Trace Organic Contaminants in Onsite Wastewater Treatment Systems and Implications for Water Quality Management. Colorado Water Institute.

Dudley, J .G., and Stephenson, D.A., 1973. Nutrient Enrichment of Ground Water from Septic Tank Disposal Systems. Inland Lake Renewal and Shoreland Management Demonstration Project Report. University of Wisconsin at Madison.

Department of Water Resources (DWR), December 1975, Bulletin No 118-1 Evaluation of Ground Water Resources: South San Francisco Bay, Volume III: Northern Santa Clara County Area

Department of Water Resources (DWR), 2003. California's Groundwater Bulletin 118 – Update 2003

DWR, 2013. Public Draft Report to the Legislature on Urban Water Management Plan Demand Management Measures Reporting and Requirements. http://www.water.ca.gov/wateruseefficiency/sb7/committees/urban/u2/docs/ITP_UWMP_Leg_Report_Public_Draft_12-24-13.pdf

EBMUD, 2013. East Bay Regional Private Sewer Lateral Program: Presentation to Real Estate Professionals Information Meeting, December 10, 2013. www.eastbaypsl.com/eastbaypsl/doc/REPInfo.pdf

Effert, D., J. Morand, and M. Cashell, 1985. Field performance of three onsite effluent polishing units. In Proc. 4th Nat. Symposium on individual and small community sewage systems, ASAE, St. Joseph, MI. pp. 351-361.

Ellis, J.B., 2001. Sewer performance: inflow, infiltration and exfiltration. In: Proceedings of the INTERURBA II Conference, Session on Interactions between sewers, treatment plants and receiving water in urban areas. Lisbon, Portugal, February 19-22, 2001.

Feth, J.H., 1966 Nitrogen Compounds in Natural Water--A Review. Water Resources Research, 2(1): 41–58.

Hansel, M.J., and R.E. Machmeier, 1980. On-site Wastewater Treatment on Problem Soils. Journal Water Pollution Control Federation, 52(3): 548–558.

Helsel, D.R., and R.M. Hirsch, 1992. Statistical Methods in Water Resources, U.S. Geological Survey, Water Resources Division, Elsevier Science

Hem, J.D., 1985, Study and Interpretation of the Chemical Characteristics of Natural Water, U.S. Geological Survey Water Supply Paper 2254

Iwamura, T.I.. 1980. Saltwater Intrusion Investigation in the Santa Clara County Baylands Area, California, Santa Clara Valley Water District Report.

Kaplan, O.B., 1991. Septic Systems Handbook. CRC Press, Boca Raton, Florida.

Karpf, C. and Krebs, P., 2004. Application of the leakage model to assess exfiltration. In: Proceedings of the International Conference on Urban Drainage Modelling, Dresden 2004, pp. 217–224.

Kopp, K., and K. Guillard, 2005. Clipping Contributions to Nitrate Leaching from Creeping Bentgrass Under Varying Irrigation and N Rates. University of Connecticut Digital Commons. Plant Science Articles. Paper 12. http://digitalcommons.uconn.edu/plsc_articles/12

LAFCO, 2011. Santa Clara Countywide Water Service Review Public Review Draft http://www.santaclara.lafco.ca.gov/service_reviews/water_2011_publicdraft/SC_Water_MSR_Public_Review_Draft_resized.pdf

Lowe, K.; Rothe, N., Tomaras, J., DeJong, K., Tucholke, M., Drewes, J., McCray, J., and Munakata-Marr, J., 2007. Influent Constituent Characteristics of the Modern Waste Stream. from Single Sources: Literature Review. WERF, 04-DEC-1. 89pg. PDF available at: www.ndwrcdp.org/publications

Malone, R.W., N. Huth, P.S., Carberry, L. Ma, T.C. Kaspar, D.L. Karlen, T. Meade, R.S. Kanwar, and P. Heilman. 2007. Evaluating and predicting agricultural management effects under tile drainage using modified *apsim. Geoderma* 140:310-322.

McCloskey, T. F. and Finnemore, E. J., 1995, Estimating Hydraulic Conductivities in an Alluvial Basin from Sediment Facies Models. Vol.34, No.6-Ground Water November-December 1995.

McCracken, D.V., M.S. Smith, J.H. Grove, C.T. MacKown, and R.L. Blevins, 1994. Nitrate leaching as influenced by cover cropping and nitrogen source. Soil Sci. Soc. Am. J. 58:1476–1483.

Meisinger, J.J., and G.W. Randall, 1991. Estimating Nitrogen Budgets for Soil-Crop Systems. In: R.F. Follett, D.R. Keeney, and R.M. Cruse (eds.), Managing Nitrogen for Groundwater Quality and Farm Profitability. SSSA, Madison, WI. p. 85-124.

Metcalf & Eddy, 1972. Wastewater Engineering: collection, treatment, disposal. McGraw Hill, New York.

Metzger, L.F., and Fio, J.L., 1997. Ground-Water Development and the Effects on Ground – Water Levels and Water Quality in the Town of Atherton, San Mateo County, California. Water-Resources Investigations Report 97-4033. U.S. Geological Survey, Menlo Park, CA.

Milly, et al., 2008. Stationarity Is Dead: Whither Water Management? Science, February, 2008: Vol. 319 no. 5863 pp. 573-574.

NADP, 2012. National Atmospheric Deposition Program Database. http://nadp.sws.uiuc.edu/ Accessed June 14, 2012.

NCCE (North Carolina Cooperative Extension Service), 2008. Nutrient Removal by Crops in North Carolina. http://www.soil.ncsu.edu/publications/Soilfacts/ag-439-16W.pdf

Newhouse M.W., Hanson R.T., Wentworth C.M., Everett R. R., Williams C.F., Tinsley J.C., Noce T.E., and Carkin B.A., 2004, Geologic, Water-Chemistry, and Hydrologic Data from Multiple-Well Monitoring Sites and Selected Water-Supply Wells in the Santa Clara Valley, California, 1999–2003. Scientific Investigations Report 2004-5250, USGS.

Otis, RJ., Boyle, W.C., and Sauer, D.K., 1975. The performance of household wastewater treatment units under field conditions. Proc. National Home Sewage Disposal Symposium., ASAE, St. Joseph, MI. 191-201.

Panno, S.V., Kelly, W.R., Martinsek, A.T., and Hackley, K.C., 2006. Estimating Background and Threshold Nitrate Concentrations Using Probability Graphs. GROUND WATER, September–October 2006, 44(5):697–709.

Popkin, R.A., and Bendixen, T.W., 1968. Improved Subsurface Disposal. Journal Water Pollution Control Federation Vol. 40(8):1499–1514.

RMC Water and Environment, 2011. South Bay Water Recycling Salinity Study. http://www.sawpa.org/wp-content/uploads/2012/05/Task-2-Source-Loading-TM_20110812-2.pdf

RMC Water and Environment, 2012. Santa Rosa Plain Subbasin Salt and Nutrient Management Plan. Final Report, March, 2012. Prepared for City of Santa Rosa.

SCVURPPP, 2006. Water Quality Monitoring and Watershed Assessment. http://www.scvurppp-w2k.com/pdfs/0506/monitoring%20factsheet.pdf

SCVWD, 1994. Llagas Groundwater Basin Nitrate Study – Nitrate Source Area Identification. Santa Clara Valley Water District.

SCVWD, 1996, Llagas Subbasin Nitrate Study Final Report. Santa Clara Valley Water District.

SCVWD, 2006. Pilot water softener rebate program, final report. Santa Clara Valley Water District. California. Department of Water Resources.

SCVWD, 2010. Urban Water Management Plan. http://www.valleywater.org/Services/UWMP2010.aspx

SCVWD, 2012 Water Supply Infrastructure Master Plan. http://www.valleywater.org/Services/WaterSupplyPlanning.aspx

SCVWD, 2013. Annual Groundwater Report for Calendar Year 2012. http://www.valleywater.org/Services/Clean_Reliable_Water/Where_Does_Your_Water_Come_From/Groundwater/Annual_Groundwater_Report_for_Calendar_Year_2012.aspx

SCVWD, 2013a. Protection and Augmentation of Water Supplies. http://www.valleywater.org/Services/PAWS2013.aspx

SCVWD, 2013b. Preliminary Analysis of Bay Delta Conservation Plan Benefits and Costs to Santa Clara County. Agenda memo to Santa Clara Valley Water Board of Directors, December 9th, 2013. http://cf.valleywater.org/About_Us/Board_of_directors/Board_meetings/_2013_Published_Meetings/PublishedMeetings.htm

Sidle, R.C. and Kardos, L.T., 1979. Nitrate Leaching in a Sludge-Treated Forest Soil. Soil Sci. Soc. Am. J. Vol. 43 No. 2, p. 278-282. doi:10.2136/sssaj1979.03615995004300020006x

Siegrist R.L., M.D. Witt, and W.C. Boyle. 1976. The Characteristics of Rural Household Wastewater. Journal of Environmental Engineering, 102(3): 533-548.

Taylor, J., 2003. Evaluating Groundwater Nitrates from On-Lot Septic Systems, a Guidance Model for Land Planning in Pennsylvania. Pennsylvania State University.

WateReuse, 2006 Characterizing and Managing Salinity Loadings in Reclaimed Water Systems. American Water Works Association Research Foundation and WateReuse. http://www.watereuse.org/files/images/91099.pdf

Weiss, S., 1999. Cars, Cows, and Checkerspot Butterflies: Nitrogen Deposition and Management of Nutrient-Poor Grasslands for a Threatened Species. Conservation Biology 13(6):1476–1486.

SWRCB, 2010. State Water Resources Control Board, Groundwater Information Sheet: Salinity. Division of Water Quality, Groundwater Ambient Monitoring and Assessment Program.

Taylor, J., 2003. Evaluating Groundwater Nitrates from On-Lot Septic Systems, a Guidance Model for Land Planning in Pennsylvania. Pennsylvania State University.

Todd Groundwater/Kennedy Jenks, 2010, Groundwater Vulnerability Study Santa Clara, California http://www.valleywater.org/Services/GroundwaterStudies.aspx

Todd Groundwater, 2014. Salt and Nutrient Management Plan: Llagas Subbasin. October, 2014. Prepared for the Santa Clara Valley Water District.

Tonnesen, G., Wang, Z, Omary, M., and Chien, C.J., 2007. Assessment of Nitrogen Deposition: Modeling and Habitat Assessment CEC PIER Energy-Related Environmental Research. CEC -500-2005-032.

UCD, 2002. Practical Lawn Fertilization. University of California Agriculture and Natural Resources Publication 8065. http://anrcatalog.ucdavis.edu/

UC Davis, 2012. Nitrogen Sources and Loading to Groundwater, Technical Report 2, Assessing Nitrate in California's Drinking Water, With a Focus on Tulare Lake Basin and Salinas Valley Groundwater: Report for the State Water Resources Control Board Report to the Legislature.

US EPA, 1993, Ground Water Resource Assessment. United States Environmental Protection Agency Office of Groundwater and Drinking Water, October 1993. EPA 813-R-93-003.

US EPA, 2006, Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA Quality System Series documents, QA/G-4. Office of Environmental Information, Washington, D.C., February 2006. EPA/240/B-06/001.

Washington Department of Ecology, 2000. Nitrogen Use by Crops and the Fate of Nitrogen in the Soil and Vadose Zone – A Literature Search. Washington State University and Washington Department of Ecology, Interagency Agreement No. C9600177, Publication No. 00-10-015

Wistrom, A., Rohwer, B., Lynch, A., Lynch, S., 2006. Salinity Impacts to Water Recycling in Southern California. Presentation to the WEFTEC 2006 Conference, October 21-25, 2006. Dallas, Texas. Water Environment Foundation. www.WEFTEC.org

Zhan, H., and Mackay, W.A., 1998. An Assessment of Nitrate Occurrence and Transport in Washoe Valley, Nevada. Environmental and Engineering Geoscience IV(4):479–489.

SNMP GLOSSARY

acre-foot – the amount covering one acre to a depth of one foot, equal to 43,560 cubic feet (325,850 gallons)

advanced treatment – treatment techniques such as microfiltration, reverse osmosis, and UV disinfection to produce highly-purified (near distilled quality) recycled water

anti-degradation analysis – an analysis to demonstrate that existing high quality water will be maintained, or that any change to existing water quality will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in the policies

aquitard – A layer of low-permeability soil (e.g. a clay) that retards but does not prevent the flow of water to or from an adjacent aquifer

assimilative capacity – the capacity for a water body to absorb constituents without exceeding a water quality objectives

bio-swale –landscape elements designed to remove silt and pollution from surface runoff water

confined aquifer – an aquifer that is overlain by a low permeability, confining layer, often made up of clay. The groundwater below the confining layer is under pressure greater than atmospheric and if penetrated with a well, the water level can rise above the top of the aquifer

constituents of emerging concern (emerging contaminants) – a broad range of unregulated chemical components found at trace levels in many of our water supplies, including surface water, drinking water, wastewater, and recycled water

conveyance losses – the combined volume of real losses from retailer distribution systems and regional transmission losses

denitrification – the microbially facilitated process of nitrate reduction that may ultimately produce molecular nitrogen (N2) through a series of intermediate gaseous nitrogen oxide products

disinfection byproducts – chemicals formed when disinfectants used in water treatment plants react with bromide and/or natural organic matter present in the source water. Disinfection byproducts for which regulations have been established fpr drinking water, include trihalomethanes, haloacetic acids, bromate, and chlorite

drainage losses – the combined quantity of water from sewer line exfiltration, storm drain exfiltration, and septic tank leach field effluent

effective porosity – the volume of pore space that will drain in a reasonable period of time under the influence of gravity

endocrine disruptors – chemicals that may interfere with the body's endocrine system and produce adverse developmental, reproductive, neurological, and immune effects in both humans and wildlife

gaining stream – a stream whose flow increases in the downstream direction due to the discharge of groundwater into the streambed

groundwater basin/subbasin – an area underlain by permeable materials capable of furnishing a significant supply of groundwater to wells or storing a significant amount of water. A groundwater basin is three-dimensional and includes both the surface extent and all of the subsurface fresh water yielding material

groundwater divide – the boundary between two adjacent groundwater basins, which is represented by a high point in the water table

groundwater recharge reuse – use of recycled water for groundwater recharge projects.

Hetch-Hetchy system – the water system constructed and owned by the San Francisco Public Utilities Commission that serves water from Hetch-Hetchy reservoir in the Sierra Nevada mountains to Milpitas, San Jose, Santa Clara, Sunnyvale, Mountain View, Palo Alto, and Stanford University, in addition to San Francisco and numerous other municipalities

inelastic land subsidence – permanent subsidence that results when sediments are compressed beyond their previous maximum effective stress, which generally occurs when groundwater levels decline past historic low levels

land subsidence – the gradual settling of the land surface owing to compaction of aquifer materials

managed aquifer recharge – the practice of artificially increasing the amount of water that enters a groundwater reservoir by diverting water to percolation ponds and timing reservoir releases to optimize in-stream recharge

mountain front recharge – subsurface inflows from bedrock in the hills surrounding the Santa Clara Plain, and inflow from uncontrolled reaches of streams

permeability – a measure of how well porous soil or bedrock can transmit water or other fluids

personal care products – consumer products including fragrances, topical agents such as cosmetics and sunscreens, laundry and cleaning products; and all the “inert” ingredients that are part of these products

saline intrusion – movement of saline water into aquifers, most often due to the incursion of saline water in the lower reaches of creeks in the Santa Clara Plain

San Felipe Project – the San Felipe Division of the federal Bureau of Reclamation’s Central Valley Project, includes the Santa Clara Valley. The project delivers 132,400 acre-feet of water annually for municipal and industrial use to users in Santa Clara and San Benito counties

sewer line exfiltration – movement of wastewater outside sewer pipes into soil and groundwater due to defects in sewer pipe materials, construction, or due to damage

storage capacity – the amount of groundwater of suitable quality that can be economically withdrawn from storage within economic, institutional, physical, and/or chemical constraints

total dissolved solids – represents the total concentration of dissolved substances in water. TDS is made up of inorganic salts, as well as a small amount of organic matter. Common inorganic salts that can be found in water include calcium, magnesium, potassium and sodium, which are all cations, and carbonates, nitrates, bicarbonates, chlorides and sulfates, which are all anions. Cations are positively charged ions and anions are negatively charged ions

unconfined aquifer – an aquifer that is open to receive water from the surface, and whose water table surface is free to fluctuate up and down, depending on the recharge/discharge rate. There are no overlying "confining beds" of low permeability to physically isolate the groundwater system

water banking – the practice of forgoing water deliveries during certain periods, and “banking” either the right to use the forgone water in the future, or saving it for someone else to use in exchange for a fee or delivery in kind

APPENDIX 1 – Recycled Water Policy

State Water Resources Control Board

Recycled Water Policy and Amendments

APPENDIX 2 – Groundwater Management Plan

Groundwater Management Plan

Basin Management Objectives and Strategies

Figure 43 – District Board Policy Framework

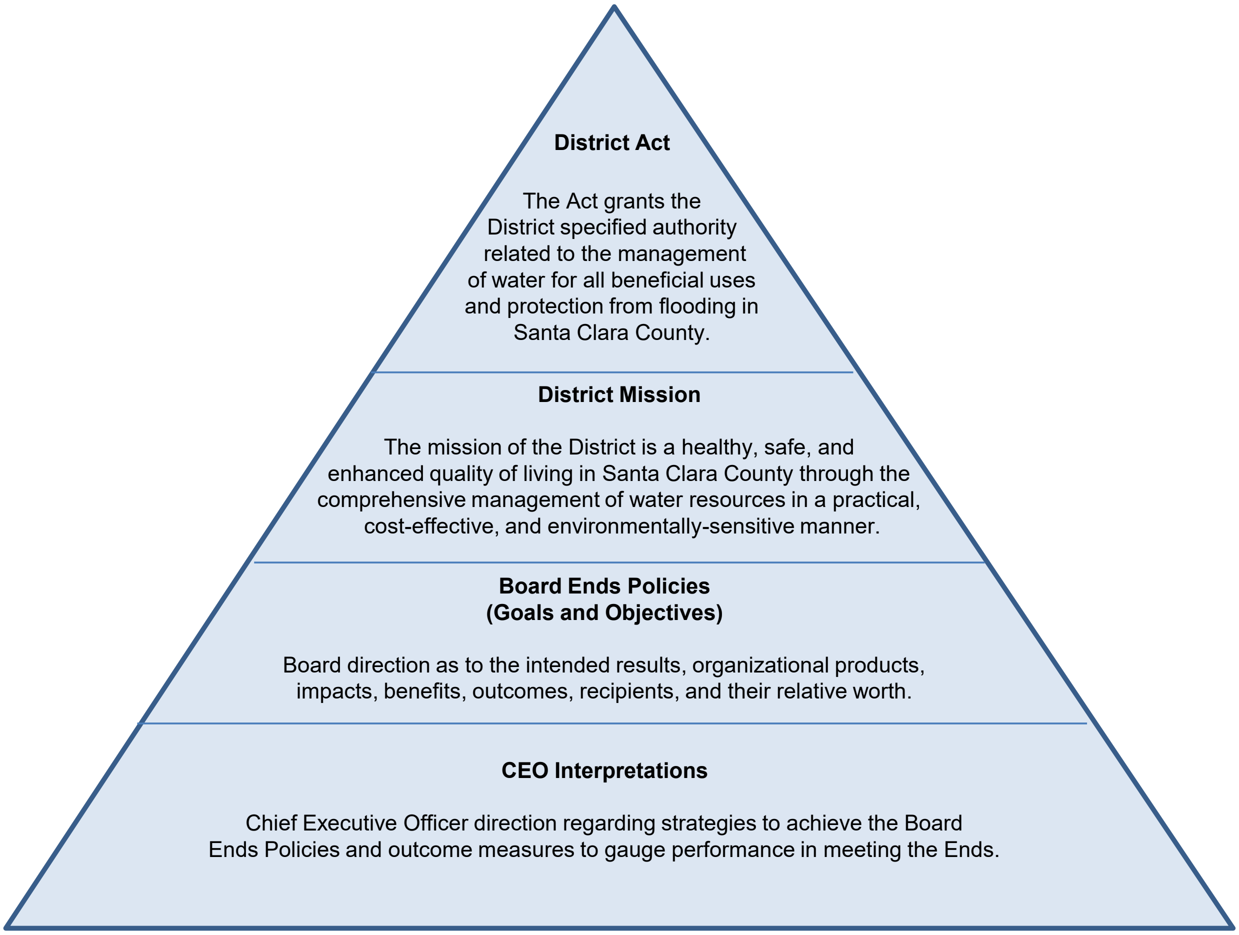
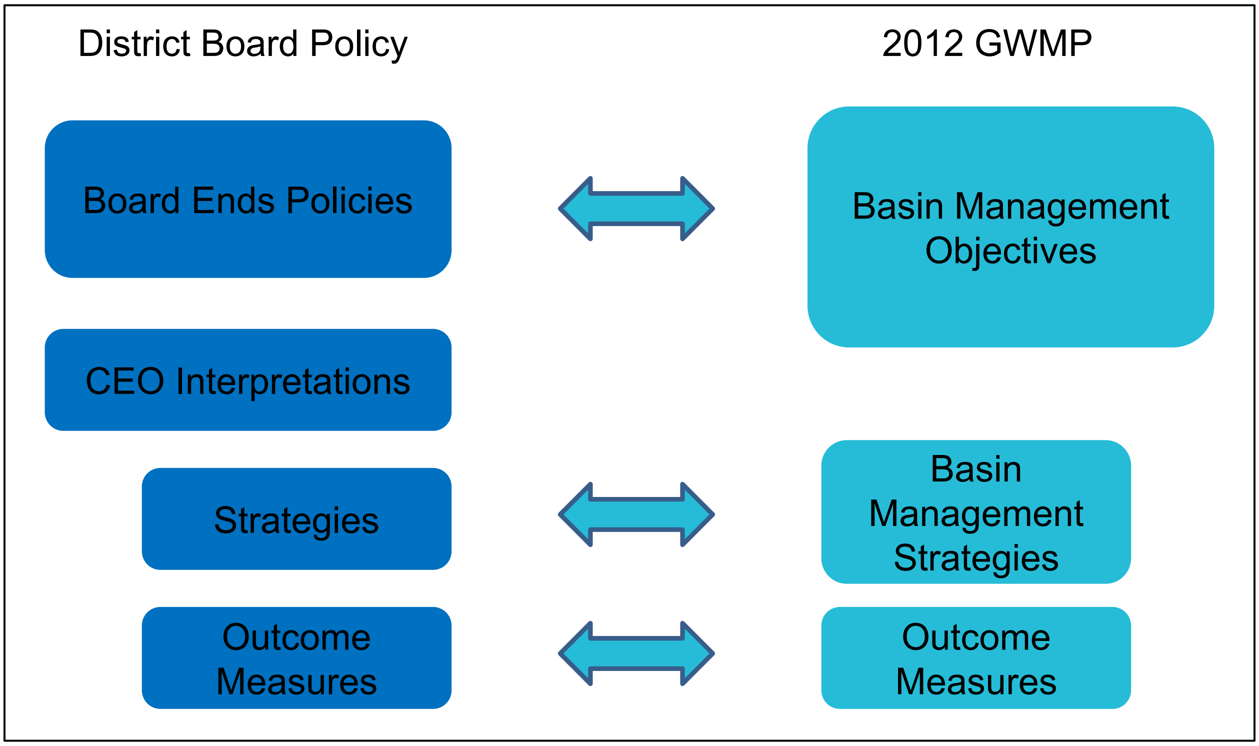


Figure 44 – Relation Between District Policy and 2012 GWMP



A-1.2 BASIN MANAGEMENT OBJECTIVES

Using the District's overall water supply management objectives, the following basin management objectives (BMOs) were developed:

BMO 1: Groundwater supplies are managed to optimize water supply reliability and minimize land subsidence.

BMO 2: Groundwater is protected from existing and potential contamination, including saltwater intrusion.

These BMOs describe the overall goals of the District's groundwater management program. The rationale and meaning of these objectives, as well as their relationship to District policies, are discussed below.

Water Supply Reliability and Minimization of Land Subsidence (BMO 1)

BMO 1: Groundwater supplies are managed to optimize water supply reliability and minimize land subsidence.

The District relies on groundwater for a significant portion of the county's water supply, particularly in South County where groundwater provides more than 95% of supply for all beneficial uses and 100% of the drinking water supply. Local groundwater resources make up the foundation of the county's water supply, but they need to be augmented by the District's comprehensive water supply management activities in order to reliably meet the needs of county residents, businesses, agriculture and the environment. The District relies on the conjunctive use of groundwater and surface water to meet the county's water demands now and in the future.

The District's goal of minimizing land subsidence is combined with the water supply reliability goal since the actions taken to address one also addresses the other. Significant historical land subsidence due to groundwater overdraft was essentially halted by about 1970 through the District's expanded conjunctive use programs, which allowed groundwater levels to recover substantially. The avoidance of inelastic (or permanent) land subsidence has been a major driver for the District over its history given the extremely high costs associated with reduced carrying capacity of flood control structures, damage to infrastructure, and saltwater intrusion.

BMO 1 reflects the District's integrated approach to water supply reliability and commitment to minimizing land subsidence and is consistent with the following Board policies:

Board Water Supply Goal 2.1: Current and future water supply for municipalities, industries, agriculture, and the environment is reliable.

Board Water Supply Objective 2.1.1: Aggressively protect groundwater from the threat of contamination and maintain and develop groundwater to optimize reliability and to minimize land subsidence and saltwater intrusion.

Groundwater Quality Protection (BMO 2)

BMO 2: Groundwater is protected from existing and potential contamination, including saltwater intrusion.

While surface water goes through significant treatment processes before being served as drinking water, groundwater in this county typically does not require wellhead treatment before being served. Although the District does not serve groundwater directly to consumers, as the local groundwater management agency the District works to help ensure that the groundwater used by the residents and businesses of Santa Clara County is of reliably high quality.

In highly urbanized areas such as the Bay Area, there are numerous threats to groundwater quality including urban runoff, industrial chemicals, and underground storage tanks. Residential and agricultural use of pesticides and nitrogen-based fertilizers can also impact groundwater quality. Although the process of moving through soil layers provides some filtration of water, this natural process is not effective for all contaminants.

Groundwater degradation may lead to costly treatment or even make groundwater unusable, resulting in the need for additional supplies. Preventing groundwater contamination is more cost effective than cleaning up polluted groundwater, a process that can take many decades or longer depending on the nature and extent of the contamination. Notable contamination sites in the county requiring significant groundwater cleanup include large solvent releases at the IBM and Fairchild sites in south San Jose in the 1980s, and the Olin perchlorate release in Morgan Hill, which was discovered in the early 2000s.

Historically, saltwater intrusion has been observed in the shallow aquifer adjacent to San Francisco Bay during periods of higher groundwater pumping and land subsidence. Significant increases in groundwater pumping or sea level rise due to climate change could potentially lead to renewed saltwater intrusion.

The goal of the District's groundwater quality protection programs is to ensure that groundwater is a viable water supply for current and future beneficial uses. In addition to the primary deep drinking water aquifers, the District works to protect the quality of all aquifers in the subbasins, including shallow groundwater, as these are potential future sources for drinking water or other beneficial use.

Section 5 of the District Act authorizes the District to prevent the pollution and contamination of District surface water and groundwater supplies. BMO 2 is consistent with the District Act and with Board Water Supply Objective 2.1.1.

A-2.3 Basin Management Strategies

The basin management strategies are the methods that will be used to meet the BMOs. Many of these strategies have overlapping benefits to groundwater resources, acting to improve water supply reliability, minimize subsidence, and protect groundwater quality. The strategies are listed below and are also described in detail in this section.

1. Manage groundwater in conjunction with surface water through direct and in-lieu recharge programs to sustain groundwater supplies and to minimize saltwater intrusion and land subsidence.

2. Implement programs to protect or promote groundwater quality to support beneficial uses.

3. Maintain and develop adequate groundwater models and monitoring systems.

4. Work with regulatory and land use agencies to protect recharge areas, promote natural recharge, and prevent groundwater contamination.

Strategy 1: Manage groundwater in conjunction with surface water through direct and in-lieu recharge programs to sustain groundwater supplies and to minimize saltwater intrusion and land subsidence.

The District relies on groundwater subbasins to help meet water demands, naturally transmit water over a wide area, and provide critical storage reserves for emergencies such as droughts or other outages. Because groundwater pumping far exceeds what is replenished naturally, the District manages groundwater and surface water in conjunction to ensure the groundwater subbasins remain an important component in meeting current and future water demands.

Maintaining the District's comprehensive managed recharge program using both local and imported waters is critical to sustaining groundwater supplies. This requires maintaining water supply sources and existing recharge facilities as well as developing additional recharge facilities to help support future needs as identified in the District's Water Supply and Infrastructure Master Plan. Currently, several of the District reservoirs have restricted storage capacity due to limitations imposed by Division of Safety of Dam (DSOD). Resolving dam safety issues that currently restrict reservoir storage is also an important component of this strategy.

Just as important as direct recharge are the availability of SFPUC supplies to the county, the District's treated water deliveries, water conservation and water recycling programs, which serve as in-lieu recharge by reducing groundwater demands. Together these programs help to maintain adequate groundwater storage, keep groundwater levels above subsidence thresholds, and maintain flow gradients toward San Francisco Bay. This, in turn, supports groundwater pumping and minimizes risks related to land subsidence and saltwater intrusion.

The District's managed recharge and in-lieu programs are described in detail in Chapter 4 and specific outcome measures related to groundwater levels and storage are discussed in Chapter 6.

Strategy 2: Implement programs to protect or promote groundwater quality to support beneficial uses.

Groundwater in Santa Clara County is generally of very high quality, with few public water systems requiring wellhead treatment prior to delivery to customers. The District evaluates groundwater quality and potential threats so that changes in groundwater quality can be detected and appropriate action can be taken to protect the quality of groundwater resources. This includes assessing regional conditions and trends, evaluating threats to groundwater quality including emerging contaminants, conducting technical studies such as vulnerability assessments, and implementing strategies to protect groundwater from contaminant sources.

Groundwater protection programs are described in detail in Chapter 4 and specific outcome measures related to groundwater quality are presented in Chapter 6.

Strategy 3: Maintain and develop adequate groundwater models and monitoring systems.

Comprehensive monitoring programs provide critical data to understand groundwater conditions and support operational decisions, including the timing and location of managed recharge. The District has implemented programs to regularly monitor groundwater levels, groundwater quality (including monitoring near recycled water irrigation sites), recharge water quality, surface water flow, and land subsidence. Local water retailers also collect groundwater quality data for compliance with California Department of Public Health regulations and monitor groundwater levels. Data from these programs is essential to evaluating current conditions, preventing groundwater overdraft and subsidence, and measuring the effectiveness of basin management programs and activities. These monitoring programs and related monitoring protocols are described in Chapter 5.

The District has also developed models to support operational decisions and long-term planning. These include operational and water supply system models, as well as models specific to groundwater. The District has developed calibrated flow models for the Santa Clara Plain, Coyote Valley, and the Llagas Groundwater Subbasin, which are used to evaluate groundwater storage and levels under various operational and hydrologic conditions. These models are used to support ongoing water supply operational decisions as well as long-term planning efforts. Maintaining calibrated models that can reasonably forecast groundwater conditions is critical to the District's comprehensive groundwater management strategy.

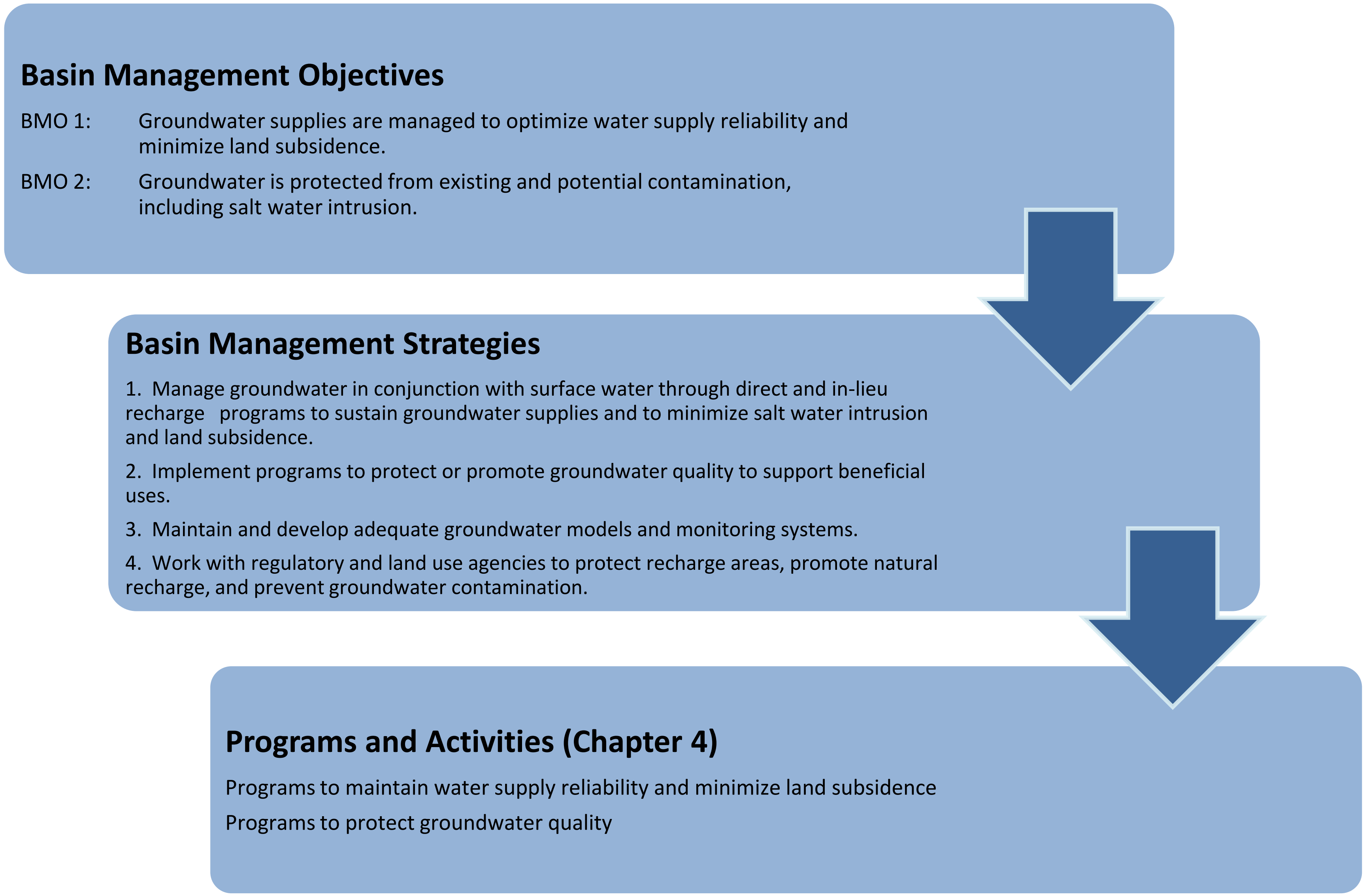
Strategy 4: Work with regulatory and land use agencies to protect recharge areas, promote natural recharge, and prevent groundwater contamination.

Since the 1950s, land use in the Santa Clara Plain has changed from largely rural and agricultural to a highly developed urban area. The increased amount of land covered by impervious materials has increased runoff and reduced natural recharge. Although not as urbanized as the Santa Clara Plain, the Llagas Groundwater Subbasin serves the growing cities of Morgan Hill and Gilroy, and significant development has been considered in the Coyote Valley. This strategy calls for working with land use agencies to maximize natural recharge by protecting groundwater recharge areas and supporting the use of low-impact development.

Increased urbanization also increases the risk of contamination particularly in groundwater recharge areas, which are more vulnerable due to the presence of highly permeable sediments. The District coordinates with land use agencies with regard to potentially contaminating land use activities and resource protection. Regulatory agencies also play a critical role in groundwater protection with regard to the establishment of water quality objectives and the cleanup of contaminated sites. The District will continue to work with these agencies and identify opportunities for enhanced cooperation to minimize impacts from existing contamination and prevent additional contamination from occurring. This includes the development of technical studies, participation in policy development, and coordination on proposed development.

The relationship between the basin management objectives, strategies, and related programs and activities, is shown below in Figure 17.

Figure 45 – Relation Between Basin Management Objectives, Strategies, and Programs



APPENDIX 3 – Groundwater Monitoring Plan

SNMP Groundwater Monitoring Plan for the Santa Clara Groundwater Subbasin

APPENDIX 4 – Groundwater Quality Management

Local Government Groundwater Quality Management Program

Groundwater Quality Management Programs

Salt and nitrate loading projections show that the average basin concentrations of TDS and nitrate in the Santa Clara Plain and Coyote Valley comply with the RWQCB's Basin Plan Objectives throughout the 25-year evaluation period. Nitrate concentrations are projected to decrease in both the Santa Clara Plain and Coyote Valley. Salt concentrations (as TDS) are projected to decrease in Coyote Valley, but will increase in the Santa Clara Plain at a rate of approximately 1.1 mg/L/year, while Basin Plan Objectives are not projected to be exceeded through 2035. Accordingly, Implementation Measures are not required for the Santa Clara Groundwater Subbasin SNMP.

Good groundwater management practice includes programs that can proactively protect groundwater quality from salt loading in the long term and there are a variety of programs and policies that cause a net reduction in salt loading. This section describes programs that have the added benefit of groundwater quality protection by limiting or reducing salt loading. Developing a quantitative enumeration of the reduction in salt loading attributable to each activity is a major undertaking that is made difficult by the inherent uncertainties of future projections. Accordingly, a qualitative description of these activities is provided. The benefit of the water quality protection programs described below is incorporated into the projections for future assimilative capacity.

A-4.1 Existing Programs and Activities that Mitigate Salt and Nutrient Loading

Existing programs can be categorized by the medium from which they reduce salt loading, which correlates to Figure 15 (Relationship of Salt and Nutrient Sources to Groundwater). For example, surface water management activities include stormwater management and conjunctive use. Wastewater management includes pretreatment programs and improvements to recycled water quality. Groundwater quality programs can include groundwater quality monitoring and reducing direct loading to groundwater from lawn and garden fertilizers. Water quality protection activities are described in more detail in the following sections.

A-4.1.1 Surface Water Programs

Programs, policies, and activities that improve the quality of surface water that infiltrates to groundwater are listed below:

- Construction stormwater management.
- Mitigation of drainage impacts from new developments (low impact development).
- Enforcement of National Pollution Discharge Elimination System (NPDES) requirements (e.g., eliminating non-stormwater discharges to storm drains).
- Rainwater capture, storage, and infiltration.

The majority of the programs that reduce salt and nitrate loading are required by or addressed in the Municipal Regional Stormwater NPDES Permit (MRP) issued in October 2009. The cities of Campbell, Cupertino, Los Altos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, and Sunnyvale, the towns of Los Altos Hills and Los Gatos, the Santa Clara Valley Water District, and Santa Clara County, have joined together to form the Santa

Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP). SCVURPPP's goals include prohibiting non-stormwater discharges and reducing pollutants in stormwater runoff, as well as administering compliance with the Municipal Regional Permit. The SCVURPPP program has been operating since 1990 and continues to promote awareness of and compliance with the MRP requirements. The centerpiece of the SCVURPPP program is the Watershed Watch Campaign, a multi-year education and outreach effort designed to increase the public's awareness of urban runoff issues including pollution prevention. SCVURPP also provides on-line resources such as guidance on low impact development (LID), rainwater harvesting, and contractor compliance with stormwater management requirements. All of the cities in the Santa Clara Plain participate in and promote the SCVURPPP programs. Because stormwater recharges groundwater, improvements to stormwater quality can decrease salt and nitrate loading to groundwater.

The cities and towns in the Santa Clara Plain have codified requirements for stormwater pollution prevention. Many of these municipal codes require permanent stormwater pollution prevention measures for development and redevelopment projects that will reduce water quality impacts of stormwater runoff from the site for the life of the project. For example, the City of Mountain View has published Storm Water Quality Guidelines for Development Projects. Similar requirements are included in the municipal codes and city policies as listed in Table 44, below. The cities of Campbell, Monte Sereno, Saratoga, and Los Gatos formed the West Valley Clean Water Program to reduce pollutants in storm drain discharges and maximize the effectiveness of pollution prevention efforts by the four West Valley Communities.

Table 44 – Example City Requirements for Stormwater Pollution Prevention

<table>
<tr><th>City</th><th>Requirement</th><th>Reference</th></tr>
<tr><td>San Jose</td><td>Minimize and treat stormwater runoff from new/re-development projects per MRP: use LID</td><td>Council Policy 6-29</td></tr>
<tr><td>Milpitas</td><td>Stormwater and Urban Runoff Pollution Control</td><td>Muni Code Ch 16</td></tr>
<tr><td>Santa Clara</td><td>Control of unauthorized discharges</td><td>City Code Ch 13.20</td></tr>
<tr><td>Sunnyvale</td><td>Stormwater and Urban Runoff Pollution Control: LID reqs.</td><td>Muni Code Ch12.60</td></tr>
<tr><td>Mountain View</td><td>Stormwater Treatment at New/Redevelopment Projects</td><td>Muni Code Ch 35.34</td></tr>
<tr><td>Palo Alto</td><td>Treat storm water runoff using LID techniques</td><td>Muni Code Ch 16.11</td></tr>
<tr><td>Los Altos</td><td>Treatment of stormwater runoff with LID measures, including rainwater harvesting and reuse, infiltration, evapo-transpiration or biotreatment</td><td>Muni Code Ch 10.16</td></tr>
<tr><td>Cupertino</td><td rowspan="4">Discharge to storm drains prohibited
Storm Water Prevention Plan (SWPPP)
http://www.cleancreeks.org/</td><td rowspan="4">Cupertino Muni Code 9.18.040, 9.18.090; Los Gatos Muni Code Ch. 12;</td></tr>
<tr><td>Saratoga</td></tr>
<tr><td>Campbell</td></tr>
<tr><td>Los Gatos</td></tr>
</table>

Individual City Stormwater Requirements may include extensive measures to protect stormwater quality. For example, the City of Mountain View requires the following:

- Development projects shall submit a stormwater management plan in accordance with the city's guidelines.

- Property owners must ensure that permanent stormwater pollution prevention measures are inspected twice annually to ensure they are working properly, and written inspection must be submitted to the city annually (an enforceable requirement).
- The city has the right of entry to inspect and repair stormwater pollution prevention measures.

New development and redevelopment projects that create or replace more than 10,000 square feet of impervious surface are required to implement Low Impact Development site design, source control, and treatment measures to address stormwater runoff pollutants and prevent increases in runoff flows. In addition, projects that add or replace one acre or more of impervious surface are required to include hydromodification control measures. These requirements limit post-project runoff to the estimated pre-project runoff rates and durations. Stormwater treatment and site design measures, such as grassy swales, bioretention, and detention in landscaping all help to detain and infiltrate increased flows.

To gauge the effectiveness of stormwater pollution prevention measures, SCVURPPP conducts a range of surface water quality monitoring activities at varying spatial scales. These include studies designed to assess water quality and beneficial uses in local creeks and the San Francisco Bay, and loading studies to evaluate the proportion of pollutants entering the Bay from local tributaries. Studies on local water bodies are typically conducted through the Program's Multi-Year Monitoring Program. Monitoring activities are conducted to evaluate pollutant loading to San Francisco Bay. These studies are conducted through regional partnerships (e.g., the Regional Monitoring Program for Water Quality).[26]

The Multi-Year Monitoring Program has collected and analyzed screening level water quality monitoring data from 73 creek sites located within the Santa Clara Plain in the last ten years. Water samples were analyzed for conventional water quality parameters, chemical pollutants (metals and organic contaminants), aquatic toxicity, and pathogen indicators (SCVURPPP, 2006).

A-4.1.2 Stormwater Infiltration Devices

Low-impact development initiatives often promote design with stormwater infiltration devices to reduce runoff and increase groundwater recharge. Stormwater infiltration devices such as dry wells and infiltration basins help to reduce runoff to creeks that carries pollutants to the bay. However, these devices also have the potential to introduce pollutants to groundwater. Dry wells may be constructed to penetrate saturated aquifers, eliminating the benefit of soil filtration that removes some dissolved constituents. Infiltration basins that are excavated to a depth that penetrates the saturated zone may also introduce salts and nutrients to groundwater. Other stormwater infiltration devices, such as bio-swales, are designed to enhance filtration of stormwater before it percolates to groundwater. While bio-swales may facilitate precipitation or adsorption of metals, oil and grease, these structures can be expected to transmit dissolved salts and nitrate (with some nitrate attenuation).

The Federal Clean Water Act requires local municipalities to implement measures to control pollution from their storm sewer systems to the maximum extent practicable. Under the auspices of the Clean Water Act, the San Francisco RWQCB issued an area-wide National Pollutant Discharge Elimination System Permit (NPDES MS4) to the fifteen co-permittees of the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) for the discharge

[26] http://www.sfei.org/node/1074

of storm water from urban areas in Santa Clara County. The fifteen SCVURPPP co-permittees are the thirteen municipalities within the Santa Clara Basin watershed area[27], the County of Santa Clara, and the Santa Clara Valley Water District.

The SCVURPPP Permit requires each of the co-permittees to ensure the reduction of pollutant discharges from development projects through incorporation of treatment and other appropriate source control and site design measures. The SCVURPPP NPDES Permit establishes minimum design criteria and maintenance requirements in certain types of development projects.

In order to protect groundwater from pollutants that may be present in urban runoff, treatment control measures such as infiltration trenches and infiltration basins must meet the following conditions:

a. Pollution prevention and source control BMPs shall be implemented to the extent necessary to protect groundwater quality at sites where infiltration devices are to be used.

b. Infiltration devices may not contribute to degradation of groundwater quality.

c. Infiltration devices must be adequately maintained to maximize pollutant removal capabilities.

d. The vertical distance from the base of any infiltration device to the seasonal high groundwater must be at least 10 feet.

e. Unless storm water is first treated by a means other than infiltration, infiltration devices may not be used in areas of:

  - industrial or light industrial activity;
  - areas subject to high vehicular traffic (25,000 or greater average daily traffic on main roadway or 15,000 or more average daily traffic on any intersecting roadway);
  - automotive repair shops, car washes, fleet storage areas (bus, truck, etc.);
  - nurseries;
  - any other land use or activity which may pose a high threat to groundwater quality, as designated by the City.

f. Infiltration devices must be located a minimum of 100 feet horizontally from any known water supply wells.

The SCVURPPP Permit is available online at:

http://www.waterboards.ca.gov/rwqcb2/water_issues/programs/stormwater/Municipal/R2-2009-0074_Revised.pdf

In 2012, the District partnered with SCVURPPP to develop updated stormwater infiltration device standards for the Regional NPDES stormwater permit. The standards are included in Appendix A of the C.3 Stormwater Handbook.[28]

---

[27] Campbell, Cupertino, Los Altos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, and Sunnyvale, and the towns of Los Altos Hills and Los Gatos.

A-4.1.3 Water Conservation Programs

A major source of salt loading identified in Section 3.2.1.7 is landscape irrigation. Due to evaporation, the TDS concentration in irrigated water is effectively concentrated as much as ten-fold and nearly all of the salt in irrigated water ultimately migrates to groundwater. Therefore, conservation of outdoor irrigation water has a direct effect on reducing salt loading.

The District Board of Directors established Water Supply Objective (E-2.1.5) to "maximize water use efficiency, water conservation and demand management opportunities." The District CEO has also established a specific Outcome Measure (OM 2.1.5.a) for this objective, which aims to conserve at least 98,000 AF/yr by the year 2030.

Indoor and outdoor water conservation is already a core stratagem for managing water supply reliability however, most water conservation savings have been realized from indoor water conservation measures. As discussed in 3.3.5.4, one consequence of indoor conservation is higher TDS and nitrate in wastewater. When indoor water conservation measures are employed (e.g., shorter showers, low-flush toilets), salt and nitrate added to wastewater through household activities is dissolved into a smaller volume of water, with a corresponding increase in salt and nitrate concentration. As a result, the TDS and nitrate concentrations of tertiary-treated recycled water are increased.

Outdoor water conservation includes replacing water intensive lawns and gardens with drought-resistant native plants that require substantially less water, improving efficiency of lawn sprinklers, promoting weather-based irrigation controllers, and other measures. For example, the Bay Area Water Supply and Conservation Agency (BAWSCA), comprised of cities whose water is supplied in part by the San Francisco Public Utility Commission, hosts workshops on sustainable landscaping, water-use efficiency in the landscape, use of California native and drought tolerant plants, alternatives to lawns, water efficient irrigation practices, and more.[29] An added benefit to replacing lawns with native or drought-tolerant plants is to reduce or eliminate the need for supplemental fertilizers, which cause salt and nitrate loading to groundwater.

The Santa Clara Valley Water District and San Jose Water Company offer residents free "water-wise house calls" in which an inspector advises homeowners of opportunities to save water, including evaluating the efficiency of sprinkler systems, issuing an individualized irrigation schedule, identifying irrigation leaks, broken or mismatched sprinkler heads, and other common irrigation problems. For example, in 2012, San Jose Water Company completed 1,936 water use audits, including:

- 1,045 Single Family residential;
- 400 landscape only;
- 59 indoor only;
- 242 multi-family residential;
- 35 commercial;
- 155 dedicated irrigation sites.

---

[28] http://www.scvurppp-w2k.com/permit_c3_docs/c3_handbook_2012/Appendix_A-Infiltration_Guidelines_2012.pdf
[29] The Cities participating in BAWSCA include Milpitas, Mountain View, Palo Alto, San Jose, Santa Clara, Sunnyvale, Purissima Hills Water District, and Stanford University. The sustainable landscaping *Green Gardner Program* is described here: http://www.mywatershedwatch.org/greengardener.html.

The San Jose Water Company and Santa Clara Valley Water District have also created demonstration gardens at their campuses to educate homeowners on landscape design with drought tolerant native plants.

The District also operates a Landscape Rebate Program, in which residents and businesses can receive rebates for upgrading irrigation hardware, installing weather-based irrigation controllers, and replacing high-water using landscape with qualifying low-water using plants.

The District is currently planning a Landscape Water Use Evaluation Program, which will provide real-time water use reports comparing actual water usage against a recommended water budget to large landscape sites. On-site surveys will be performed as needed. The estimated savings from outdoor water conservation programs operated by the District in 2012 is 1,200 AF/yr. The projected savings from District managed outdoor water conservation for 2030 is 10,300 AF, which would avert future TDS loading of about 4,000 tons salt per year.

Gray water (non-toilet wastewater, i.e., from washing machines, dishwashers, showers and baths, kitchen sink water, etc.) is another potential source of irrigation water. The District is promoting gray water use through a rebate program that funds installation of systems that take washing machine effluent directly into drip irrigation systems. The program is limited in scope and is expected to decrease the demand for outdoor irrigation water by 300 AF, depending on the extent of homeowner participation. While gray water displaces retailer water now used for outdoor irrigation, it has higher TDS than the water it is displacing. Household wastewater typically has TDS that is ~200 mg/L higher than the source water (Kaplan, 1991). Of the sources of TDS in wastewater, 42% comes from washing machines using conventional detergents (Siegrist et al., 1976). On this basis, 300 AF/yr of graywater use would add ~34 tons of salt/year. However, best management practices for graywater systems include promoting low-salt detergents. Therefore, at the subbasin scale, TDS loading from graywater use is expected to be negligible for the volumes considered in the District's graywater system rebate program.

A-4.1.4 Groundwater Management Programs

Several groundwater management programs and policies decrease salt and nitrate loading or increase recharge with water that is low in salts and nitrates. A wide range of existing programs that focus on other objectives is aligned with loading reduction and increased recharge of high quality water.

A-4.1.4.1 Composting

Composting greenwaste generated from gardening activities and then adding compost to soil lowers the plant demand for fertilizers. While compost is not itself a fertilizer, soils amended with compost have improved capacity for storing nutrients for gradual release. Compost added to soil also improves soil water retention capacity, thereby reducing demand for irrigation water. Mulch also serves to conserve irrigation water for landscaping.

Increasing the use of compost and mulch in gardens is the goal of several outreach programs, which have the joint objective of reducing solid waste generation. Table 45 lists some of the ongoing compost and mulch outreach programs.

Table 45 – Compost and Mulch Programs in the Santa Clara Groundwater Subbasin

Jurisdiction	Program	Link
SCVURPPP + Solid Waste Programs	Eco-Gardeners Program	http://www.bayareaecogardens.org/
City of Palo Alto	Garden Workshops – Composting	http://www.cityofpaloalto.org
City of Mountain View	Composting & Yard Trimmings Program	http://www.ci.mtnview.ca.us
City of Sunnyvale	Monthly Home Composting Workshops	www.recycling.insunnyvale.com
City of Santa Clara	Partners with County of Santa Clara Master Composter Program	http://www.sccgov.org/sites/iwm/hc/Pages/How-to-Compost.aspx
City of San Jose	Composting classes and bin sales	http://www.sanjoseca.gov/calendar.aspx
City of Milpitas	Partners with County of Santa Clara Recycling and Waste Reduction Commission Programs	http://www.sccgov.org/sites/iwm/hc/pages/classes.aspx
City of Campbell	Partners with County of Santa Clara	
City of Cupertino	Free compost; Partners with County of Santa Clara	
City of Saratoga	Compost bin sales and partners with County of Santa Clara	
City of Morgan Hill	Partners with County of Santa Clara	

A-4.1.4.2 Fertilizer Management

Agricultural fertilizer use in the Santa Clara Plain is a minor component of overall estimated nitrate loading (78 tons per year or 8.7%), but is the primary component of nitrate loading estimates for Coyote Valley (117 tons per year or 54.8% – see Table 29). Estimated nitrate loading from lawn fertilizer (76 tons per year) makes up 8.4% of nitrate loading in the Santa Clara Plain and 1.4% (3 tons) of nitrate loading in Coyote Valley. Several programs educate homeowners on optimal fertilization rates, timing, and application methods. For example, the Santa Clara County Integrated Pest Management program provides outreach materials for healthy lawn care practices that achieve both fertilizer and irrigation reduction (www.sccgov.org). The Santa Clara County Master Gardeners program conducts similar outreach for "water-wise lawns" (http://www.mastergardeners.org/scc.html).

The University of California Cooperative Extension –"Healthy Crops, Safe Water Initiative" promotes reduced agricultural fertilizer use. Some achievements include:

- Developed best management practices to minimize nitrate leaching in irrigated crop production.
- Developed "nitrate quick test" for managing fertilizer decisions in vegetable production.

- Studying the nitrogen use efficiency of high-nitrogen crops to improve timing of fertilizer application.

- Promoting fall-planted non-legume cover crops that can take up in excess of 100 lb N/acre (nitrogen that otherwise could leach to groundwater).

In the past, the District operated the Infield Nutrient Assessment Assistance Program (INAAP). The INAAP program provides:

- Free testing of agricultural pumps and irrigation systems.

- Irrigation scheduling consultation.

- Testing and consultation in plant nutrient status and fertilizer management for three years.

The program's objectives were to increase water and nutrient use efficiencies and reduce nitrogen fertilizer loading to groundwater. The program ended in 2008 due to insufficient funding and participation.

A-4.1.4.3 Septic Tank Management

Effluent from septic tank leach fields adds nitrate and salt to groundwater. About 10% (38 tons) of the estimated nitrate loading in Coyote Valley is from septic tanks, while there are fewer than 100 septic tanks in the Santa Clara Plain. The County of Santa Clara issues septic tank permits. In December, 2013, the County adopted a new Onsite Wastewater Treatment System Ordinance (OWTSO), which became effective on December 26, 2013. The OWTSO modernizes construction standards and citing requirements for the disposal of wastewater on site, and allows for alternative treatment technologies.

The OWTSO requires applicants to conduct a backhoe excavation to verify the soil profile to a depth of 5 feet below ground surface, and a wet weather groundwater investigation where the water table is high. The County's septic tank ordinance requires groundwater to be at least 5 feet below the leachfield in soils with moderate percolation rates, and 20 feet in highly permeable soils. For alternative OWTS a 2 to 5-foot separation to groundwater is required.

The County has published an extensive Onsite Systems Manual,[30] which provides updated information regarding design details and guidelines for conventional and alternative systems, and system operating and monitoring requirements.

To the extent that new systems may replace older, conventional systems, some reduction in nitrate loading may be realized. For example, recirculating sand filters (e.g., Venhuizen Standard Denitrifying Sand Filter) can provide additional nitrogen removal, as can aerobic treatment units and alternative media filters. However, the OWTSO does not require that older or failing systems be replaced rather, OWTSO requires that they be repaired. Some homeowners may be motivated to install alternative treatment technologies to address challenging soil conditions, extend the life of the leach field, or to achieve other advantages. Nevertheless, it is difficult to predict the effect that the new OWTSO will have on nitrate loading.

---

30 http://www.sccgov.org/sites/deh/Consumer%20Protection%20Division/Program%20and%20Services/Land%20Use%20Program/Pages/Onsite-Wastewaster-Treatment-Systems-Ordinance.aspx

A-4.1.4.4 Livestock Manure Management

In addition to onsite wastewater management, many rural residences in Coyote Valley and some parts of the Santa Clara Plain must also deal with livestock wastes. The County has recommended best management practices for mud and manure management to owners of horses, goats, sheep and other livestock (http://livestockandland.org/resources/). The website includes guidance on manure composting, manure management, designing horse paddocks to protect water quality, stormwater management, and more, in both English and Spanish. At Stanford University, the equestrian program includes manure composting and stormwater management.

A-4.1.4.5 Groundwater Monitoring Programs

As described in Appendix 3, the District operates a county wide groundwater monitoring program that includes analysis for nitrate and TDS. Annual reports include summary statistics by subbasin and trend analyses in individual wells. Monitoring does not in itself change loading, but it is a required element of salt and nutrient management in order to determine the condition of the groundwater basin on an ongoing basis.

In addition to gaining a basin-wide understanding of groundwater conditions, it is important for individual domestic well owners to understand the quality of their well water. The District currently operates a free basic water quality-testing program for domestic well owners, which includes analysis of nitrate and has produced a detailed picture of the distribution of nitrate in domestic wells. Results from the domestic well testing program are included in the District's Annual Groundwater Report.

In order to understand the long-term impacts of recycled water on groundwater quality, the District has undertaken two programs to monitor groundwater beneath sites irrigated with recycled water (one in Edenvale/south San Jose and the other at two locations in Gilroy). Shallow monitoring wells are sampled at the Edenvale and Gilroy sites, and groundwater and recycled water are analyzed for TDS and nitrate, as well as a wide range of other constituents associated with recycled water, including constituents of emerging concern. Analyzing the concentration trends of TDS, nitrate, and other constituents over time provides insights to the impact of irrigation with tertiary treated recycled water on shallow groundwater at a local scale.

At the San Jose site, this monitoring program may also allow observation of the time lag between initiation of irrigation with lower TDS recycled water (tertiary treated recycled water blended with advanced treated recycled water, TDS of 500 mg/L), and any corresponding changes to groundwater TDS concentrations. Understanding the amount of time needed for groundwater quality to change in response to recycled water application can assist with refining salt loading projections.

The City of San Jose has also undertaken long term shallow groundwater monitoring at recycled water irrigation sites, using six shallow monitoring wells installed in 1997, and six deep production wells. Recycled water application at the shallow monitoring well sites began in 1999. Statistical analysis of long term concentration trends is updated periodically based on annual sampling in March each year.

A-4.1.4.6 Drinking Water Source Assessment Program and District Groundwater Vulnerability Assessment

The 1996 reauthorization of the federal Safe Drinking Water Act (SDWA) included an amendment requiring states to develop a program to assess sources of drinking water and encouraging states to establish drinking water source protection programs. The Drinking Water Source Assessment Program (DWSAP) includes delineation of the areas around drinking water sources through which contaminants might move and reach drinking water supplies. The DWSAP includes an inventory of "potentially contaminating activities" (PCAs) that might contribute to the release of contaminants within the delineated area. This enables a determination to be made as to whether the drinking water source might be vulnerable to contamination. The DWSAP was administered by the California Department of Public Health (CDPH) and implemented by each water retailer. DWSAP guidance identifies PCAs that have the potential to contribute salt or nitrate to groundwater, listed in Table 46.

Table 46 – Potentially Contaminating Activities Contributing Salt and Nitrate to Groundwater

Potentially Contaminating Activity	Nitrate Contribution	Salt Contribution
Agricultural Drainage	✓	✓
Car Washes		✓
Cement/concrete plants		✓
Food processing plants	✓	✓
Metal plating/finishing/ fabricating		✓
Dairies	✓	✓
Lagoons (for animal waste or irrigation tail water) and Agricultural Drainage	✓	✓
Golf Courses, Parks, Schools, Sports Fields, Cemeteries	✓	
Housing (lawn maintenance, swimming pools, etc.)	✓	✓
Landfills, Waste Transfer and Recycling, Composting	✓	✓
Mines/gravel pits		✓
Livestock operations	✓	✓
Irrigated crops	✓	✓
Apartments and condominiums	✓	✓
Sewer Lines and Septic Systems	✓	✓

Groundwater contamination from the above PCAs could result from the misuse and improper disposal of liquid and solid wastes; illegal dumping of household, commercial, or industrial wastes; accidental spills; and ongoing leaching from septic leach fields, construction sites, infiltration of roadway and parking lot runoff, and leaching of fertilizers from farms, landscaping, and lawns, parks, golf courses, cemeteries, and sports fields.

The DWSAP does not have an ongoing funding mechanism or mandate to update the inventories of PCAs. The intended benefit of the DWSAP program is to increase public awareness of the interconnection of land use activities and groundwater quality, and for planners to consider groundwater vulnerability in their permitting decisions.

In 2010, the District published a comprehensive Groundwater Vulnerability Study for Santa Clara County.[31] The study analyzed the two key components of groundwater vulnerability:

1) groundwater sensitivity, and 2) risk from potentially contaminating activities. Four factors were found to be the most important in characterizing groundwater sensitivity. These include 1) soil media characteristics in the unsaturated zone, 2) groundwater recharge, 3) depth to top of well screens, and 4) annual groundwater production. The potentially contaminating activities risk analysis found that large portions of the Santa Clara Plain are at high risk due to the high level of development and many associated industrial and commercial contaminant release sites, along with the lingering impacts of past agricultural releases. Although the confined zone in the Santa Clara Groundwater Subbasin affords relatively good protection from surface contamination, the outer western unconfined zone appears to be highly sensitive to contamination due to the significant groundwater production in this area.

Relatively lower overall risks from potentially contaminating activities are associated with the Coyote Valley, which is rural and less developed with far fewer industrial/commercial contaminant release sites. Nonetheless, most of Coyote Valley shows a moderate level of risk associated with irrigated agriculture. Although the risk from potentially contaminating activities is lower than in the Santa Clara Plain, the Coyote Valley exhibits high to very high vulnerability, which is driven by high sensitivity due to high recharge rates and permeable soils. Coyote Valley has the most potential for future development and thus the most potential for an increase in groundwater vulnerability in the future.

The Groundwater Vulnerability Study produced a detailed vulnerability map of the study area along with a Geographical Information System (GIS) tool, which allows the District to better focus groundwater management programs and assess potential groundwater quality impacts from future changes in land use. The tool features sensitivity (for Shallow and Principal Aquifers), PCA risk, and vulnerability maps (for Shallow and Principal Aquifers). Additional maps are also provided to enhance the usefulness of the tool. Pull-down menus feature tables with explanatory fields. The tool enables District staff to work interactively with the vulnerability study analysis. The objectives of the tool are to enable District staff to:

- Evaluate potential impacts of new developments.
- Prioritize basin management activities.
- Prioritize oversight of known contamination sites.

A-4.1.4.7 Water Distribution System Leak Detection Programs

Water utilities and water companies are motivated to locate and correct leaks in water distribution system piping to conserve costs and avoid nuisance conditions and possible secondary damage to streets and landscaping. Most water retailers are prepared to respond to major leaks or breaks 24/7 and are able to be on site within 30-minutes of dispatch. Water distribution piping is subjected to significant stresses that cause leaks to occur relatively frequently. Seven of the 13 water retailers serving the Santa Clara Plain and Coyote Valley

[31] http://www.valleywater.org/Services/GroundwaterStudies.aspx

reported the number of water main line and service connection breaks or leaks in the 2011 LAFCO report, “Santa Clara Countywide Water Service Review”. These seven retailers have 130,608 connections, and collectively experienced a total of 273 water main line leaks or breaks and 473 service connection leaks or breaks in 2010 (LAFCO, 2011).

Leak detection programs are pursued at the initiative of the water retailers to meet their system management and business needs. For example, the City of Sunnyvale conducted a pilot program to install “Smart Meters” allowing real-time monitoring using web-based analysis tools of water use at parks and City Facilties. The meters allow water use to be optimized, and the data collected to be analyzed to identify leaks. The program identified one leak of 224 gallons per hour (Aquacue, 2011). Other approaches commonly used for leak detection include temporary or permanent installation of acoustic data loggers that can detect leaks based on the sound produced by a leaking pipe.

To address leaks detected on privately owned service connections, many cities have Water Waste Ordinances. These ordinances prohibit water waste due to unattended open hoses, broken sprinkler heads or irrigation lines, plumbing leaks, and excessive irrigation running off property or spraying on sidewalks or gutters. Upon detecting a leak or violation, the party who owns the leaking pipe or irrigation system is given notice and a timeframe to correct the problem.

Water retailers also have capital improvement plans to periodically replace aging infrastructure. While leak detection programs help to locate and eliminate some system leaks, pipeline replacement with new materials installed using superior construction methods go much further to mitigating salt and nitrate loading from system losses.

The District operates 140 miles of pipelines for treated and untreated water. The District’s Leak Detection Program includes continuous 24 hour monitoring of meters on all major conveyance facilities, daily flow records, monthly pipeline inspections, and water balances. Meters are calibrated regularly as part of the District’s Preventative Maintenance Program. Average summertime raw water conveyance through District pipelines is approximately 200 million gallons per day. Flows in major facilities are monitored continuously with a SCADA system at the District's Operations Center and at each of the District's water treatment plants. Technicians and operators perform daily inspections and record metered and gaged flows daily to verify system integrity. Each month the right of way in which facilities are buried is inspected by helicopter for signs of leakage. An overall water balance and a treated water balance is conducted monthly to establish distribution and to identify possible meter problems or leakage. The District operates a facility for meter testing where smaller meters up to 24 inches are tested based upon volume or time period following AWWA standards, larger meters are periodically tested using volumetric methods where feasible, and all meters are calibrated to manufacturer's specifications regularly as part of the District's preventative maintenance program.

For the 2015 Urban Water Management Plan, the California Department of Water Resources is considering several amendments to plan reporting requirements. An Independent Technical Panel on Demand Management Measures released a public draft report to the legislature on Urban Water Management Plan Demand Management Measures Reporting and Requirements (DWR, 2013). The report notes that substantial system losses are commonplace, and recommends that for the 2015 Urban Water Management Plan update, water utilities quantify their distribution system water losses a minimum period of one year prior to 2015. For all subsequent UWMP updates, water utilities would report the distribution system water loss for each of the five years preceding the plan update. If these recommendations are adopted, the method for quantifying the distribution system water loss would be reported in accordance with a standardized worksheet based on the water system balance methodology (water audit software) developed by the American Water Works Association. Several of the water retailers in the Santa Clara Plain using SFPUC Hetch Hetchy water are already carrying out loss reporting by this standard following best management practices promoted by the California Urban Water Conservation Council.[32]

A-4.1.4.8 Managing Swimming Pool Water

Swimming pools must be drained occasionally to allow pool maintenance. Pool water has elevated chlorine, which converts to chloride and can contribute to salt loading. To prevent discharge to creeks, ordinances and public information campaigns guide the public to discharge to sewer cleanouts instead of storm drains. Because most creeks also recharge groundwater, and sewer lines transmit their contents with only minor losses, mandating sewer line discharge of pool water and prohibiting storm drain discharge of pool water will control and reduce salt loading to groundwater. SCVURPPP has prepared educational brochures to be placed in pool supply stores and community centers. Many city ordinances expressly prohibit the discharge of chlorinated pool water to storm drains. These outreach programs and controls are particularly important in view of the trend toward saltwater swimming pools and chlorine free pool systems that rely on copper and silver biocides and algaecides.

A-4.1.4.9 Water Softener Technology Improvements

Water softeners that require dosing with salt for regeneration contribute substantial amounts of salt to wastewater, which in turn contributes to higher TDS in recycled water. Most water softeners are ion-exchange resin bed systems. Water softener resin beds exchange sodium or potassium on the resin for magnesium and calcium in the treated water, thereby reducing water hardness. The ongoing exchange increases the total sodium in the wastewater from businesses and homes that use water softeners. Water softening resins use sodium chloride brines for regeneration. The quantity and rate of addition of salt to water softening systems can be used to predict the total loading of salt to the sewer system. Reducing salt use by water softeners is a strategy employed to control the salinity of recycled water. Timer-based water softeners are regenerated twice as often as demand-initiated regenerations, and therefore use twice as much salt. Substituting potassium for sodium can also improve the quality of recycled water, increasing its suitability for landscape irrigation however, the TDS contribution from regenerations would not change signficantly.

Rebate programs to motivate replacement of timer-based water softener regeneration with demand-initiated regeneration are effective at lowering both salt discharge to the sewer and total water use. In 2003 and 2004, the District conducted a pilot program to issue rebates to residents who upgrade their water softeners to more efficient models. The pilot program issued rebates for 400 water softeners, saving an estimated 1.2 million gallons per year, and reducing salt discharge by approximately 120 tons per year (SCVWD, 2006).

A survey of Santa Clara County residential water use in 2004 found that 17% (± 3.6%) of the 410 single-family residences canvassed and 3% (± 2.3%) of the 187 multi-family residences canvassed used water softeners. The survey identified 71% of single-family residences using self-regenerating water softeners and 40% of multi-family residences using self-regenerating water softeners. Extrapolated over the many single-family and multi-family residences overlying

[32] http://www.cuwcc.org/resource-center/resource-center.aspx

the Santa Clara Plain, there is a large number of water softeners in use, representing a significant potential for reducing wastewater influent salinity content, as enumerated in Table 48. On average, each water softener dischages about 3 pounds salt per day to the sewer (SCVWD, 2006).

The City of San Jose commissioned the *South Bay Water Recycling Salinity Study* to assess salt discharges to the sanitary sewer (RMC, 2011). The study included:

- Sample collection (composite samples) and laboratory analysis of key industrial dischargers with high flows and/or suspected high salinity discharges.
- Continuous conductivity monitoring of the influent flows at the WPCP for a one month period.
- Continuous conductivity and flow monitoring (in the collection system) of representative residential and commercial sites around the tributary area to better understand residential consumptive use, residential water softener use, and the commercial contribution of key commercial categories. Conductivity monitors were installed for a one week period at each site.
- Hourly composite sample collection and laboratory analysis of TDS at a key pump station in Alviso, using a 24-hour sample collector. Hourly samples were collected for a four day period at the site.

The continuous monitoring of wastewater TDS determined that about 70 mg/L of wastewater TDS is contributed by water softener discharges, as depicted in Figure 46 (RMC, 2011). The data show periodic spikes in wastewater TDS concentration which reflect discharges from timer-based water softener regeneration,

The 2011 South Bay Water Recycling Salinity Study also estimated the total salt discharges to sewers from self-regenerating water softeners. The estimate used three approaches:

- Alternative 1: Water Softener Load Based on Survey of Bags of Salt Used Per Month.
- Alternative 2: Water Softener Additions Estimated from Collection System Monitoring.
- Alternative 3: Water Softener Worksheet Estimate of 35.3 mg/l TDS added area wide.

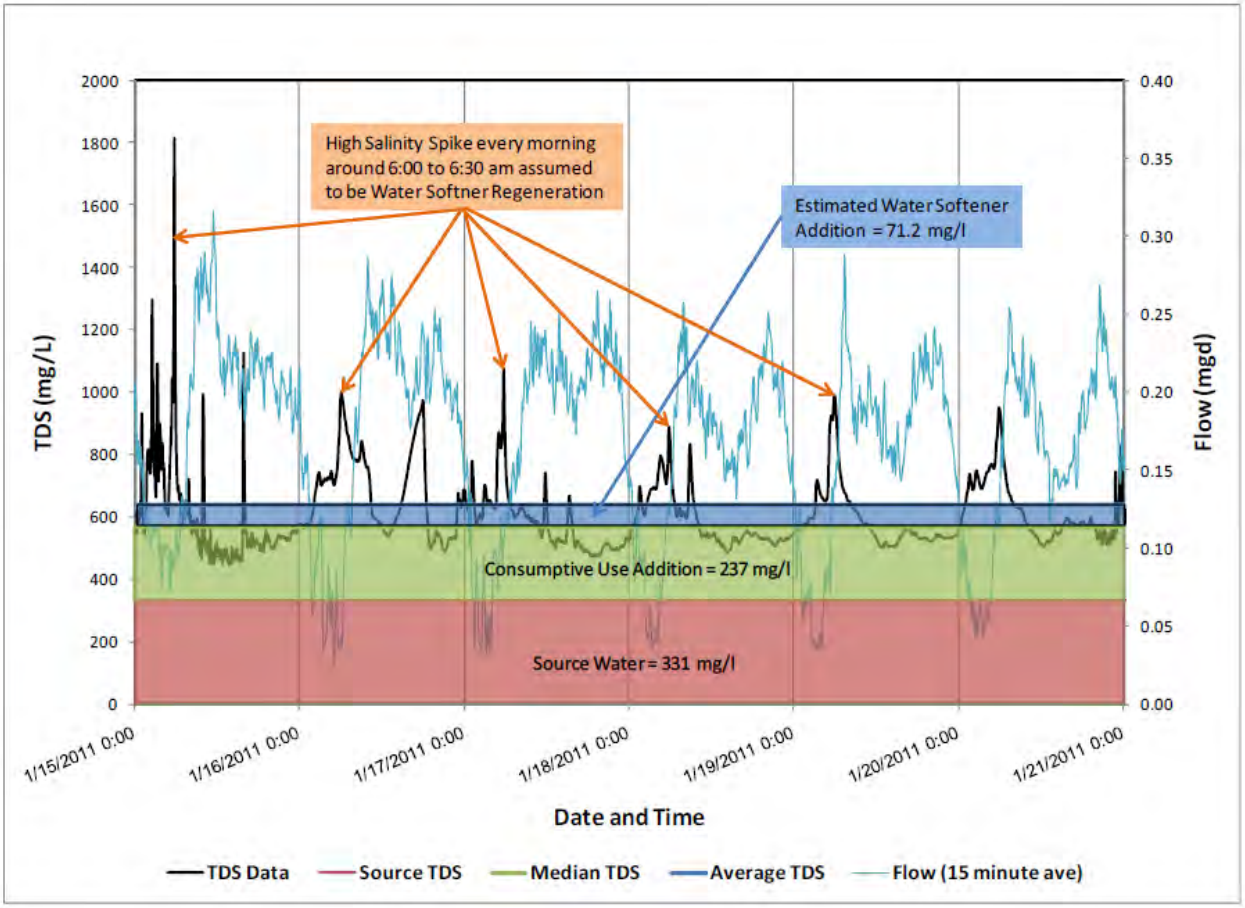


Figure 46- Interpretation of Continuous Wastewater TDS Monitoring Data (RMC, 2011)

The salt discharge estimates from the three methods were integrated with the District's 2004 survey of water softener use. In conjunction with housing metrics (i.e., single family and multifamily dwelling units) for the City, an estimated 10% of San Jose households in the tributary area are assumed to have self regenerating water softeners (RMC, 2011). The estimate based on survey data for salt use varies substantially from the estimates based on collection system monitoring data and on the water softener worksheet basis:

Table 47 – Estimates of Water Softener Discharge in SJ-SC WPCP Tributary Area

Method for Estimating Water Softener Discharge to Sewer	Salt Added in SJ-SC WPCP Tributary Area (as TDS)
1. Water Softener Load Based on Survey of Bags of Salt Used Per Month	22,200 tons/yr
2. Water Softener Additions Estimated from Collection System Monitoring	4,200 tons/yr
3. Water Softener Worksheet Estimate of 35.3 mg/l TDS added area wide	4,400 tons/yr

Data from RMC 2011. Estimates were carried across 410,546 homes.

The confidence level in all three estimates is low due to the variability of source water quality and numerous variables that impact water softener regeneration however, methods 2 and 3 are in relatively close agreement. The San José-Santa Clara Regional Wastewater Facility (SJ-SC RWF) tributary area covers about three quarters of the area of the Santa Clara Plain. Applying these assumptions for all the households within incorporated cities (and presumably on sewer) for the enitire Santa Clara Plain, gives the following results:

Table 48 – Estimates of Water Softener Discharge in Tributary Areas for All 3 POTWs

Method for Estimating Water Softener Discharge to Sewer	Salt Added in SJ-SC WPCP, Sunnyvale WPCP, and Palo Alto RWQCP Tributary Areas
1. Water Softener Additions Estimated from Collection System Monitoring	5,610 tons/yr
2. Water Softener Worksheet Estimate of 35.3 mg/l TDS added area wide	5,880 tons/yr

Based on 548,412 households (US Census 2010 – by city) exclusive of homes on sewer in the unincorporated county areas. This estimate may be in error where homes inside city limits are on septic or where homes in the unincorporated area are connected to sewers.

New technology for salt free water softening using physical, rather than chemical methods is now commercially available. Electromagnetic and electrically-induced precipitation devices can reduce scale formation by approximately 50 percent. Another approach called template-assisted crystallization reduces scale formation by greater than 90 percent. While none of the municipalities in Santa Clara County have prohibited conventional water softeners, some communities such as Santa Clarita Valley in southern California have already banned the use of ion exchange water softeners to improve wastewater quality for water reuse applications. The development of viable, salt free alternatives is a critical step toward eliminating brine discharges to wastewater. A few of the commercially available salt free water softeners are listed here:[33]

- Pelican NaturSoft
- Next Filtration Technology – nextScaleStop
- LifeSource Water System – ScaleSolver
- NuvoH20 – Home Salt-Free Water Softener
- Aquasana SimplySoft
- Eddy Electronic Descaler
- AQUA REX
- AQUA EWP
- BIOSTAT2000

Industries also use water softeners and reverse osmosis systems to condition water for various industrial applications. Reverse osmosis systems can also be a source of salinity in wastewater because 15 to 20% of the water treated is rejected to the sewer, bearing salts at five to seven times the initial TDS of the source water. Similarly, some cooling towers used in factories and

[33] No commercial product endorsement is implied. The Santa Clara Valley Water District has not tested these systems and cannot recommend one system over another. Other systems not listed here may be equally effective.

other facilities discharge evapo-concentrated wastewater that may carry as much as seven times the source water salinity content to the sewer.

The 2011 South Bay Water Recycling Salinity Study estimated industrial salt discharge to sewers using data from the 2007 US Economic Census to determine the number of each of these commercial businesses that are located in the tributary area. Water use data from each type of business was obtained from the 2006 City of Santa Clara Sewer Capacity Analysis to estimate average commercial sewer flows by industry type. TDS values for each of the types of commercial businesses were added from 2011 sewer monitoring data, if available, or from the report, "Characterizing and Managing Salinity Loadings in Reclaimed Water Systems" (WateReuse, 2006).

Several city ordinances include provisions limiting the discharge of salt to the sewer. For example, the City of Mountain View's City Code (§35.33.13.3) requires that the average TDS of discharges to the sewer not exceed 5,000 mg/L, and the maximum TDS not exceed 10,000 mg/L. Industrial pretreatment inspections may test for specific conductance or sample for TDS to check for compliance however, compliance testing is not usually conducted for residential dischargers.

A-4.2 Future Measures and Activities to Mitigate and Remove Salts and Nutrients

Future developments that are incorporated into long range plans or are under consideration can change the S/N balance in the Santa Clara Groundwater Subbasin. Over the 25-year planning horizon for SNMP, it is likely that some plans and forecasts will not materialize, while other developments may occur that have not yet been anticipated. This section examines the potential impacts of planned and foreseeable changes to the S/N balance in the Santa Clara Groundwater Subbasin.

A-4.2.1 Advanced Treatment of Recycled Water

Recycled water produced at the South Bay Water Recycling, Sunnyvale WPCP, and Palo Alto RWQCP has TDS ranging from 725 to 865 mg/L. Construction of the Silicon Valley Advanced Water Purification Center (SVAWPC) adjacent to the SJ-SC RWF was completed in 2013, and the system began operating in March 2014. Plans are under consideration for additional treatment at both the Sunnyvale WPCP and the Palo Alto RWQCP, which will improve the quality of recycled water by lowering TDS.

A-4.2.1.1 Silicon Valley Advanced Water Purification Center

The SVAWPC is designed to treat tertiary treated recycled water to produce 8 million gallons per day of low-TDS water.[34] Salts are removed using micro-filtration and reverse osmosis, and pathogens are removed using ultraviolet light. The highly purified water produced at SVAWPC will have an average TDS concentration of around 40 milligrams per liter. The addition of this purified water to tertiary-treated recycled water from South Bay Water Recycling will reduce the TDS levels from the current average of 725 mg/L to 500 mg/L for irrigation, and to 50 mg/L or less for indirect potable reuse (augmenting managed aquifer recharge). The reduction in TDS from advanced treatment of recycled water for irrigation and indirect potable reuse is incorporated into the assimilative capacity projections presented in Section 3.3.5.3.

[34] The 8 MGD figure is the current capacity as constructed. Future capacity can be achieved by expanding SVAWPC with additional storage and treatment capacity. The SVAWPC facility was designed to accommodate future expansion.

One of the goals of the Water Supply Infrastructure Master Plan is to provide advanced treated recycled water for blending with local reservoir water to produce 20,000 AF/yr of indirect potable reuse (IPR) by 2030 (SCVWD, 2012). Using recycled water for IPR will replace the imported water currently used for some recharge ponds. Advanced treated water may be blended with local reservoir water or used directly, depending on the logistical constraints at the recharge facilities slated for future IPR. The quality of advanced treated water used for IPR will depend on several factors including operational capacity, availability of local reservoir water for blending, blending ratios, and the quality of advanced treated water produced at SVAWPC. The quality of IPR water recharged to groundwater can range from 40 mg/L to 500 mg/L TDS.

Advanced water purification provides another new opportunity for recycled water use as a raw water source for drinking water treatment. Advanced treated water is free of pathogens and has low dissolved solids. With modifications, constituents of emerging concern such as NDMA, 1,4-dioxane, and perfluorinated, compounds can also be removed. Advanced water purification is capable of producing high-quality water that consistently and reliably meets the California Department of Public Health Title 22 Drinking Water Standards. It is therefore a natural fit to integrate this high-quality, drought proof drinking water source into the District's drinking water treatment and treated water distribution system. Incorporation of advanced treated recycled water into drinking water treatment is referred to as Direct Potable Reuse (DPR). Planning for DPR adds operational flexibility to decrease reliance on imported water whose availability is subject to change in the event of prolonged drought, levee or pump failure, or seismic disruption.

For planning purposes, a 50:50 blend scenario was evaluated. A 50:50 blend of advanced treated water at 50 mg/L TDS and current sources of recharge (volume-weighted average TDS of 286 mg/L) will produce recharge water quality of 168 mg/L TDS. Table 49 presents the forecasted future assimilative capacity under this scenario.

Table 49 – Changes to Assimilative Capacity for the 50:50 Blend IPR Scenario

Scenario	2035 Santa Clara Plain TDS, mg/L	2035 Assimilative Capacity	Rate of TDS increase, mg/L/year
Baseline	456.8	43.2	1.23
TDS = 168 mg/L	456.0	44.0	1.20

A-4.2.1.2 Sunnyvale Recycled Water Improvements

The Sunnyvale WPCP produces tertiary-treated recycled water with a TDS of approximately 870 mg/L (TDS ranged from 771 to 965 mg/L between 2002 and 2011). Plans for additional treatment would reduce TDS to 760 mg/L in 2023, and increase the volume of recycled water produced for landscape irrigation. The future reduced TDS for recycled water produced at Sunnyvale WPCP is incorporated into the projections shown in Section 3.5.3.3.

A-4.2.1.3 Palo Alto Recycled Water Improvements

The Palo Alto RWQCP Clean Bay Pollution Prevention Plan describes a Phase III recycled water expansion project to add 5,500 AF/yr of recycled water irrigation by 2027. Up to 915 AF/yr additional expansion may occur in the current Phase II, which is not yet serving at full capacity. Changes to recycled water treatment are not planned within the 25-year planning horizon for SNMP however, Palo Alto's Long Range Facilities Master Plan mentions advanced treatment of recycled water using ultra-filtration and reverse-osmosis by 2050 (City of Palo Alto, 2012).

A-4.2.1.4 Dual Plumbing with Recycled Water

New developments present the opportunity to incorporate recycled water into household plumbing so that toilets are flushed using recycled water. Toilets use a minor portion of total indoor water use (10 – 20%), and only a small fraction of recycled water production is projected for indoor purposes (3%). The effect of indoor uses for recycled water is to conserve treated drinking water, which also increases the salinity of wastewater and in turn can increase the TDS concentration of tertiary-treated recycled water. Because the volumes in question are small (~ 1,400 AF/yr in 2035),[35] dual plumbing of recycled water was not incorporated into future loading analysis.

A-4.2.3 Wastewater Infrastructure Improvements

As discussed in Section 3.2.3.4 (Groundwater Infiltration into Sewer Lines), where sewer mains are buried below the water table, groundwater may flow under hydrostatic pressure into the sewers through defective joints, cracks, or other openings. The shallow groundwater condition where sewer lines are submerged is found near the bay, where groundwater is locally saline.

Infiltration of saline groundwater into sewer lines contributes a significant amount of salt to wastewater, and recycled water may have elevated TDS as a result. Projects to reduce intrusion of saline groundwater to sewer lines favor better quality recycled water.

One such project, funded and managed by the City of Mountain View, upgraded the Mountain View Trunk Line, which carries wastewater to the Palo Alto Regional Water Quality Control Plant and is located within an area of highly saline groundwater. The Mountain View Trunk Line was resleeved[36] in 2013, reducing TDS in recycled water from 950 to 775 mg/L. This trunk line contributes 31% of the 21.7 MGD total flow to the Palo Alto Regional Water Quality Plant. Additional capital improvements to wastewater infrastructure in Mountain View and Palo Alto are expected to achieve a reduction in recycled water TDS from the present 775 mg/L to 600 mg/L by 2022. Resleeving sewer mains will also result in a reduction in salt removal of 2,240 tons TDS per year. The reduction in salt loading from Palo Alto recycled water and the reduction in salt removal from saline intrusion into sewer lines are incorporated into the forecasts presented in Section 3.3.5.6.

In recent years, the City of Sunnyvale completed a major sewer trunk line rehabilitation project on Borregas Avenue, and the City of San Jose has been following a maintenance-driven schedule of sewer line repairs and replacements. To the extent that these improvements reduce intrusion of saline groundwater to sewer lines, a reduction of recycled water TDS will result.

The City of San Jose sanitary sewer system consists of approximately 2,250 miles of sewer mains ranging in diameter from 6 to 90 inches, and includes 16 pump stations. San Jose has identified potential improvements to recycled water quality from rehabilitating sewer mains where intrusion of saline groundwater occurs. The 2011 South Bay Water Recycling Salinity

---

[35] This volume equates to about 1.2 million gallons per day, which is less than 1% of the current wastewater treatment capacity at the SJ-SC WPCP, and a still smaller fraction of 2035 wastewater treatment capacity.
[36] Resleeving a pipe involves inserting a smaller diameter intact pipe inside a larger diameter defective pipe or inserting a flexible epoxy liner that is cured to form a rigid and durable pipe.

Study reports monitoring results for a site was selected in Alviso for hourly sampling of wastewater TDS over a 4-day period. The results show TDS ranged from 7,000 to more than 30,000 mg/L, and visible groundwater intrusion was observed in the course of the test. The total annual salt load from intrusion of saline groundwater at this single Alviso manhole, after subtracting source water quality and consumptive use salinity, was 1,250 tons per year (RMC, 2011). The City of San Jose's 2014-2018 Capital Improvement Plan identifies 17 major sewer improvement projects, including the Alviso section studied in 2011. The City plans to spend $2 million to upgrade sections of sewer mains in Alviso by mid 2016, which is also expected to eliminate significant salt addition to wastewater from intrusion of saline groundwater.

Stanford University also conducts routine video monitoring of campus sewer lines, and has an ongoing Capital Improvement Project to replace aging and deteriorating sewer pipes.

A-4.2.4 Managed Recharge Infrastructure Improvements

The District currently operates 393 acres of recharge ponds and 91 miles of controlled in-stream recharge. Water used for managed recharge comes from three sources: 1) imported water 2) local reservoirs and 3) stormwater runoff. As described in Sections 3.2.1.4 and 3.2.1.5, the volume-weighted average recharge water concentrations are 191 mg/L and 0.6 mg/L for TDS and nitrate in the Santa Clara Plain, and 238 mg/L and 0.36 mg/L for TDS and nitrate in Coyote Valley. Capital projects are underway to improve three diversion dams for recharge ponds in the Santa Clara Plain. As described in Table 38, the improvements will allow more flexible operations that will increase the number of days per year that flow in streams is partially diverted to fill recharge ponds. Replacing flashboard dams with inflatable dams allows quicker dam removal with less labor, so that the dams can remain in place longer before storm events and releases from upstream dams require dam removal. The estimated increased recharge capacity from these improvements at three diversion dams is 11,800 AF/yr (SCVWD, 2010). The projects will be completed in 2014, 2018, and 2020. However, the addition of recharge capacity does not directly translate into increased volume of groundwater recharge. If the subbasin is in a relatively full condition, recharge operations are typically scaled back. Similarly, recharge operations are typically scaled back when surface water supplies are limited.

In addition to new capacity from diversion dam improvement projects, the Water Supply and Infrastructure Master Plan identifies increased recharge capacity from constructing new recharge ponds in the western Santa Clara Plain. The yield from the new ponds is projected to be about 3,300 AF/yr. The recharge ponds could be located on the west side of the valley, along Saratoga Creek near Highway 85 (SCVWD, 2012). For planning purposes, we assume that on average, 20% of the increased capacity created by the dam diversion improvements, and 50% of new recharge facility capacity is used, i.e., the net additional recharge for determining loading is 4,000 AF/yr. We further assume that all of the additional recharge would be with local sources and not advanced treated recycled water. This increased recharge is incorporated into the projections in Section 3.3.5.2.

A-4.2.5 Imported Water Quality Improvements

As shown in Figure 47, water imported for treatment and/or distribution to retailers comprised about 182,000 AF in 2013, which is about 48% of the water used by retailers and other beneficial uses (SCVWD, 2013a)[37]. Even though imported water is of good quality with low

[37] Includes water used for banking outside Santa Clara County and Hetch Hetchy water from SFPUC, and excludes imported water used for recharge.

TDS in many years, any improvements to imported water quality will produce a significant reduction of overall loading. Imported water quality is controlled by conditions in the south Sacramento-San Joaquin Delta, where pumping stations convey runoff from the Sierra Nevada Mountains to the State Water Project and Central Valley Water Projects (SWP and CVP). The Bay-Delta Conservation Plan (BDCP) includes alternative water conveyance arrangements that could improve protection of sensitive fish species in the Delta and reliability of water supplies. The new conveyance facility would withdraw water from further north in the Delta, where salinity levels are lower than in the south Delta.

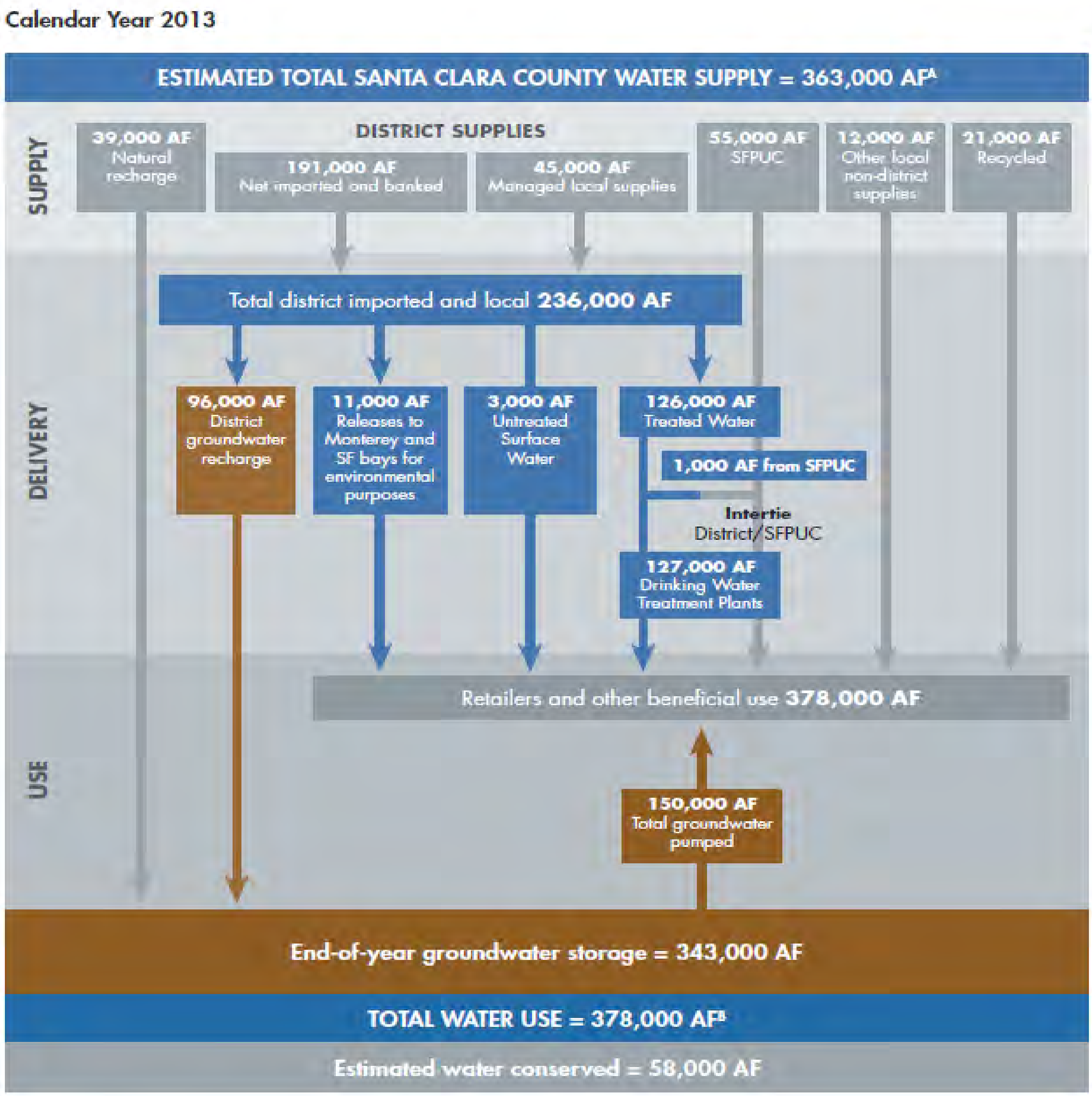


Figure 47 – 2013 Water Supply

A Includes net district and non-district surface water supplies and estimated rainfall recharge to groundwater basins.
B Includes municipal, industrial, agricultural, and environmental uses.

Operation of the proposed new north delta intakes is anticipated to decrease the average annual TDS of SWP and CVP Delta exports by about 22 percent under the BDCP proposed project when compared with the BDCP future “no action” scenario (SCVWD, 2013b). This would reduce the salt loading of deliveries to the District’s three drinking water treatment plants, and to the District’s managed groundwater recharge program. Current drinking water treatment plant processes cause minor increases in the salt content of the source water.[38] Any improvement in the salinity of source water translates to a reduction in salt loading from landscape irrigation and managed recharge as well as lower-TDS recycled water at plants without advanced treatment. Reducing the TDS of imported water by 22 percent would reduce the amount of salt loading to the basin through landscape irrigation, managed recharge, and conveyance losses by approximately 9,300 tons per year. Because the outcome of BDCP is not yet known, this reduction in salt loading was not incorporated into the future loading projections.

A-4.3 Future Assimilative Capacity Changes from Additional Groundwater Quality Management Programs and Other Changes

The majority of the water quality management strategies identified in Sections A-4.2 and A-4.3 are programs and measures that are already being carried out. The benefit of existing programs is incorporated into the projections for future assimilative capacity. Future changes that are not yet incorporated into the projection include the following categories described in Section A-4.2.

- As yet unidentified rehabilitation of sewer lines where intrusion of saline groundwater occurs (would improve quality of tertiary-treated recycled water).
- As yet unplanned conversion of brine-regenerated water softeners to no-salt alternatives.
- Imported water quality improvements.
- As yet unidentified changes to recycled water quality and quantity, e.g., Palo Alto adopting advanced treatment before 2050.

The effect that these changes may have on future assimilative capacity is difficult to estimate quantitatively due to the lack of detailed information on key parameters. However, a qualitative assessment can be made, with a comparison of which future measures will lead to larger or smaller changes in future assimilative capacity. A qualitative comparison of possible future scenarios is shown in Table 49.

[38] Drinking water treatment disinfects imported surface water and removes suspended solids, but is not designed to remove salt. The treatment processes used to disinfect the water and remove natural organic matter add salt to treated water. The 10-year average increase of median TDS in treated water compared to raw water at Penitencia, Santa Teresa, and Rinconada Water Treatment Plants is 7.8%, 4.1%, and 10.3%, respectively.

Table 50 – Comparison of Qualitative Changes to Future Assimilative Capacity from Unquantified Potential Changes to Future TDS Loading

Prospective Change	Change in Future Loading from		Change in Future Assimilative Capacity
Sewer Line Rehabilitation to mitigate infiltration of saline groundwater	Recycled Water	↓	↑ Decreased recycled water loading = increased assimilative capacity
Sewer Line Rehabilitation to mitigate exfiltration	Drainage Losses	↓	↑ Decreased loading = increased assimilative capacity
Lower-TDS Recycled Water Irrigation (i.e., <500 mg/L)	Salt Loading	↓	↑ Decreased loading = increased assimilative capacity
Water Softener Conversion to No-Salt Alternatives	Recycled Water TDS Drainage Losses	↓ ↓	↑ Decreased loading = increased assimilative capacity
Improved Quality of Imported Water	Outdoor Irrigation Managed Recharge Conveyance Losses Recycled Water	↓ ↓ ↓ ↓	↑ Decreased loading = increased assimilative capacity

Size of arrows indicate relative magnitude of change

Not included in Table 49 is any change to rainfall and evapotranspiration that may occur due to climate changes such as prolonged drought or prolonged periods of cooler and wetter conditions. Like many other hydrologic forecasts, future projections for this SNMP make the assumption of stationarity, i.e., that the natural systems controlling natural recharge fluctuate within an unchanging envelope of variability. The stationarity assumption is widely considered to be inadequate for managing water resources, in view of anthropogenic changes in recent decades that influence hydrologic outcomes (Milly, et al., 2008). These anthropogenic changes did not influence earlier records of rainfall or other climate factors, so assuming that early climatic patterns will persist (assuming stationarity) may be ignoring a long-term or near-term shift in rainfall, temperature, evaporation, etc. The alternative is detailed stochastic modeling of hydrologic responses to future climate scenarios predicted by global-scale climate models, which are also limited by inherent uncertainty. It is beyond the scope of this SNMP to engage in "Monte Carlo" style conditional simulations of future salt-loading outcomes in response to prospective future hydrology scenarios.

APPENDIX 5

Groundwater Infiltration to Sanitary Sewers and Storm Drains

Groundwater Infiltration to Sanitary Sewers and Storm Drains

The magnitude of groundwater infiltration (GWI) to sanitary sewers can be estimated by several different methods. These include:

1. Applying estimates generated by sanitary system operators (SSOs).
2. Applying literature values for infiltration based on the diameter of the pipes within the areas where the water table is above the pipes.
3. Applying literature values for infiltration based on the number of acres or sewered areas within the zone of high groundwater (applies to sanitary sewers only).
4. Contrasting wet season and dry season baseline flows and subtracting estimated total wastewater based on per capita wastewater generation literature values and census data (applies to sanitary sewers only).

Estimates of GWI to storm drains were made using method 2. To increase confidence in the GWI estimate for sewers currently used in the District's flow model, estimation methods 2 and 3 above were carried out for sewers and compared. The results are shown in Table 51.

Sewer GWI Estimates Generated by Sanitary System Operators

The City of San Jose estimated GWI into the Santa Clara-San Jose (SJSC) sanitary sewer system in 1992. This estimate (5,600 AF/yr) has been used for the District's groundwater flow model and is about 4.5% of the 10-year median SJSC-WPCP flows in 2001-2010 (CH2M Hill, 1992). The same ratio was applied to the inflow volumes for the Palo Alto and Sunnyvale wastewater plants to arrive at a total estimated GWI into sewers of 7,520 AF/yr.

To determine the amount of salt removed by this GWI estimate, we applied the locally interpolated average TDS concentrations for groundwater in the shallow aquifer. The Coyote Valley is not served by a sanitary sewer system, so there is no salt and nitrate removal by this mechanism. The SSO estimate includes GWI within the zone of saline intrusion north of the 100 mg/L chloride contour, which was also excluded from the SNMP loading analysis. The value may therefore over-estimate the salt removal within the domain of the SNMP analysis.

Sewer GWI Estimates Using Literature Rates Based on Pipe Diameter

Typical sewer laterals are constructed at depths 4 feet for houses on slabs and 8 feet for houses with basements. Sewer mains are typically constructed 8 to 10 feet below ground.

Sewer mains are most commonly located beneath streets; hence, street maps are a suitable surrogate for sewers in the Santa Clara Plain. The distribution of sewer line materials, diameters, and ages from available sanitary system data was applied to the street surrogates for sewer lines in all areas subject to GWI. This approach excludes sewer laterals on private property, which are generally assumed to be above the water table. The portion of the sewer system residing in the area where depth to water was 10 feet or less was selected for the infiltration evaluation.[39] The following assumptions and approximations are made for estimating GWI in the zone with depth to water less than 10 feet (exclusive of the saline intrusion zone):

[39] Depth to water was mapped for the principal aquifer for the Fall of 2002. Spring depth to water is generally shallow so that the area with depth to water less than 10 feet is larger. To capture year-round infiltration and dry years, the

- The rate of GWI used, 100 gpimd,[40] represents the majority of the system and corresponds to the 65% of pipes older than 45 years (EPA, 1971).
- 1/3 of the area has year-round GWI.
- 2/3 of the area has GWI from December through April (150 days, or 41%).
- Roads classified as "Class 1" (e.g., freeways) are assumed not to represent locations of sewers.
- 95% of sewer pipes are made of vitrified clay pipe (VCP).
- The distribution of VCP diameter in all areas follows the general pattern for sanitary systems with available data:

6"	65%
8"	20%
10"	5%
12"	3%

- Pipes older than 45 years infiltrate at 10 times the estimated exfiltration rate.
- Pipes between 45 years and 25 years old infiltrate at 5 times the estimated exfiltration rate.
- Pipes between 25 years and 15 years old infiltrate at the same rate as assumed exfiltration.
- Pipes younger than 15 years old have no infiltration.
- The ~5% of sewers made of materials other than VCP (e.g., ductile iron pipe, PVC pipe, HDPE pipe, reinforced concrete pipe) may be larger in diameter but are generally less vulnerable to infiltration and are ignored for this analysis.

The result of combining these assumptions is shown in Table 51.

Sewer Line Infiltration Estimates Based on Area Methods

GWI into sewers is sometimes estimated based on acres of development. For example, the City of Santa Clara Sanitary System Management Plan uses design criteria of 1,000 gallons infiltration per acre per day (gpad) for construction north of Highway 101, and 750 gallons per acre per day for construction south of Highway 101 (City of Santa Clara, 2010).

Because it is difficult to predict GWI rates based on physical system data alone, estimates of GWI based on actual flow monitoring data are considered more reliable. The City of Santa Clara estimated GWI based on minimum flows during non-rainfall periods and during a wet weather flow monitoring period. Minimum flows typically occur at night or during early morning hours when base wastewater flows are lowest. GWI can also be estimated as the difference between average metered flows during non-rainfall periods and computed average base

---

Fall groundwater depths were used to estimate the portion of the system in which infiltration may occur. The principal aquifer is used as a surrogate for the water table however, that assumption may not be valid where there is a cone of depression or upward vertical gradients outside the artesian zone.

[10] gpimd = gallons per inch diameter per mile of sewer per day

wastewater flow. In either case, the resulting GWI is expressed on a unit basis (gpd/acre or gpad) by dividing by the sewered acreage of the monitored area. Typical GWI rates may range from 100 to over 1,000 gpad (City of Santa Clara, 2010). The assumed GWI for this SNMP is 250 gpad in areas with year-round infiltration, and 100 gpad in areas with infiltration occurring only from December through April. One-third of the area mapped in Fall 2002 as 0 to 10 ft depth to water is presumed to have year-round GWI, while two-thirds is presumed to have GWI from December through April.

The result of the area-based estimation method is included in Table 51, below.

Table 51 – Comparison of 3 Different Methods to Estimate Groundwater Infiltration to Sewers

	System Operator Estimate*	Literature Rates, Pipe Diameter Method**	Santa Clara Area Method
Groundwater Infiltration	7,520 AF/yr	2,930 AF/yr	3,500 AF/yr
TDS removed	6,550 tons/yr	2,520 tons/yr	3,130 tons/yr
Nitrate removed	56 tons/yr	28 tons/yr	16.2 tons/yr

* includes areas in zone of saline intrusion that are excluded from SNMP loading analysis.

**this method was selected for estimating GWI

The difference between the SSO estimate and the pipe diameter and area methods may be due to a combination of:

- The inclusion of areas excluded from SNMP analysis in the SSO estimate.
- Use of factors that may be too low (e.g., 100 gpidm instead of 150 or higher).
- Using Fall depth to groundwater contours instead of Spring. These choices are made to ensure that salt and nitrate removal by GWI is not over-estimated to avoid understating the long-term effects of salt and nitrate loading.

The area method may overstate the magnitude of GWI because land uses were not differentiated when selecting the area within the zone of shallow groundwater where sewer lines are submerged. Accordingly, the pipe diameter method was selected for estimating GWI.

Storm Drain Infiltration

Storm drains in both the Santa Clara Plain and the Coyote Valley may remove groundwater where they are submerged year-round or seasonally. To estimate the magnitude of groundwater infiltration into storm drains, an estimate of exfiltration was developed and the ten-fold infiltration estimation factor described in 3.3.1.10 was applied.

Sanitary sewer lines made of concrete typically have an exfiltration rate of less than 200 gallons per inch of internal diameter per mile of sewer over 24-hours (ASTM C 969). For this analysis, we assume that the rate is 100 gallons per inch of internal diameter per mile (gpidm) of sewer length over 24 hours. Applying this leakage rate to an average 3,000-ft reach of concrete storm sewer with a diameter of 60-inches, the rate of stormwater loss would be 4,380 gallons per day.

Storm sewers however, are not held to the tight leakage standards required of sanitary sewers so the rate of exfiltration could be greater.

For sanitary sewers, we assume that exfiltration is 10% of infiltration. Exfiltration usually occurs when the pipe is carrying less than total capacity and has lower pressure head driving the leakage. When a storm drain is submerged in groundwater, hydrostatic pressure drives groundwater into the pipe from all directions, resulting in a substantially higher flow of water into the storm drain.[41] For consistency, we also assume that groundwater infiltration into storm drains is 10-fold the rate of exfiltration.

The District has compiled GIS coverages of storm drain locations and lengths, and mapped the depth to groundwater (using Fall, 2002 as explained in 3.3.3.4). To estimate the length of storm drains that are submerged, the following simplifying assumptions are made:

- One-third of the storm drains within the mapped 0 to 10 feet depth to groundwater zone are submerged year-round.

- Two-thirds of the storm drains within the mapped 0 to 10 feet depth to groundwater zone are submerged seasonally, i.e., between December 1st and April 30th.

- The average diameter of all storm drains is 24 inches.

There are 371 miles of storm drains within the area mapped as 0 to 10 feet minimum depth to groundwater, exclusive of the “saline intrusion zone” where chloride exceeds 100 mg/L. The storm drains included in the groundwater infiltration estimate are shown in Figure 48. Applying the assumptions listed above, the 100 gpidm ASTM exfiltration factor, and the 10-fold infiltration assumption, the estimated annual groundwater infiltration to storm drains is 4,380 AF/yr. Using the volume-weighted average shallow groundwater concentration spatial distribution[42] for TDS, nitrate as nitrogen, and assigning concentrations to storm drain reaches, the annual salt and nitrate removal is estimated to be 3,200 and 46 tons per year, respectively.

---

[41] For example, the East Bay Municipal Utility District reports that during the rainy season, inflow and infiltration can lead to a 10-fold increase in the volume of wastewater that makes its way to EBMUD’s Main Wastewater Treatment Plant (EBMUD, 2013). Inflow refers to rainfall runoff entering sewers through manholes, while infiltration refers to movement of groundwater into storm drains that are positioned below the water table.
[42] See Section 3.4.2 for derivation of basin-wide volume-weighted average concentrations for the shallow and principal aquifers.

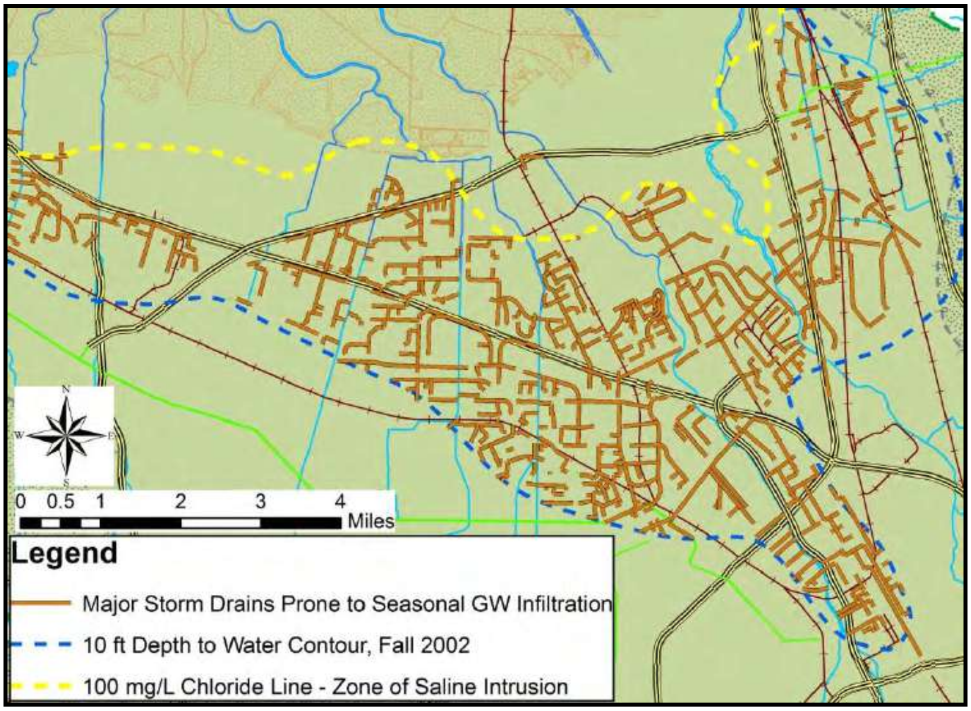


Figure 48 – Storm Drains Located in Zone of Minimum Depth to Groundwater Less than 10 Feet

NOTE: Zone of 10-foot depth to water approximated from elevations of groundwater pressure surface from principal aquifer mapped for Fall, 2002 and USGS land surface elevation contours. Storm Drain map may not reflect recent development in this area.

APPENDIX 6

San Francisco Bay Regional Water Quality Control Board Comments and District Responses to Comments

5750 Almaden Expressway, San Jose, CA 95118-3614 | (408) 265-2600 | www.valleywater.org

Santa Clara Valley Water District

May 15, 2015

Dr. Keith Roberson
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, 14th Floor
Oakland, CA 94612

Subject: Santa Clara Subbasin Salt and Nutrient Management Plan – Response to Regional Water Board and State Water Board Comments

Dear Dr. Roberson:

The Santa Clara Valley Water District (District) appreciates the Water Board's participation in the Salt and Nutrient Management Plan (SNMP) stakeholder process for the Santa Clara Subbasin. We received the Regional and State Water Boards' detailed and helpful comments on the Draft SNMP. This letter provides responses to your comments. The District has updated the SNMP based on comments received from the Water Board and basin stakeholders. The District has posted the updated report to our website, and will send you a hard copy for your reference. The District requests that the Water Board formally concur with the findings of the Santa Clara Subbasin SNMP.

Comments on Analysis Approach

1. *Please discuss the appropriateness of using the median as the best indicator of groundwater quality. A graph of the ranked median concentration by well from lowest to highest would be a helpful way to summarize the data and quickly see clusters and outliers.*

   Response: There is significant range in the groundwater quality data, which are not normally distributed due to a wide range of values for some parameters and low- and high-concentration outliers. As it represents the 50th percentile, or middle of the sample population, the median is the most robust value to represent the basin-wide groundwater quality, and is superior to the mean. The District reports median values for water quality data in the Annual Groundwater Report, which will also be used for SNMP monitoring reporting. For consistency, the District completed the SNMP analysis using median concentrations; however, basin-wide volume-weighted averages were used to assess assimilative capacity. A chart of ranked median concentration by well to show clusters and outliers would not retain the spatial component of the data, as not all wells monitor the same groundwater features (e.g. shallow vs. principal aquifer, Coyote Valley vs. Santa Clara Plain, recharge zone vs. confined zone, land use variation, etc.). A justification for using the median concentration was added to the SNMP.

2. *For the various salt and nutrient loading sources, was there any attempt to model the effects of loading based on where within the basin it occurs? For example, section*

3.3.1.8 discusses 6,725 tons of salt loading due to landscape irrigation with 6,640 acre-feet of recycled water. Was it assumed that all the salt load instantaneously mixes throughout the basin?

Response: Mixing assumptions and rationale are described in Section 3.4.4.2. To simplify calculations, salts and nutrients are assumed to mix completely throughout the saturated volume of the basin in the same year they are added. Due to this simplifying assumption, the geographic location of loading sources did not need to be modeled.

3. *Was salt and nitrate loading from septic systems accounted for? If so how? Is there a spatial component to it?*

   Response: Yes, loading from septic systems was included in the analysis under the loading category of "drainage losses" – see Sections 3.3.1.10, 3.4.5.4., and Figure 3-13a and b. The District added Figure 3-5 to show the general locations of septic tanks in the Santa Clara Subbasin.

4. *Section 3.4.2 (page 65) – Is there a particular reason that the volume-weighted average concentrations for the Santa Clara Plain and Coyote Valley were based on data from 2006-2010 when there appears to be ample data available for the period 2002 – 2012 as presented in Tables 2-2, 2-3, and 2-5?*

   Response: The District updated the volume-weighted average data in Tables 3-21 and 3-22 with the most recent five years of data available (2008–2012).

5. *What is the rationale for combining the shallow and principal aquifer zones of the Santa Clara Plain as one for net TDS and nitrate loading evaluation such as in Figures 3-13 and 3-13b? Figure 3-13 shows approximately a 30 mg/L TDS increase for these zones over 25 years based on the various loading assumptions. That's about a 7% increase or use of assimilative capacity. Could this be determined for each aquifer zone independently?*

   Response: The Recycled Water Policy calls for comparison of basin assimilative capacity to Basin Plan water quality objectives. Because the Basin Plan does not distinguish between shallow and principal aquifers, a combined assimilative capacity approach was used. The SNMP findings indicate there is available assimilative capacity for both salts and nutrients, even under the conservative assumption of instantaneous, basin-wide mixing. While it is possible to assess available assimilative capacity separately for the shallow and principal aquifers with more time and effort, the results still need to be added to predict total consumption of assimilative capacity, which is the metric upon which the Recycled Water Policy is focused.

6. *For the Santa Clara Plain it appears that the largest increase in TDS loading is due to projected recycled water use over the next 25 years. Currently 6,600 acre-feet of*

recycled water is applied as landscape irrigation for a TDS loading of 6,700 tons. That's about 8% of the total TDS loading to the sub-basin. Over the next 25 years, recycled water use could increase to 16,000 acre-feet (Table 3-27) for a TDS loading of nearly 25,000 tons (Figure 3-9a). What percentage of total TDS loading would that constitute in 25 years?

Response: In 2035, the percentage of TDS loading contributed by recycled water is about 19% as shown in Table 3-29 (percentage is the ratio of TDS assimilative capacity consumed by recycled water to the total for 2035). However, to gage cumulative consumption of assimilative capacity over the 25 year evaluation period, the yearly TDS loading from all sources is divided by the basin volume and a revised basin TDS concentration is calculated. By 2035, 41% of available basin assimilative capacity is projected to be consumed by TDS loading from all sources, of which 6.2% is due to loading from recycled water irrigation in the Santa Clara Plain (see Table 3-29).

7. *Would the greatest loadings still be due to the managed recharge and landscape irrigation using non-recycled water sources?*

   Response: Yes. Bear in mind that the loading charts (e.g., Figures 3-9 through 3-13) show only half the balance, before accounting for the removal terms. Of the 41% assimilative capacity consumed, the portion consumed by recycled water is 15%, while the portion consumed by managed recharge and irrigation with distributed water is 73%. These percentages are derived from the ratios of the total assimilative capacity consumption in Table 3-29.

8. *The references for the literature used to estimate the nitrate attenuation factor seem to be pretty old. A better explanation of how the attenuation factors were arrived at would be a good addition.*

   Response: Most of the literature cited was published in the last three decades (and some in the last few years); the information used is still valid and relevant. The nitrate leaching estimate of 35% used in the SNMP is in reasonable agreement with a median value for leaching of applied nitrogen used in the 2012 UC Davis study on nitrogen sources and loading prepared for the State Water Board (30.2 percent).

9. *Some justification should be provided for using TDS as the sole indicator of salinity.*

   Response: As described in Section 2.5.1: "TDS is a comprehensive measure of all salts in groundwater, and is therefore used as the indicator parameter for salts in this SNMP. Tracking individual salts such as sodium, magnesium, or calcium is less informative for salt management because these solutes are subject to cation exchange with clays and other minerals, which may decrease concentrations of one solute while increasing another. The relative proportions of calcium, sodium or magnesium may change from geochemical reactions, but the TDS stays relatively constant and is therefore a more robust measure of salts in groundwater. Limitations to TDS measurement accuracy can make comparison of TDS analyzed by different methods difficult. However, the consistent application of a single method employed for analysis of District samples makes TDS the best overall indicator of salt in groundwater for this SNMP."

10. *The Santa Clara Plain model was not calibrated to include a module for gaining reaches of streams. Some explanation or correction factor could be considered.*

    Response: Gaining reaches of streams are expected to occur in tidal reaches, which makes it difficult to gage streams with sufficient accuracy to discern volumes of groundwater discharge. Resolution of the water balance for the District's Santa Clara Plain flow model is made by adjusting other lumped terms from which gaining reaches of streams cannot be separated. Because the discharge of groundwater and associated salts and nutrients to streams is not included in the SNMP analysis, the estimates for net loading are conservative in terms of basin protection. In spite of loading estimates being biased high, projections show that the Santa Clara Subbasin does not accumulate enough salt in 25 years to exceed Basin Plan Water Quality Objectives.

11. *As far as assimilative capacity and baseline, these should be estimated with vertical boundaries (shallow and principal aquifers) because the loading happens in one or the other aquifer (usually the shallow) and groundwater does not mix the way they are assuming. The statement that simplifying assumptions have the effect of overstating the rate of salt accumulation is only partially true, because the rate of salt accumulation in the shallow aquifer is being underestimated. However, because the major sources of anticipated loading are irrigation and managed recharge, this may not be as critical because these sources lend themselves to potential controls.*

    Response: This SNMP was prepared using the groundwater basin boundaries described in the Basin Plan, which does not distinguish between the shallow and principal aquifers when considering beneficial uses. The best opportunity to curtail salt and nitrate loading in the subbasin is from conservation of water used for outdoor irrigation. Due to the extreme drought, the District has offered residents of Santa Clara County rebates for outdoor water conservation measures. Since 2013, these rebate programs have converted more than 1,380,000 square feet of residential lawns to drought-resistant landscaping and paid for smart irrigation controls, permanently reducing loading from irrigation. If implemented, measures in the Bay Delta Conservation Plan may also reduce the salinity of imported water, thereby decreasing loading from landscape irrigation using non-recycled water, and from managed recharge.

12. *Regarding potential controls, the document should include some implementation plan to lower salt loading in the Santa Clara Plain because the use of assimilative capacity in this basin is predicted to increase. This will be the main gist of the SNMP and will figure prominently in the decision to adopt a Basin Plan Amendment.*

    Response: The District has provided an inventory of ongoing programs and projects that limit or reduce salt and nutrient loading (Appendix 4). However, the conclusion of the SNMP analysis, which relied on conservative assumptions, is that Basin Plan Water Quality Objectives will not be exceeded within the 25 year planning horizon. Per the

Recycled Water Policy, a formal implementation plan is therefore not required (see Section 6.b.(2)). The Recycled Water Policy allows consumption of some assimilative capacity to enhance water supply reliability by supporting recycled water projects, particularly those that incorporate advanced treatment.

Comments on Document Clarity (Text, Tables, Figures)

13. *The resolution of Figure 2-2 is poor and could be improved to show the demarcation between the shallow and principal aquifers. According to footnote 1 the boundary is at the 150 foot depth.*

    Response: This Figure has been replaced with a better quality graphic. Additional lines and explanatory text were added to indicate that the approximate location of the 150 foot boundary between shallow and principal aquifer, and to advise that this demarcation is conceptual and not a clear geologic boundary that is consistently present in boring logs at all locations.

14. *On page 20 (section 2.1.1) there is mention of the Evergreen area and the zone of saline intrusion. No figures are referenced but Figure 3-3 does show the zone of saline intrusion. Please consider referencing Figure 3-3 here and also showing the zone of saline intrusion on Figures 2-13 and 2-14. Also, is the Evergreen area shown on any figure? Is the source of elevated TDS and/or nitrate in that area discussed somewhere?*

    Response: The District adjusted Figure 3-3 to show the location of the Evergreen area and to indicate the zone of saline intrusion. The source of elevated TDS is described in Section 3.4.1.

15. *Figure 3-3 shows 4 wells in the zone of saline intrusion. Are there additional monitoring wells in this area?*

    Response: There are 15 monitoring wells shown on Figure 4-1 that are used to measure changes in groundwater salinity near the bay. Four of these wells have consistently measured > 100 mg/L chloride.

16. *Division of the Santa Clara Plain into shallow and principal aquifers is only mentioned as a footnote to table 2-2. Better discussion of this division is warranted, especially because Figure 2-2 does not seem to support it. Similarly, the decision not to separate Coyote Valley into shallow and principal aquifers should be addressed. (e.g. no major aquitard etc.)*

    Response: Figure 2-2 was revised to make the shallow/principal designation more clear, and language was added language to Section 2.1.1 to explain this designation. For the Coyote Valley, text was edited to explain why it is treated as a single, unconfined aquifer.

17. *On page 23, I believe the figure being referenced should be 2-5. If so, I don't really see the correlation between the statement that high production wells are in the southern portion of Coyote Valley in that figure. Maybe it's a drafting issue?*

    Response: Yes, it was a drafting issue. Pumping in the Llagas Subbasin was shown, which obscured production wells at the southern end of Coyote Valley. Figure 2-5 was revised to show only Santa Clara Plain and Coyote Valley pumping.

18. *There is a lack of information regarding the modeling software used. What is the "District groundwater flow model" (p.27)? What are the SCPMOD and CVMOD models? (p.38). Are they MODFLOW with associated interfaces?*

    Response: A footnote was added to Section 2.1.5 with a brief explanation of the District's MODFLOW models.

19. *Both the TDS and Nitrate sections of Table 2-8 are identical. This would be quite a coincidence and may be a cut and paste error.*

    Response: This was a cut and paste error; the table has been corrected.

20. *The text in the Nitrate Trends section on page 31 does not match the associated table and does not appear to match Figures 2-13 and 2-14.*

    Response: The incorrect language was for the entire county, including the Llagas Subbasin. The wording and counts in the nitrate trends section have been updated, and the text was re-written so that the sections are now parallel. Note that in the PDF copy on the District website, the page number referenced is now 33.

21. *There are a number of tables listing values that do not align with the corresponding values shown in Table 3-20.*

    Response: The disparity between values in individual loading category tables and the summary table were primarily the result of rounding. Each table was checked and updated to confirm agreement with the underlying calculations and the summary table, which is numbered 3-19 in the PDF version on the District's website.

22. *Is basin inflow loading included with managed recharge? The numbers seem to indicate this but I'm not sure it's advisable.*

    Response: Basin inflow was inadvertently omitted from Table 3-20 (now Table 3-19 in the online PDF version). It has been added in and the percentages in Table 3-19 have been adjusted.

The District appreciates the Water Boards' participation in the development of the Santa Clara Subbasin SNMP as well as the detailed review of the Draft SNMP. If these responses require any further resolution, please contact me at (408) 630-2051 or Vanessa De La Piedra at (408) 630-2788.

Sincerely,

Thomas Mohr, P.G., H.G.
Senior Hydrogeologist

cc: Alec Naugle, San Francisco Bay Water Board
Diane Barclay, State Water Board
V. De La Piedra, G. Hall

5750 Almaden Expressway, San Jose, CA 95118-3614 | (408) 265-2600 | www.valleywater.org

Santa Clara Valley Water District

Sent via electronic mail, no hardcopy to follow

November 18, 2015

Ms. Dyan Whyte
Assistant Executive Officer
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Subject: Response to San Francisco Bay Regional Water Quality Control Board Comments on Santa Clara Subbasin Salt and Nutrient Management Plan

Dear Ms. Whyte:

The Santa Clara Valley Water District (District) appreciates the San Francisco Bay Regional Water Quality Control Board's (Water Board) detailed supplemental review of the Santa Clara Subbasin Salt and Nutrient Management Plan (SNMP) and related comments dated September 1, 2015. We have conferred with Dr. Roberson and Mr. Naugle, and determined that the best format for responding to these comments will be as an SNMP Appendix that includes Water Board comments and District responses.

As requested in your September 1, 2015, letter, we are providing additional figures and explanations to delineate specific locations where Basin Plan Water Quality Objectives for salts and nutrients are exceeded. We are eager to finalize the Santa Clara Subbasin SNMP and will work with your staff to confirm these responses have fully addressed their comments. We are targeting District Board of Directors adoption of the SNMP in January 2016, after which we will seek a Water Board Resolution of Concurrence. If you have any questions regarding our responses, please call Mr. Thomas Mohr at (408) 630-2051, or me at (408) 630-2788.

Sincerely,

Vanessa De La Piedra, P.E.
Groundwater Monitoring and Analysis Unit Manager

Attachments:
1. September 1, 2015, Comment Letter From the San Francisco Bay Regional Water Quality Control Board
2. Santa Clara Valley Water District Response to Comments

cc/att: Mr. Keith Roberson, San Francisco Bay Regional Water Quality Control Board
Mr. Alec Naugle, San Francisco Bay Regional Water Quality Control Board
T. Mohr, G. Hall, J. Fiedler

San Francisco Bay Regional Water Quality Control Board

September 1, 2015

Sent via electronic mail: No hardcopy to follow

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3686

Attn: Mr. Thomas Mohr
Email: tmohr@valleywater.org

Subject: **Comments on the Revised Salt and Nutrient Management Plan (SNMP) for the Santa Clara Subbasin, dated November 2014**

Dear Mr. Mohr:

The revised SNMP provides a solid foundation for guiding decision making, and we appreciate the District's efforts to address our comments on the initial July 2014 draft. In order for the Water Board to endorse the SNMP, we require additional information about the location and distribution of existing salt and nutrient concentrations in the Santa Clara Plain and Coyote Valley. While we recognize that our Basin Plan does not explicitly distinguish between the shallow and deep aquifers of the Santa Clara Plain, SNMPs must provide us with a better understanding of any localized areas (shallow and deep) where elevated salt and nutrient concentrations exist. This information is critical for the Water Board to effectively evaluate the need for source control measures in the context of waste discharge permitting related to salt and nutrient source discharges (e.g., OWTS and recycled water use). Just as we must understand the location of solvent and petroleum contaminants within shallow and deep aquifers, we must also understand the specific locations of salt and nutrient problems. Attached are additional suggestions for improving the SNMP and our remaining outstanding questions.

If you have any questions, please feel free to contact me (dwhyte@waterboards.ca.gov, 510-622-2441) or Keith Roberson (kroberson@waterboards.ca.gov 510-622-2404).

Sincerely,

Dyan Whyte
Assistant Executive Officer

SF Bay Regional Water Board staff questions and comments on the Revised Salt and Nutrient Management Plan (SNMP) for the Santa Clara Subbasin, dated November 2014

1. Executive Summary
   a. Consider including a brief summary of the District's role (or lack thereof) with managing fertilizer use and septic system regulation.
2. Introduction
   a. Section 1.1 – Consider including a brief summary of the current and projected recycled water use here. It's not until section 3.3.1.8 where the first quantification recycled water use is mentioned (6,6,40 AF), and that is the current use only. Table 3-23 indicates projected recycled water use by 2035 will be 26,500 AF.
   b. Section 1.2 - Consider including a brief summary of the District's plans for recharge/use of stormwater as per the State Board's Recycled Water Policy.
3. Chapter 2: Groundwater Subbasin Characterization
   a. The locations and spatial distribution of wells with elevated TDS and nitrate in the shallow and deep aquifers of the Santa Clara Plain and the Coyote Valley should be provided on figures (see comment s d and e below for further detail).
   b. While Figures 2-13 and 2-14 show the locations of wells with increasing TDS and nitrate trends, concentrations do not need to be increasing to pose a problem if they already exceed WQOs. The locations of wells where TDS and nitrate concentrations are currently elevated above WQOs should be provided (see comment s d and e below for further detail).
   c. Section 2.5.2 - The "Basin Plan agricultural objective" for nitrate + nitrite of 5 mg/L is not a water quality objective (WQO). Rather it is a threshold, and the objective is the "limit" value of 30 mg/L (see Table 3-6 in the Basin Plan). While this objective might be more appropriate to use as a basis for comparison, it would still be valuable for Water Board staff to know the locations of wells exceeding the agricultural guidelines (see comment s d and e below for further detail).
   d. Section 2.5.1 - Total Dissolved Solids – While we recognize that figures 3-7 and 3-8 do show the monitoring well locations used to estimate basin-wide average TDS and nitrate concentrations, respectively, for the Santa Clara Plain (shallow and deep) and the Coyote Valley, there are no figures that show the location-specific TDS or nitrate concentrations. Providing such figures would be very helpful to our evaluation of the SNMP and understanding the nature of localized areas of elevated TDS and nitrate that could affect our future source control/permitting efforts. Please consider providing figures that include:
      - All shallow aquifer wells in the SCP that exceed the TDS SMCL of 500 mg/L (as summarized in Table 2-2); include the zone of saline intrusion above 500 mg/L.
      - All 32 wells in the SCP principal (i.e., deep) aquifer that exceed the TDS SMCL of 500 mg/L ; the four (or is it five?) that are within the zone of saline

intrusion; the 27 that are outside it; and the distribution by shallow and deep (i.e., principal) aquifer.

- The two wells that exceed the TDS SMCL in the Coyote Valley.
- The location of any wells within the SCP or CV with upward trending TDS or TDS > SMCL that are intended to monitor the effects of recycled water use.

e. Section 2.5.2 – Nitrate – Same as 3d above, except regarding nitrate concentrations. Please consider providing figures that include:

- All shallow and deep aquifer wells in the SCP and CV that exceed the Basin Plan Water Quality Objectives *Threshold* and *Limit* values for Agricultural Supply of 5 mg/L and 30 mg/L, respectively, for nitrate + nitrite (see Table 3-6 in the Basin Plan), and the MCL of 45 mg/L, as summarized in section 2.5.2 and tables 2-2, 2-3, and 2-5.
- The location of any wells within the SCP or CV with upward trending nitrate, or nitrate > Ag or MCL objectives that are intended to monitor the effects of recycled water use.

4. Chapter 3: Salt and Nutrient Loading

a. Section 3.4.1 – Ambient Groundwater Quality – This section describes two areas with naturally-occurring elevated TDS (i.e., Evergreen and Palo Alto). Are there similar localized elevated TDS areas of non-natural origin?

b. Table 3-23 and figure 3-11a suggest that as recycled water use for landscape irrigation increases from about 7,000 AF today to 25,000 AF, so does the loading, in tons. That's about a 1-1 correlation (1 ton of salt loading per every 1,000 acre-feet of recycled water use). Is that meant to be a static assumption? Does it account for the addition of advanced-treated water with lower TDS? Also, what is the projected breakdown of tertiary vs. advanced-treated recycled water use for landscape irrigation over the 25 year planning period?

c. Table 3-22 (and ES-2) clearly shows that the shallow aquifer in the Santa Clara Plain has no assimilative capacity (negative 28 mg/L TDS). Section 3.4.1 indicates that the zones of naturally-occurring elevated TDS (Evergreen and Palo Alto) were included in the estimate. Was the area of saline intrusion also included? Our concern is that for purposes of projecting assimilative capacity use over the next 25 years, the shallow and deep aquifers of the SCP are averaged together. This yields an apparent positive assimilative capacity of 75 mg/L TDS. We are interested to know what the shallow zone would look like if it did not include certain portions of the zone of saline intrusion and/or the naturally-occurring areas of elevated TDS.

5. Chapter 4: Salt and Nutrient Monitoring Plan

a. This chapter concludes that the District's existing groundwater monitoring program adequately accomplishes the monitoring necessary to assess salt and nutrient loading in the Santa Clara Plain and Coyote Valley basins. However, as noted in Chapter 2, there are localized areas where TDS and nitrate already exceed WQOs. Is the groundwater monitoring capability *in these particular areas* adequate to provide the information necessary to assess threats to water quality and human health? Are there any places where additional wells would be beneficial?

6. Appendix 3: Groundwater Monitoring Plan

   a. Sections 2.4.1 and 2.4.2 indicate that the index well coverage for the SCP and CV is incomplete – the SCP shallow zone has 11 of 18 wells needed (61% coverage); the SCP deep zone has 20 of 35 wells needed (57% coverage); the CV has 8 of 11 wells needed (73% coverage). The specific well locations are shown in figures 2-2, 2-3, and 2-4 of Appendix 3. What is the plan and schedule to reach 100% monitoring coverage in these basins?

   b. Section 3.7.2 – South Bay Water Recycling Program – This section indicates that the SBWRP monitors six deep supply wells and six shallow monitoring wells in the vicinity of San Jose's recycled water use locations. Were the data from these monitoring wells included in the baseline groundwater quality evaluation for the shallow and deep aquifers of the SCP? The data from these wells should also be included with figures requested under 3d and 3e above. Any other wells specifically monitored in association with recycled water projects should be included

   c. Section 4.2 – Salt Water Intrusion Monitoring Network – The District's 22 shallow aquifer monitoring wells for salt water intrusion should be included in figures requested under 3d above.

SANTA CLARA VALLEY WATER DISTRICT RESPONSES TO THE SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD'S SEPTEMBER 1, 2015, COMMENTS

Water Board Comment 1:

Executive Summary - Consider including a brief summary of the District's role (or lack thereof) with managing fertilizer use and septic system regulation.

SCVWD Response:

Since the 1990s, the District has implemented numerous programs and activities to address elevated nitrate. The District's nitrate management strategy is to implement programs and work with stakeholders, regulatory and land use agencies to: 1) define the extent and severity of nitrate contamination, 2) identify potential sources, 3) reduce nitrate loading to groundwater, and 4) reduce customer exposure to elevated nitrate. Recently, the District was the recipient of the Groundwater Resources Association of California's esteemed *Kevin J. Neese* award for its free nitrate testing program for domestic wells.

District efforts to address elevated nitrate include:

- Conducting ongoing monitoring and analysis of nitrate trends and hot spots,
- Recharging low-nitrate surface water through district recharge facilities to help dilute nitrate in groundwater,
- Initial pilot testing of approximately 600 South County domestic wells for nitrate in 1998,
- Providing in-field nutrient assistance for growers between 2002 and 2007,
- Conducting outreach through workshops and targeted materials including nitrate fact sheets and nutrient management guidelines for growers,
- Leading efforts to develop Salt and Nutrient Management Plans in collaboration with basin stakeholders (including the agricultural community) and the Regional Water Quality Control Boards,
- Working with the Resource Conservation Districts to provide irrigation efficiency and nutrient management resources to Santa Clara County growers,
- Working to influence state and/or local legislation and policies related to nitrate, including participation in efforts such as the Wastewater Advisory Group related to the Santa Clara County Onsite Wastewater Treatment System ordinance update,
- Offering basic water quality testing to eligible domestic well owners, with over 1,150 individual wells tested since 2011 http://www.valleywater.org/Services/FreeTestingProgram.aspx,
- Offering rebates for nitrate treatment systems for well users exposed to elevated nitrate beginning in fall 2013 as part of the Safe, Clean, Water and Natural Flood Protection Program approved by county voters http://www.valleywater.org/NitrateRebate/,
- Maintaining a Nitrate in Groundwater Web Page and comprehensive Private Well Owner's Guide.

District staff will continue to work in coordination with the Regional Water Quality Control Boards, agricultural community, and other basin stakeholders to address elevated nitrate in South County groundwater and wells.

Water Board Comment 2a:

Introduction Section 1.1 – Consider including a brief summary of the current and projected recycled water use here. It's not until section 3.3.1.8 where the first quantification recycled water use is mentioned (6,640 AF), and that is the current use only. Table 3-23 indicates projected recycled water use by 2035 will be 26,500 AF.

SCVWD Response:

An updated summary is provided below:

Current and Projected Recycled Water Use (updated October 2015)

The three wastewater treatment plants operating in the Santa Clara Plain currently produce tertiary treated recycled water for landscape irrigation and industrial uses. Advanced treated recycled water ("purified water") is also produced at the Silicon Valley Advanced Water Purification Center. Purified water is currently blended with tertiary treated recycled water from the South Bay Water Recycling system, which results in substantially lower TDS and nitrate concentrations for recycled water users.

In response to the District Board of Directors policy to "protect, maintain, and develop recycled water" the District's Chief Executive Officer has identified a goal of that at least 10% of the County's water demands be met with recycled water by 2025. In response to the continuing drought, the District is expediting potable reuse projects, including groundwater recharge projects using purified water in existing and new percolation ponds and injection wells. The preliminary target is to produce 45,000 acre-feet of purified water by 2020; however, the quantity and schedule are subject to change pending outcome of ongoing planning studies. The District is currently producing up to 8 million gallons per day of purified water, which has a salt content averaging 50 mg/L (as total dissolved solids).

A summary of the projected recycled water production for each facility located in the Santa Clara Plain is listed in Table A6-1 below.

Table A6-1
Current and Projected Recycled Water Production and Quality

System	Current Production and Quality	Future Production and Quality
South Bay Water Recycling (San Jose/Santa Clara)	10,200 AFY 500 mg/L TDS	25,000 AFY tertiary + adv. 500 mg/L TDS
Sunnyvale	1,700 AFY tertiary 760 to 1,100 mg/L TDS	3,100 AFY advanced 760 mg/L TDS
Palo Alto	1,500 AFY tertiary 770 mg/L TDS	7,000 AFY tertiary 600 mg/L TDS
Silicon Valley Advanced Water Purification Center	9,000 AFY 50 mg/L TDS currently blended with SBWR tertiary for irrigation and industrial uses	45,000 AFY 50 mg/L TDS to be used for indirect potable reuse or possible future direct potable reuse

Recycled Water Production Figures Updated October 2015; average values rounded to nearest 100 AFY. Note that all future projections are subject to change. The projected increase of 15,000 AFY for the South Bay Water Recycling System is included in the 45,000 AFY projected for the Silicon Valley Advanced Water Purification Center.

Water Board Comment 2b:

Introduction Section 1.2 - Consider including a brief summary of the District's plans for recharge/use of stormwater as per the State Board's Recycled Water Policy.

SCVWD Response:

The District's plans for recharge and use of stormwater are stated in Section 1.5.4 Goals and Objectives for Recycled Water and Stormwater. The District actively recharges stormwater, which is incorporated into managed aquifer recharge operations throughout the County. As a member of the Santa Clara Valley Urban Runoff Pollution Prevention Program, the District works with other co-permittees to maximize stormwater infiltration while protecting groundwater quality. Section A-4.1.2 in the SNMP provides a detailed description of this effort.

Water Board Comments 3a and 3b:

Chapter 2 - Groundwater Subbasin Characterization

a. The locations and spatial distribution of wells with elevated TDS and nitrate in the shallow and deep aquifers of the Santa Clara Plain and the Coyote Valley should be provided on figures (see comments d and e below for further detail).
b. While Figures 2-13 and 2-14 show the locations of wells with increasing TDS and nitrate trends, concentrations do not need to be increasing to pose a problem if they already exceed WQOs. The locations of wells where TDS and nitrate concentrations are currently elevated above WQOs should be provided (see comments d and e below for further detail).

SCVWD Response:

Figures A6-1, A6-2, and A6-3 have been added to the SNMP in this appendix to show the locations of wells in which Basin Plan Water Quality Objectives are exceeded.

Water Board Comment 3c:

Section 2.5.2 - The "Basin Plan agricultural objective" for nitrate + nitrite of 5 mg/L is not a water quality objective (WQO). Rather it is a threshold, and the objective is the "limit" value of 30 mg/L (see Table 3-6 in the Basin Plan). While this objective might be more appropriate to use as a basis for comparison, it would still be valuable for Water Board staff to know the locations of wells exceeding the agricultural guidelines (see comments d and e below for further detail).

SCVWD Response:

Thank you for the clarification. Because the distinction between "threshold" and "limit" in Table 3-6 of the Basin Plan was not clear, the SNMP compared local groundwater quality against the more conservative "threshold" values. Figures A6-4 and A6-5 show locations where the threshold for water quality in agricultural supply (Table 3-6 of the Basin Plan) was exceeded. The Basin Plan 30 mg/L limit was not exceeded in any shallow or principal zone wells.

Given the Water Board's clarification, the last paragraph of Section 2.5.2 is updated to read:

The Basin Plan Agricultural Objective of 30 mg/L for nitrate + nitrite (as N) was not exceeded in any shallow or principal zone wells in the Santa Clara Groundwater Subbasin. For the more conservative "threshold" of 5 mg/L, thirty seven of 210 wells (18%) in the principal aquifer zone of the Santa Clara Plain exceeded the threshold, as did 22 wells (56%) in the Coyote Valley.

Water Board Comment 3d:

Section 2.5.1 - Total Dissolved Solids

While we recognize that figures 3-7 and 3-8 do show the monitoring well locations used to estimate basin-wide average TDS and nitrate concentrations, respectively, for the Santa Clara Plain (shallow and deep) and the Coyote Valley, there are no figures that show the location-specific TDS or nitrate concentrations. Providing such figures would be very helpful to our evaluation of the SNMP and understanding the nature of localized areas of elevated TDS and nitrate that could affect our future source control/permitting efforts. Please consider providing figures that include:

- All shallow aquifer wells in the SCP that exceed the TDS SMCL of 500 mg/L (as summarized in Table 2-2); include the zone of saline intrusion above 500 mg/L.
- All 32 wells in the SCP principal (i.e., deep) aquifer that exceed the TDS SMCL of 500 mg/L; the four (or is it five?) that are within the zone of saline intrusion; the 27 that are outside it; and the distribution by shallow and deep (i.e., principal) aquifer.
- The two wells that exceed the TDS SMCL in the Coyote Valley.
- The location of any wells within the SCP or CV with upward trending TDS or TDS > SMCL that are intended to monitor the effects of recycled water use.

SCVWD Response:

Figures A6-1 and A6-2 have been added to the SNMP in this appendix to show the locations of wells in which Basin Plan Water Quality Objectives are exceeded. These figures include TDS SMCL exceedances in the zone of saline intrusion.

Figure A6-6 is added to the SNMP in this appendix to show the location of monitoring wells intended to monitor the effects of recycled water irrigation.

A separate City of San Jose monitoring program for recycled water irrigation has been conducted to evaluate trends in shallow groundwater during more than a decade of recycled water irrigation. The District incorporates the City's findings in the Annual Groundwater Report. For example, the general water quality findings related to groundwater monitoring at Santa Clara Plain recycled water irrigation sites per the District's 2013 Annual Groundwater Report are listed in Table A6-2, below:

Table A6-2
Summary of General Water Quality Findings for Santa Clara Plain Recycled Water Irrigation Monitoring Wells

Recycled Water Irrigation Groundwater Monitoring Site	General Water Quality Observations
IDT	x Basic chemical composition is stable compared to previous events. x Increasing trends continue to be observed at three of the four wells for salts (bromide, chloride, calcium, sodium, TDS) and dissolved oxygen.
SBWR	x The basic chemical composition for various wells indicates a shift towards more saline water, primarily due to increasing chloride at the Curtner, Kelley Park, Columbus Park, Watson Park, and Evergreen Park wells. x Increasing trends continue to be observed for salts (including chloride, boron, sodium, and sulfate) at the majority of SBWR monitoring wells.

The City of San Jose commissioned a report on the SBWR recycled water irrigation groundwater monitoring network in 2009. A plot of TDS trends from the City's 2009 analysis is included as Figure A6-7. Figure A6-8 had been added to the SNMP in this appendix to show the locations of recycled water irrigation monitoring wells within the Santa Clara Plain with upward trending TDS. There is no recycled water irrigation in the Coyote Valley and, as such, no related monitoring wells.

Water Board Comment 3e:

Section 2.5.2 – Nitrate

Same as 3d above, except regarding nitrate concentrations. Please consider providing figures that include:

- All shallow and deep aquifer wells in the SCP and CV that exceed the Basin Plan Water Quality Objectives Threshold and Limit values for Agricultural Supply of 5 mg/L and 30 mg/L, respectively, for nitrate + nitrite (see Table 3-6 in the Basin Plan), and the MCL of 45 mg/L, as summarized in section 2.5.2 and tables 2-2, 2-3, and 2-5.
- The location of any wells within the SCP or CV with upward trending nitrate, or nitrate > Ag or MCL objectives that are intended to monitor the effects of recycled water use.

SCVWD Response:

Figure A6-3 shows the locations of wells in which the MCL for nitrate is exceeded. Figures A6-4 and A6-5 show locations of wells in which the Ag Water Quality Threshold is exceeded. None of the monitored wells in the Santa Clara Subbasin exceed the Ag Water Quality Objective from Table 3-6 of the Basin Plan (30 mg/L nitrate + nitrite as N). The District's Annual Groundwater Reports summarize significant trends for monitored parameters at recycled water irrigation sites.

Figure A6-9 has been added to the SNMP in this appendix to show the locations of recycled water irrigation monitoring wells within the Santa Clara Plain with upward trending nitrate. Trend determination is based on District analysis (as reported in the Annual Groundwater Report) or the 2009 SBWR evaluation as noted on the figure. There is no recycled water irrigation in the Coyote Valley and, as such, no related monitoring wells.

Water Board Comment 4a:

Section 3.4.1 Ambient Groundwater Quality – This section describes two areas with naturally-occurring elevated TDS (i.e., Evergreen and Palo Alto). Are there similar localized elevated TDS areas of non-natural origin?

SCVWD Response:

The District monitors 58 shallow and principal zone wells in the Santa Clara Plain annually, and merges that data with municipal well data from the Division of Drinking Water database. The District is not aware of any spatial patterns that reflect localized elevated TDS of non-natural origin.

Water Board Comment 4b:

Table 3-23 and Figure 3-11a suggest that as recycled water use for landscape irrigation increases from about 7,000 AF today to 25,000 AF, so does the loading, in tons. That's about a 1-1 correlation (1 ton of salt loading per every 1,000 acre-feet of recycled water use). Is that meant to be a static assumption? Does it account for the addition of advanced-treated water with lower TDS? Also, what is the projected breakdown of tertiary vs. advanced-treated recycled water use for landscape irrigation over the 25 year planning period?

SCVWD Response:

Per Figure 3-11a, the salt loading from all recycled water use within the Santa Clara Plain is nearly 25,000 AF in 2035, which is essentially a 1:1 correlation (1 ton of salt loading per 1,000 AF of recycled water use) in that year. However, this is not a static assumption, as the projected loading for each year is assessed independently considering recycled water use and water quality. For example, since 2014, the District has been operating the Silicon Valley Advanced Water Purification Center (SVAWPC), which produces 8 million gallons per day of advanced-treated water with TDS less than 60 mg/L. Purified water is blended with SBWR tertiary treated recycled water to produce delivered water with TDS of about 500 mg/L. The SNMP analysis accounts for increased recycled water irrigation from SBWR, Sunnyvale, and Palo Alto, as well as water quality improvements over the 25 year planning period, which are summarized in Table 3-27.

At present, SBWR delivers a blend of tertiary treated and advanced-treated water with TDS of about 500 mg/L, while Palo Alto and Sunnyvale deliver recycled water with TDS ranging from 700 to 1,100 mg/L. The volumes and quality of recycled water used for irrigation in Palo Alto and Sunnyvale may change significantly within the SNMP planning horizon. Recently, the City of Palo Alto and the District formed a joint committee to explore opportunities to produce purified water to further lower the TDS of recycled water used for irrigation. The City of Sunnyvale is in the final stages of preparing an EIR for upgrades to their Water Pollution Control Plant, which may include advanced treatment. Sunnyvale anticipates producing lower TDS recycled water to irrigate more sites, including the new

Apple II campus in Cupertino. These improvements may produce substantial decreases in salt loading from the current practice of using tertiary treated recycled water for irrigation. As the expected water quality is not known with certainty, the SNMP conservatively assumes that the current tertiary treated water will continue to be used for irrigation.

Water Board Comment 4c:

Table 3-22 (and ES-2) clearly shows that the shallow aquifer in the Santa Clara Plain has no assimilative capacity (negative 28 mg/L TDS). Section 3.4.1 indicates that the zones of naturally-occurring elevated TDS (Evergreen and Palo Alto) were included in the estimate. Was the area of saline intrusion also included? Our concern is that for purposes of projecting assimilative capacity use over the next 25 years, the shallow and deep aquifers of the SCP are averaged together. This yields an apparent positive assimilative capacity of 75 mg/L TDS. We are interested to know what the shallow zone would look like if it did not include certain portions of the zone of saline intrusion and/or the naturally-occurring areas of elevated TDS.

SCVWD Response:

The area of saline intrusion as delineated by the extent of the 100 mg/L chloride contour was excluded from the calculation of shallow aquifer assimilative capacity, as indicated in SNMP section 2.5.1 on page 31. The locations of naturally occurring elevated TDS are within the principal aquifer, so they do not affect the determination of assimilative capacity in the shallow aquifer. Therefore, assimilative capacity in the shallow aquifer is expected to remain negative in the next 25 years. However, there are a few mitigating factors that could lead to improvements in shallow aquifer TDS:

- Since the District implemented its turf replacement rebate program, well over 4 million square feet of irrigated turf has been replaced with xeriscape or other low-water landscaping alternatives in 2015 alone, bringing the total turf replaced since the program began to nearly 7 million square feet. This program reduces outdoor irrigation, a primary source of salt loading and was not incorporated into the projected salt loading from outdoor irrigation.

- As described above, the District's Silicon Valley Advanced Water Purification Center is now producing 8 million gallons per day of purified water with TDS less than 60 mg/L. That water is blended with tertiary treated recycled water, to lower TDS from the 750 to 950 mg/L TDS range to approximately 500 TDS. These factors were included in the projected assimilative capacity calculation for the subbasin as a whole. New plans are in development to double the capacity of indirect potable reuse projects. The scale and volume of the planned program far exceeds the projections included in this SNMP. As the District's expedited indirect potable reuse program is still in development, the configuration and volume of projects is not finalized. The projections included in the SNMP also assumed a 50:50 blend of purified and local water. Current plans are to use 100% purified water for IPR, pending the outcome of geochemical compatibility studies. This would result in water with much lower TDS being recharged to groundwater than assumed in the SNMP. Percolating greater volumes of purified water is expected to significantly dilute shallow aquifer TDS in the long term.

- The cities of Mountain View and Palo Alto are working to resleeve sections of sewer trunk mains in which saline shallow groundwater is infiltrating. Completion of the first section of pipe near Shoreline Amphitheater resulted in an immediate and significant decrease in the TDS of recycled water used for irrigation in Palo Alto. Planned continuation of this program will result in decreased salt loading.

Water Board Comment 5:

This chapter concludes that the District's existing groundwater monitoring program adequately accomplishes the monitoring necessary to assess salt and nutrient loading in the Santa Clara Plain and Coyote Valley basins. However, as noted in Chapter 2, there are localized areas where TDS and nitrate already exceed WQOs. Is the groundwater monitoring capability in these particular areas adequate to provide the information necessary to assess threats to water quality and human health? Are there any places where additional wells would be beneficial?

SCVWD Response:

The District's groundwater monitoring network provides extensive areal coverage of the Santa Clara Subbasin, which encompasses nearly 300 square miles. The District samples 70 wells each fall for many constituents, including nitrate and TDS. Through our voluntary domestic well testing program, the District tests nitrate at 200 to 300 domestic wells every year, including many in Coyote Valley, which is more prone to elevated nitrate due to agricultural fertilizers and septic tanks. In addition to this District monitoring, we evaluate water quality data (including nitrate and TDS) from hundreds of public water supply wells each year.

Although we believe the District's monitoring network is comprehensive and adequate to assess threats to water quality, we continually work to maintain and improve the monitoring network as needed. The District is in the process of updating the Groundwater Management Plan to satisfy the requirements of the Sustainable Groundwater Management Act. The findings of the SNMP and ongoing monitoring results may further shape the District's groundwater monitoring efforts. Findings from annual groundwater sampling, including updated long term trend analysis, are available in the District's Annual Groundwater Report[1]. The District believes that salt and nutrient monitoring data and analysis included in the Annual Groundwater Report satisfies the intent of the 2009 Recycled Water Policy.

Water Board Comment 6a:

Sections 2.4.1 and 2.4.2 indicate that the index well coverage for the SCP and CV is incomplete – the SCP shallow zone has 11 of 18 wells needed (61% coverage); the SCP deep zone has 20 of 35 wells needed (57% coverage); the CV has 8 of 11 wells needed (73% coverage). The specific well locations are shown in figures 2-2, 2-3, and 2-4 of Appendix 3. What is the plan and schedule to reach 100% monitoring coverage in these basins?

SCVWD Response:

In addition to the response to Comment 5, above, we note that the statistical analysis undertaken to identify the number of monitoring wells was meant to serve as a guideline for planning purposes. There are practical considerations that must be considered such as related costs to ratepayers, available land, and available funding. As compared to many other areas, the District conducts very extensive monitoring. Through our current network

[1] http://www.valleywater.org/Services/Groundwater.aspx

and ongoing modifications as conditions or needs change, we believe we are meeting our goal of obtaining adequate data to assess regional groundwater conditions.

Water Board Comment 6b:

Section 3.7.2 – South Bay Water Recycling Program – This section indicates that the SBWRP monitors six deep supply wells and six shallow monitoring wells in the vicinity of San Jose's recycled water use locations. Were the data from these monitoring wells included in the baseline groundwater quality evaluation for the shallow and deep aquifers of the SCP? The data from these wells should also be included with figures requested under 3d and 3e above. Any other wells specifically monitored in association with recycled water projects should be included.

SCVWD Response:

The data from the shallow South Bay Water Recycling (SBWR) recycled water irrigation monitoring wells was not included in the baseline groundwater quality evaluation for the shallow aquifers of the Santa Clara Plain. Wells used for deep monitoring were included as they are part of the Division of Drinking Water database. The data from the SBWR shallow monitoring wells is not ideally suited to merging with the District's regional monitoring because several of the wells had elevated nitrate or other constituents prior to initiation of recycled water irrigation. The District has not validated the SBWR data or incorporated it into its GIS and database; hence, it was excluded from the SNMP analysis. Figure A6-6 is provided to show the location of both the SBWR monitoring wells and the District's south San Jose recycled water irrigation monitoring wells (the "IDT" site). Data from the IDT wells was incorporated in the SNMP analysis.

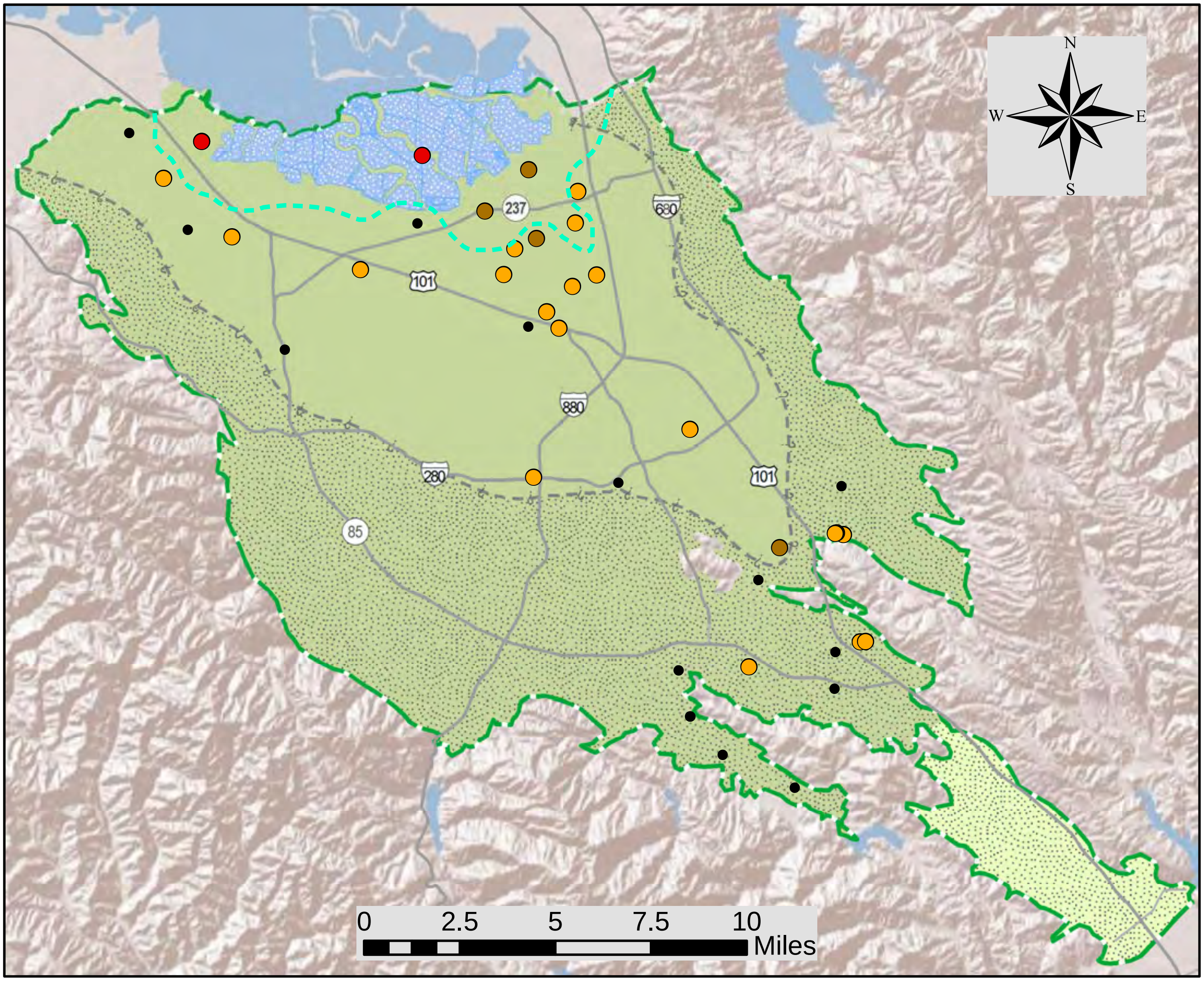
See responses to Comment 3d above to review the findings of the SBWR monitoring.

Water Board Comment 6c:

Section 4.2 – Salt Water Intrusion Monitoring Network – The District's 22 shallow aquifer monitoring wells for salt water intrusion should be included in figures requested under 3d above.

SCVWD Response:

The zone of saline intrusion is mapped in Figure 3-3 of the SNMP. This figure presents chloride concentration, which is conservatively indicative of saline intrusion where it exceeds 100 mg/L. New Figure A6-1, provided for this response to comments, includes the shallow monitoring wells currently used to monitor saline intrusion.



Legend

- - - 2012 100 mg/L Chloride Contour

TDS (mg/L) Shallow Zone

- < 500 (below SMCL)
- 500 - 1000
- 1000 - 1500
- 1500- 60000

- - -? Approximate Extent of Confined Area

Groundwater Subbasins

DWR Subbasins

Santa Clara (2-9.02)

District Groundwater Areas

Santa Clara Plain

Coyote Valley

Hydrographic Units

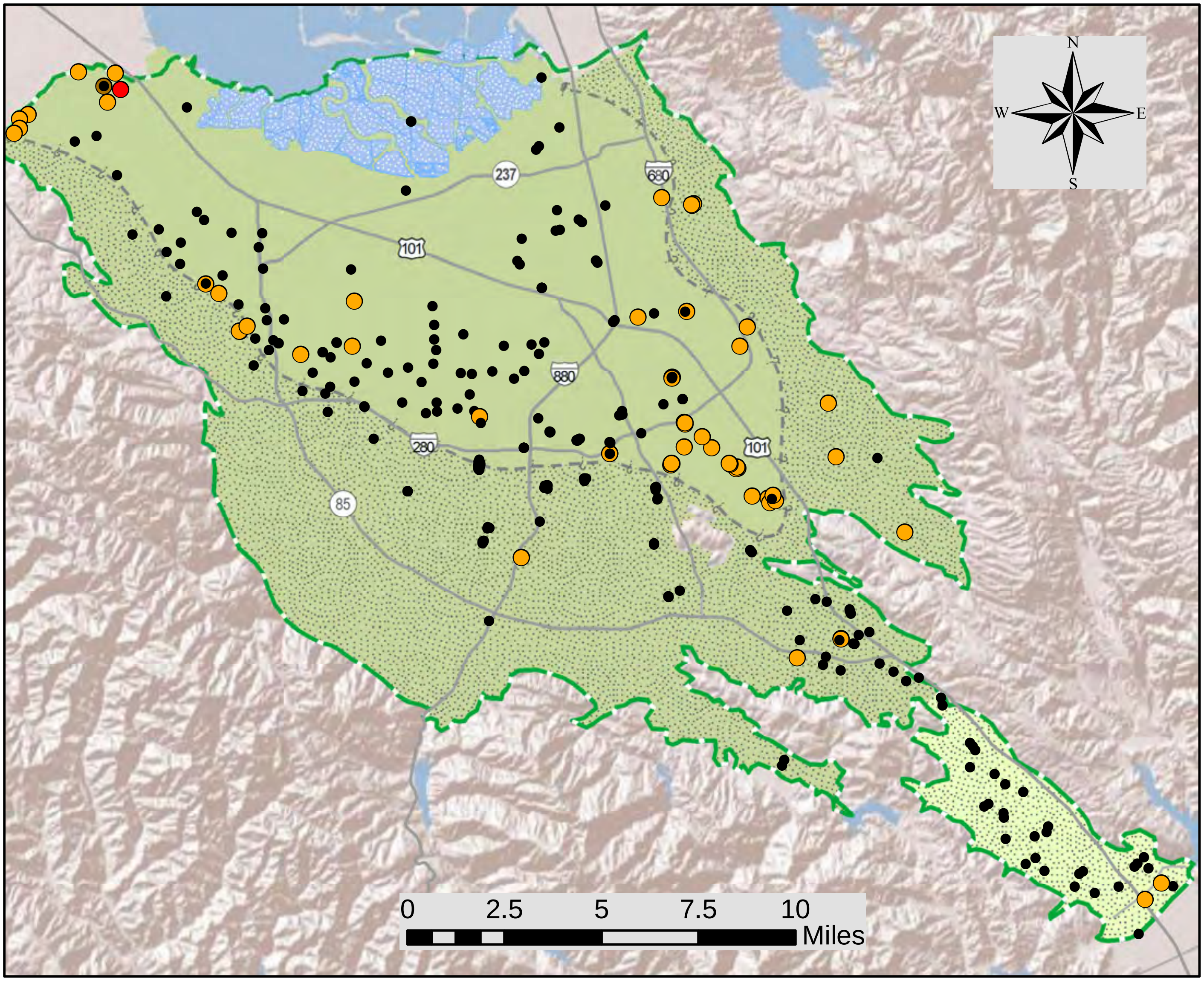
Santa Clara Plain Confined Area

Santa Clara Plain Recharge Area

Coyote Valley Recharge Area

Santa Clara Valley Water District

Figure A6-1 Shallow Aquifer Wells with TDS above SMCL Water Quality Objective (2000 - 2012 Median)



Legend

TDS (mg/L) Principal Zone

- < 500 (below SMCL)
- 500 - 1000
- 1000 - 1500
- 1500 - 6000
- Approximate Extent of Confined Area

Groundwater Subbasins

DWR Subbasins

Santa Clara (2-9.02)

District Groundwater Areas

Santa Clara Plain

Coyote Valley

Hydrographic Units

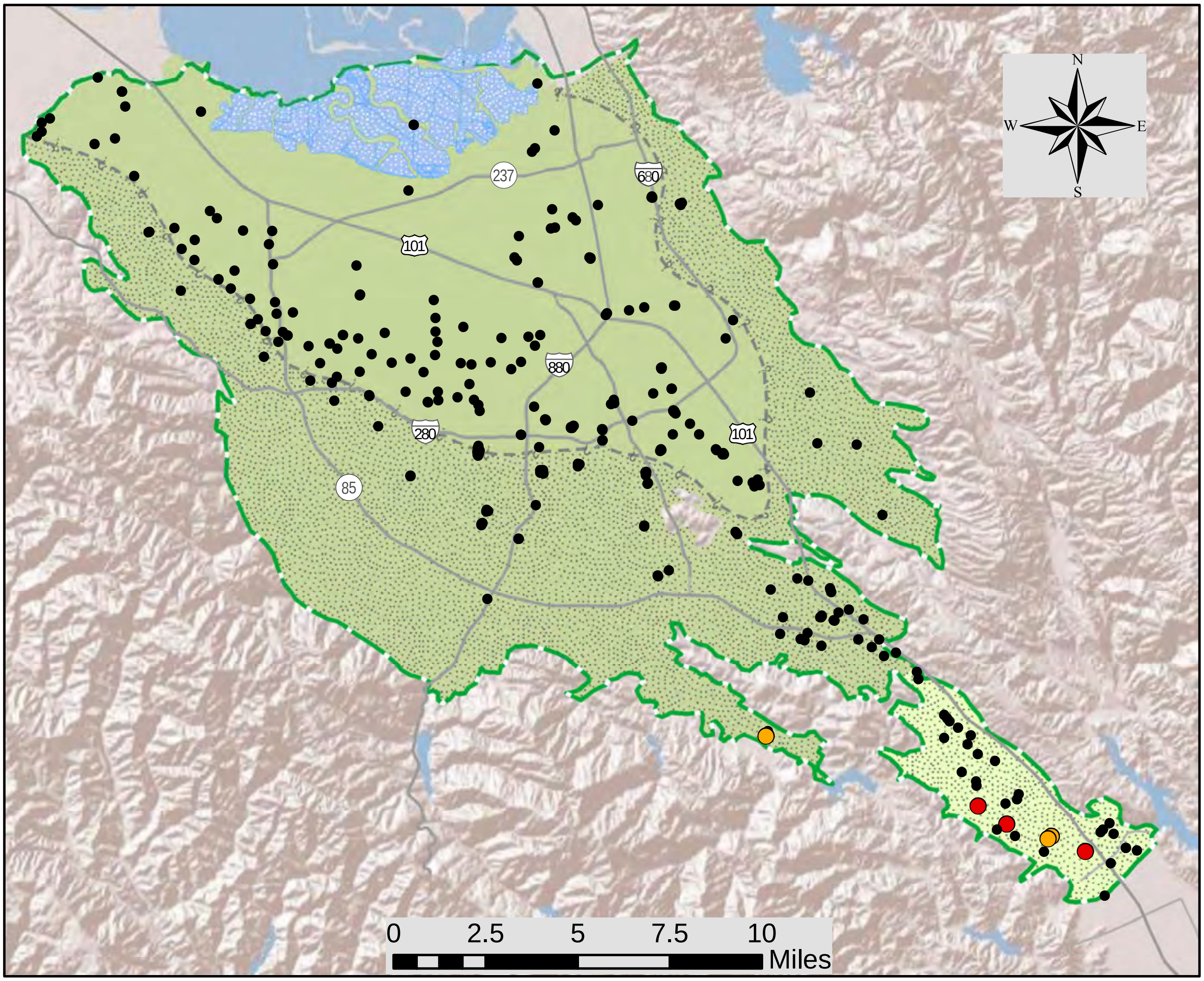
Santa Clara Plain Confined Area

Santa Clara Plain Recharge Area

Coyote Valley Recharge Area

Santa Clara Valley Water District

Figure A6-2 Principal Aquifer Wells with TDS above SMCL Water Quality Objective (2000 - 2012 Median)



Legend

Nitrate as NO3 (mg/L) Principal Zone

- < 45 (below MCL)
- 45 - 58
- 58 - 70
- Approximate Extent of Confined Area

Groundwater Subbasins

DWR Subbasins

- Santa Clara (2-9.02)

District Groundwater Areas

- Santa Clara Plain
- Coyote Valley

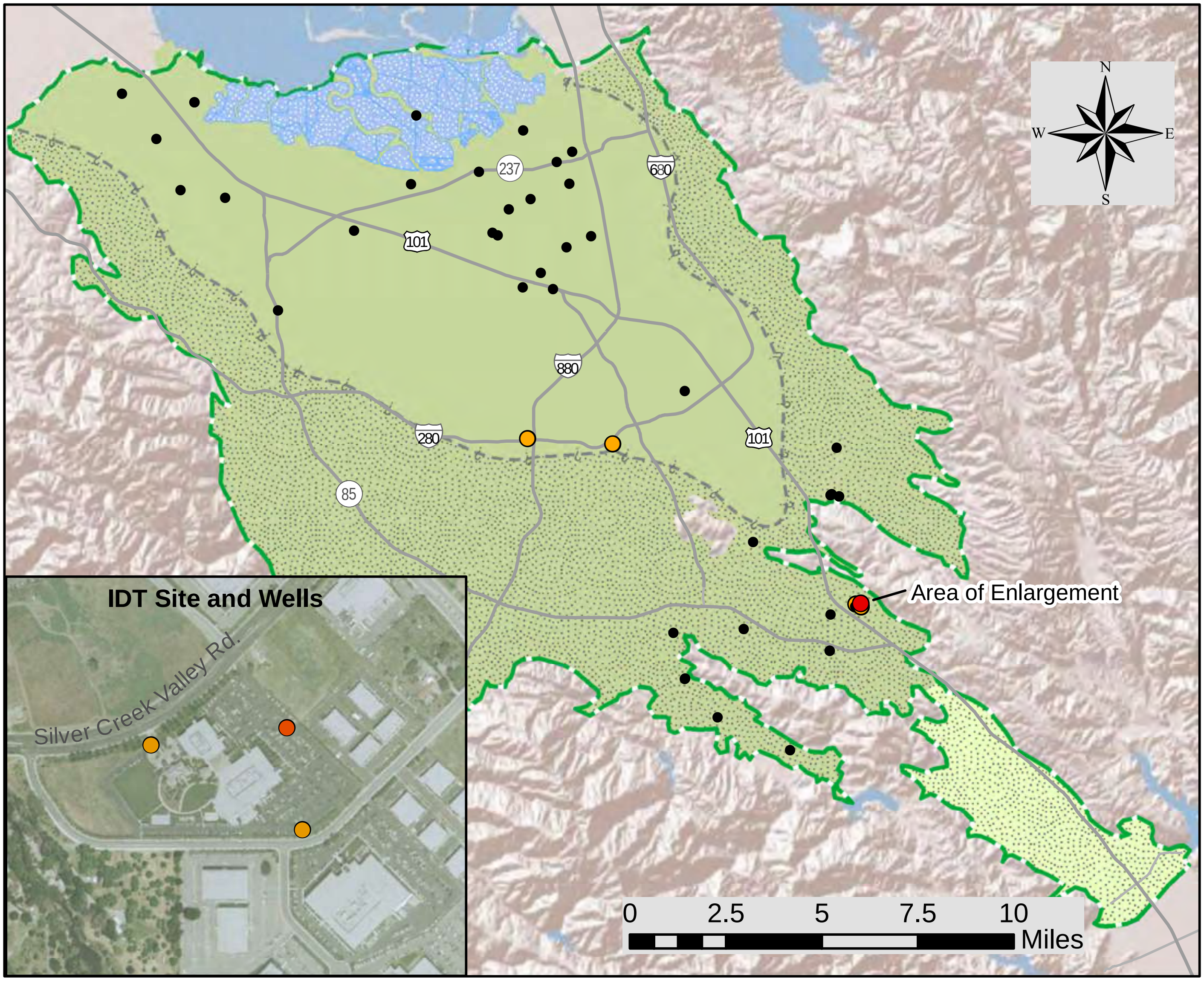
Hydrographic Units

- Santa Clara Plain Confined Area
- Santa Clara Plain Recharge Area
- Coyote Valley Recharge Area

Note:
Shallow Aquifer Wells had no Nitrate above MCL Water Quality Objective between 2000 and 2012

Santa Clara Valley Water District

Figure A6-3 Principal Aquifer Wells with Nitrate above MCL Water Quality Objective (2000 - 2012 Median)



Legend

Nitrate (mg/L) as N

- ● < 5 (below Ag Threshold)
- ● 5 - 7.5
- ● 7.5 - 10
- Approximate Extent of Confined Area

Groundwater Subbasins

DWR Subbasins

- Santa Clara (2-9.02)

District Groundwater Areas

- Santa Clara Plain

- Coyote Valley

Hydrographic Units

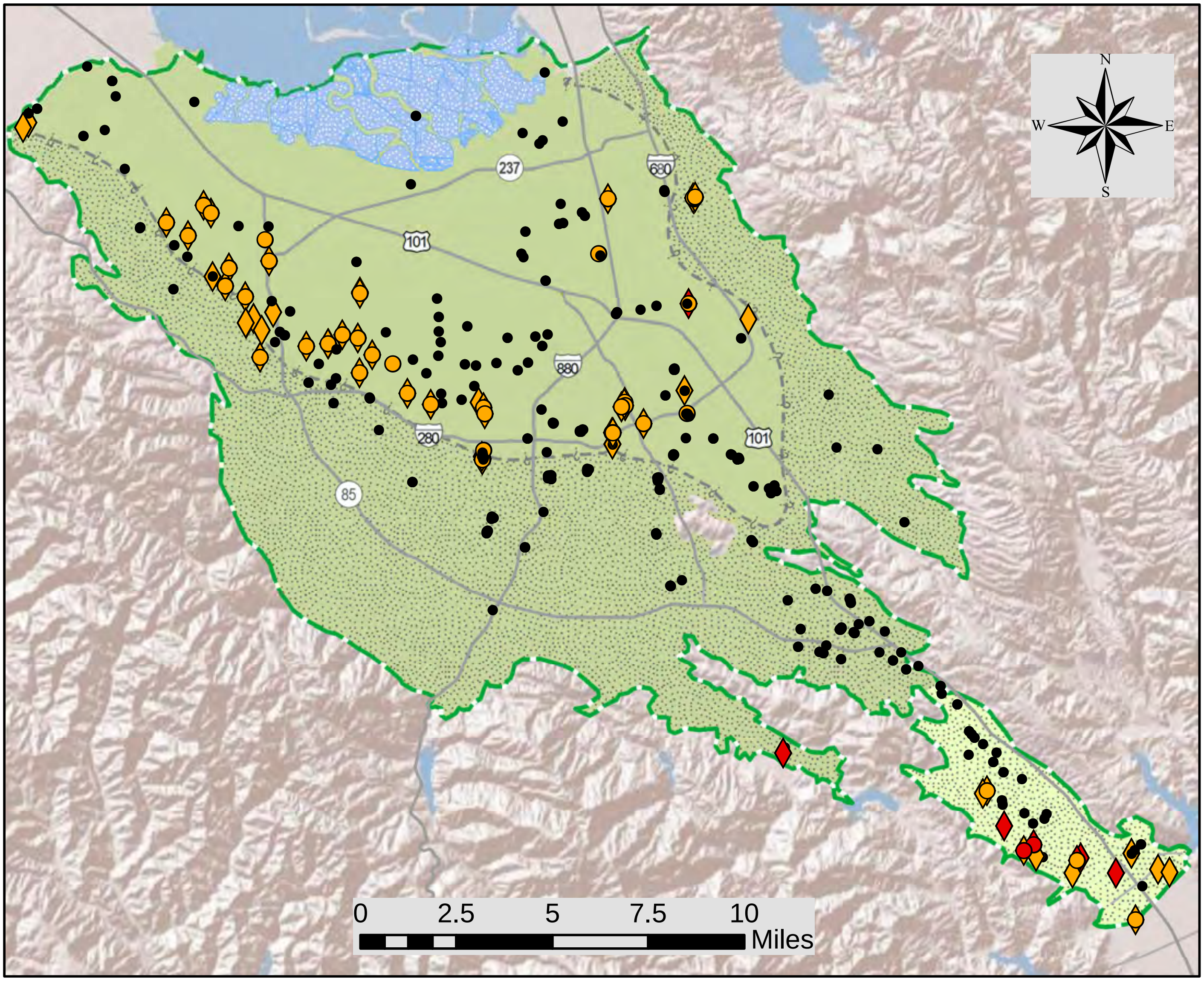
- Santa Clara Plain Confined Area
- Santa Clara Plain Recharge Area
- Coyote Valley Recharge Area

Santa Clara Valley Water District

Notes:

1. No wells exceeded the 30 mg/L Basin Plan Water Quality Objective.
2. Because nitrate as N is above 5 mg/L, nitrate + nitrite is assumed to be above 5 mg/L.

Figure A6-4 Shallow Aquifer Wells Exceeding Basin Plan Agricultural Water Quality Threshold for Nitrate + Nitrite as N (2000 - 2012 Median)



Legend

Nitrate as N

- < 5 (below Ag Threshold)
- 5 - 10
- 10 - 20

Nitrate + Nitrite as N

- <5 (below Ag Threshold)
- 5 - 10
- 10 - 15
- Approximate Extent of Confined Area

Groundwater Subbasins

DWR Subbasins

- Santa Clara (2-9.02)

District Groundwater Areas

- Santa Clara Plain
- Coyote Valley

Hydrographic Units

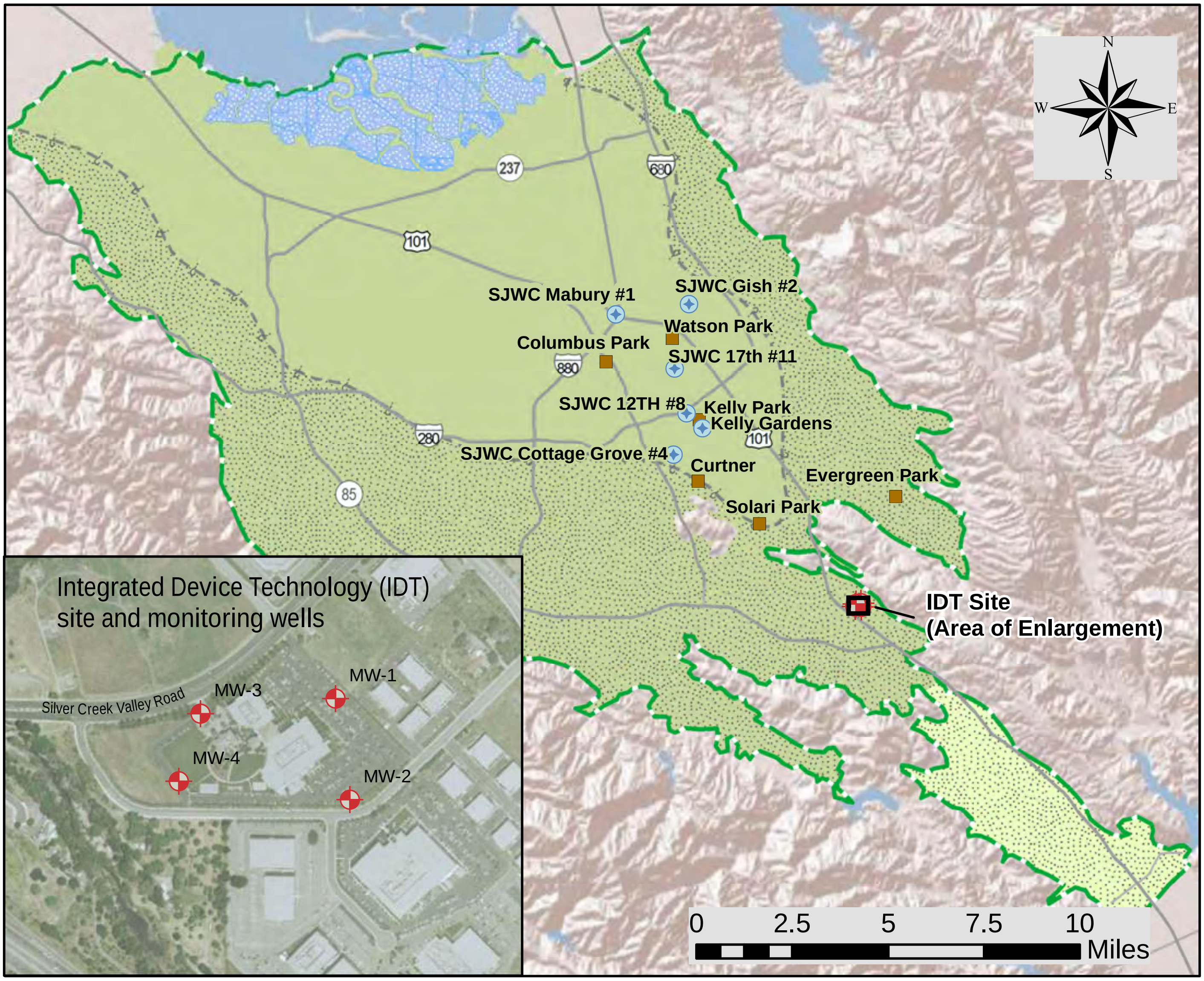
- Santa Clara Plain Confined Area
- Santa Clara Plain Recharge Area
- Coyote Valley Recharge Area

Santa Clara Valley Water District

Notes:

1. No wells exceeded the 30 mg/L threshold Basin Plan Water Quality Objective.
2. Analyses reported as nitrate + nitrite as N, or nitrate (as N or NO3)
3. Because nitrate as N is above 5 mg/L, nitrate + nitrite is assumed to be above 5 mg/L.

Figure A6-5 Principal Aquifer Wells Excceding Basin Plan Agricultural Water Quality Threshold for Nitrate + Nitrite (2000 - 2012 Median)



Legend

IDT Monitoring Wells

SBWR Monitoring Wells

Shallow Zone

Principal Zone

Approximate Extent of Confined Area

Groundwater Subbasins

DWR Subbasins

Santa Clara (2-9.02)

District Groundwater Areas

Santa Clara Plain

Coyote Valley

Hydrographic Units

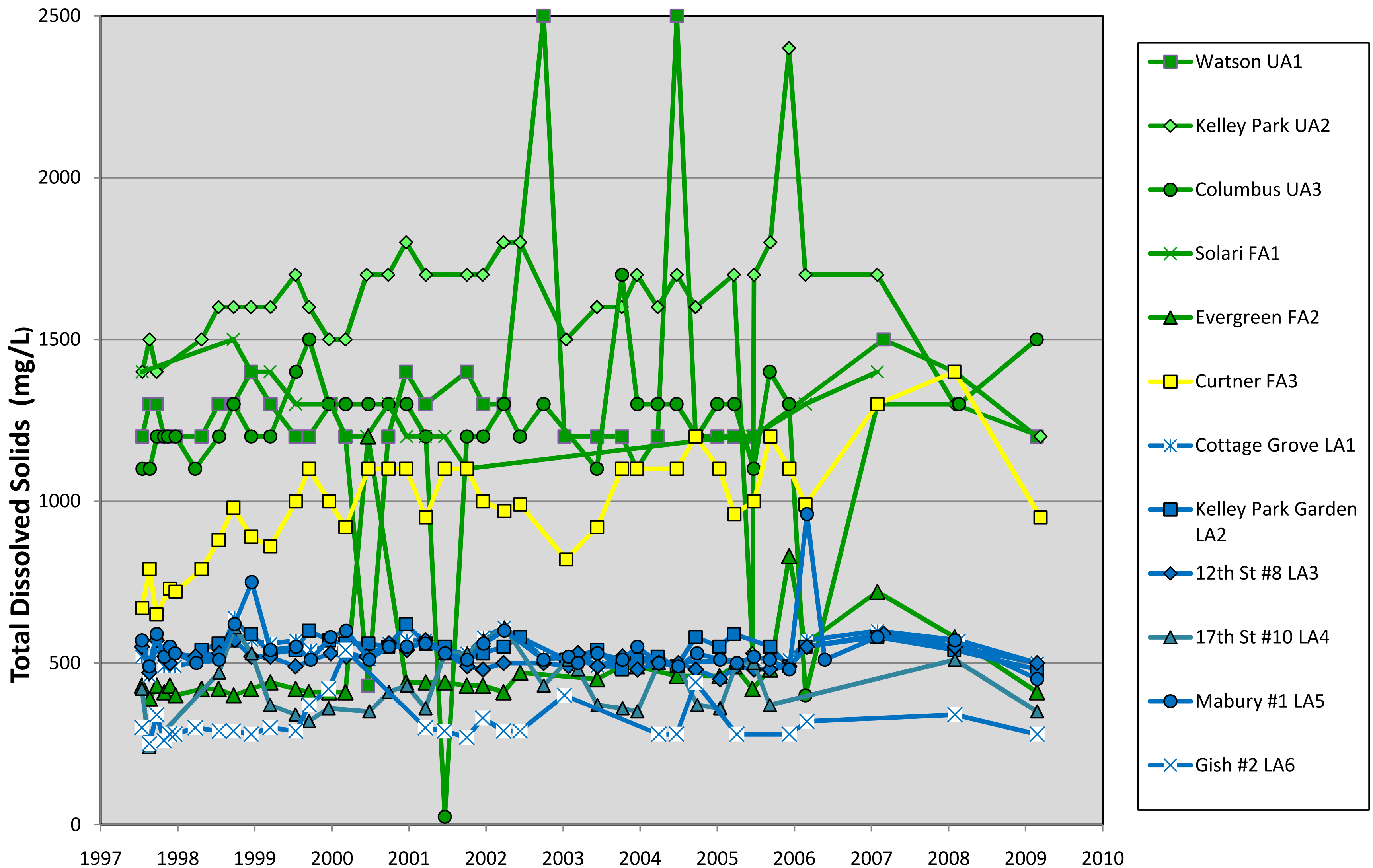
Santa Clara Plain Confined Area

Santa Clara Plain Recharge Area

Coyote Valley Recharge Area

Santa Clara Valley Water District

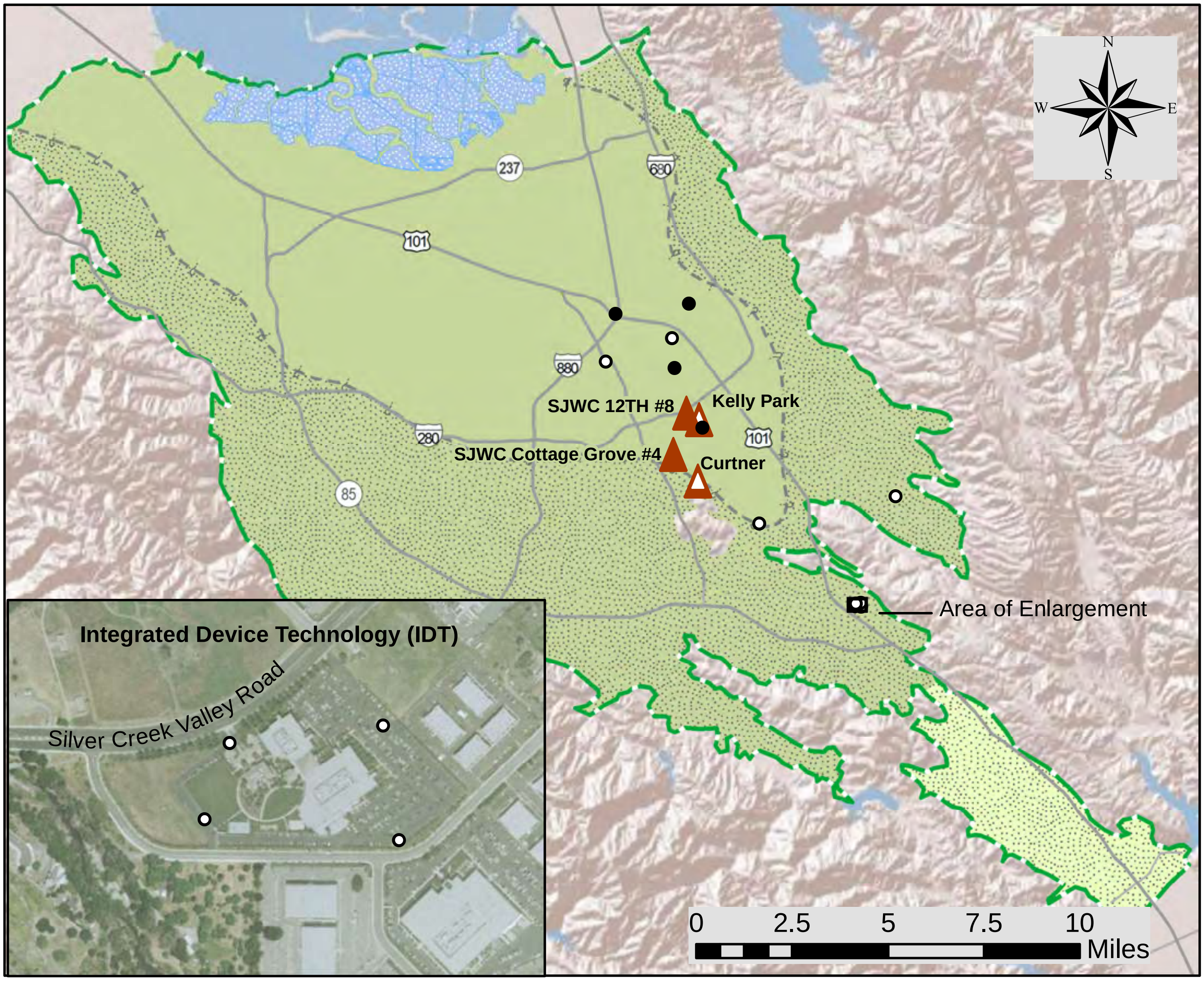
Figure A6-6 Location of Wells Used to Monitor Recycled Water Irrigation



July 2009	**Figure E14**
TODD ENGINEERS Alameda, California	**Total DissolvedSolids City of San Jose GMMP Update**

Figure A6-7 TDS Concentrations in SBWR Recycled Water Irrigation Monitoring Wells

Source: SBWR Technical Memorandum No. 2 Groundwater Monitoring and Mitigation Program Update Project, November 2009



Legend

Principal Zone Nitrate Trends

- No Trend
- Upwards Trend

Shallow Zone Nitrate Trends

- No Trend
- Upwards Trend
- Approximate Extent of Confined Area

Groundwater Subbasins

DWR Subbasins

- Santa Clara (2-9.02)

District Groundwater Areas

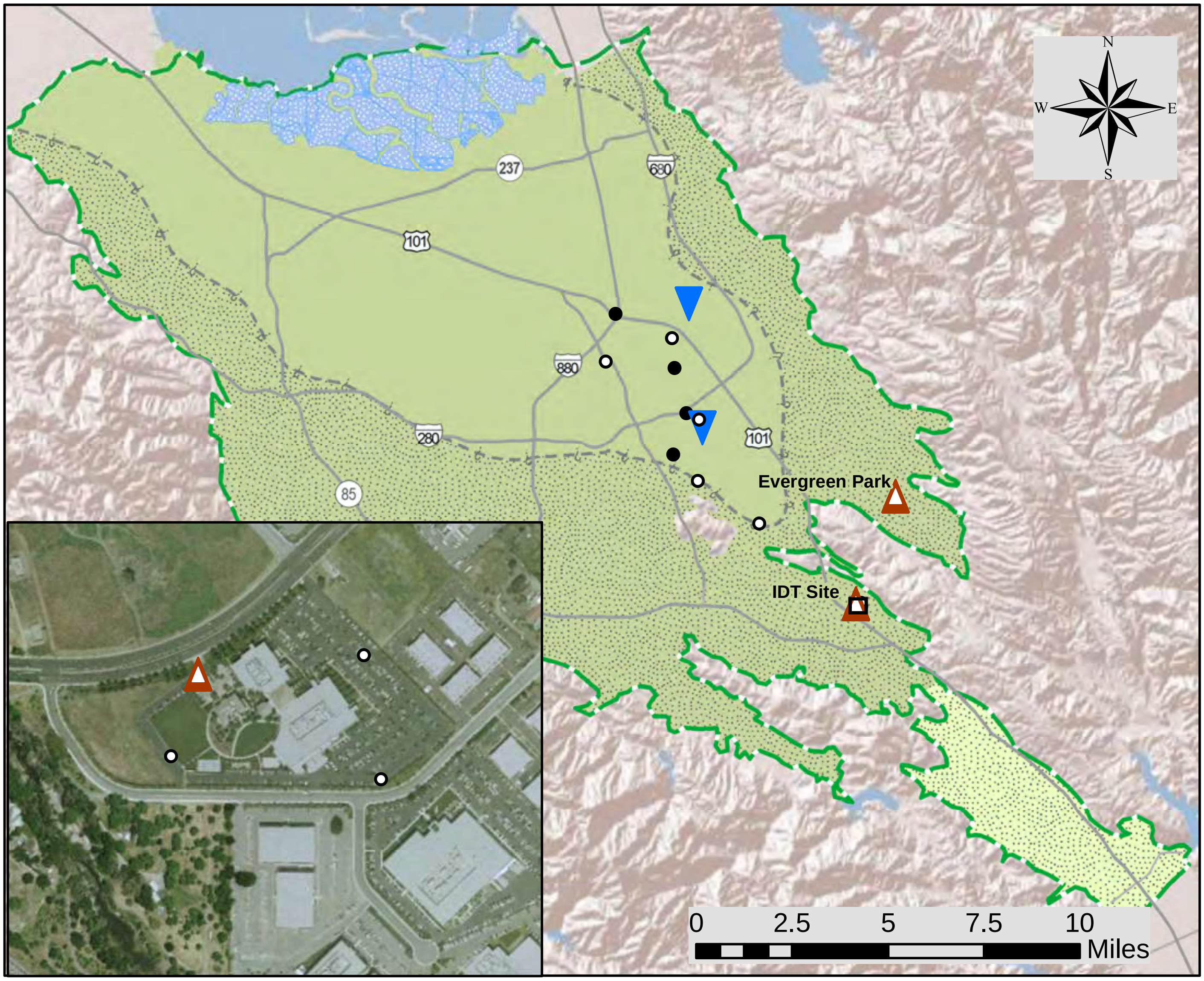
- Santa Clara Plain
- Coyote Valley

Hydrographic Units

- Santa Clara Plain Confined Area
- Santa Clara Plain Recharge Area
- Coyote Valley Recharge Area

Santa Clara Valley Water District

Figure A6-8 Post-Irrigation Nitrate Trends in Recycled Water Monitoring Wells



Legend

Shallow Zone TDS Trends

TDS_Trend

Upward Trend

No Trend

Principal Zone TDS Trends

Downward Trend

No Trend

Approximate Extent of Confined Area

Note: no principal zone recycled water irrigation monitoring wells have increasing TDS trends

Groundwater Subbasins

DWR Subbasins

Santa Clara (2-9.02)

District Groundwater Areas

Santa Clara Plain

Coyote Valley

Hydrographic Units

Santa Clara Plain Confined Area

Santa Clara Plain Recharge Area

Coyote Valley Recharge Area

Santa Clara Valley Water District

Figure A6-9 Post-Irrigation TDS Trends in Recycled Water Irrigation Monitoring Wells

5750 Almaden Expressway, San Jose, CA 95118-3614 | (408) 265-2600 | www.valleywater.org

Santa Clara Valley Water District

April 21, 2016

Mr. Alec Naugle
Senior Engineering Geologist
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Subject: Response to San Francisco Bay Regional Water Quality Control Board Additional Comments on Santa Clara Subbasin Salt and Nutrient Management Plan

Dear Mr. Naugle:

The Santa Clara Valley Water District (District) has reviewed the San Francisco Bay Regional Water Quality Control Board's (Water Board) additional comments on the Santa Clara Subbasin Salt and Nutrient Management Plan (SNMP) transmitted on February 3, 2016, by e-mail. Please see our attached responses to Water Board comments, which we will append to the previously submitted SNMP Appendix that includes Water Board comments and District responses.

We are eager to finalize the Santa Clara Subbasin SNMP and will work with you to confirm these responses have fully addressed the Water Board's comments. We are targeting District Board of Directors adoption of the SNMP in June 2016, after which we will seek a Water Board Resolution of Concurrence. If you have any questions regarding our responses, please call Mr. Thomas Mohr at (408) 630-2051, or me at (408) 630-2788.

Sincerely,

Vanessa De La Piedra, P.E.
Groundwater Monitoring and Analysis Unit Manager

Attachment:
1. Santa Clara Valley Water District Response to February 3, 2016 E-mail Comments from San Francisco Bay Regional Water Quality Control Board

cc/att: Mr. Keith Roberson, San Francisco Bay Regional Water Quality Control Board
Mr. Nathan King, San Francisco Bay Regional Water Quality Control Board
Ms. Katrina Kaiser, San Francisco Bay Regional Water Quality Control Board
T. Mohr, G. Hall

SANTA CLARA VALLEY WATER DISTRICT RESPONSES TO THE SAN FRANCISCO BAY REGIONAL WATER QUALITY CONTROL BOARD'S FEBRUARY 3rd 2016 COMMENTS ON SANTA CLARA SUBBASIN SALT AND NUTRIENT MANAGEMENT PLAN

Water Board Comment 1:

The District's annual groundwater report for 2013 indicates that many domestic wells in the Coyote Valley are affected by nitrate and highlights differences between the District's regional monitoring program wells and purely domestic wells in the south county, which includes the Coyote Valley and Llagas sub-basin. Specifically, the regional wells have a median nitrate concentration of 17.6 mg/L, while 286 domestic wells tested throughout the south county have a median of 33.1 mg/L, and 34% of them exceed the MCL (45 mg/L). At the same time, the SNMP (Figure 3-19) indicates that about 75% of the total nitrate loading in the Coyote Valley is due to irrigated agriculture and fertilizer use, while about 15% is due to septic systems and other drainage losses.

SCVWD Response:
The apparent disparity noted between nitrate concentrations in the regional monitoring program wells and domestic wells is an artifact of the well groupings used in various tables in the District's 2013 Annual Groundwater Report. Table 9 lists the median nitrate concentration for "Zone W-5, South County" as 33.1 mg/L; however, Zone W-5 is a water revenue charge zone that includes both Coyote Valley and the Llagas Subbasin.

It is more informative to compare the regional monitoring wells used to obtain the 17.6 mg/L median in Table 7 of the 2013 Annual Report and the 2013 median of domestic wells located only within the Coyote Valley. With regard to nitrate results in the Coyote Valley for calendar year 2013, the District database includes data from 9 monitoring wells, 24 wells sampled by public water systems, and 35 domestic wells sampled under the District's domestic well testing program. The median nitrate concentration for all 68 wells was 23 mg/L, while the median of domestic wells was 21.1 mg/L. If domestic wells are excluded, the median was 25.8 mg/L.

When results for only Coyote Valley are considered, the median nitrate concentration from the District's regional monitoring program wells and domestic wells are in reasonable agreement. The Llagas Subbasin is addressed in a separate SNMP that was submitted to and accepted by the Central Coast RWQCB[1].

While we hope this clarifies the Water Board's specific question regarding 2013 data, the broader thrust of the question is to understand the overall occurrence of nitrate when considering all data. Because the number of wells tested varies by year, there is value in examining data from all wells for all years. Attachment 1 provides summary statistics, maps, and charts of nitrate test results for the Coyote Valley. Important limitations to the data are noted.

[1] The Llagas Subbasin SNMP is available on the District's website: http://www.valleywater.org/GroundwaterStudies/

Water Board Comment 2:

We would like to discuss with the District the details of an implementation plan to address this situation.

> ***District Response:***
> The District engages in many groundwater quality management activities that are similar to the type of measures included in an implementation plan. A summary of these past and ongoing activities is provided in Appendix 4 to the SNMP. Our understanding is that implementation plans are necessary when the SNMP finds that assimilative capacity is either not available or will be exhausted within the 25-year SNMP planning horizon. The Santa Clara Subbasin SNMP finds that assimilative capacity is still available in 2035.
>
> We believe that the District's ongoing groundwater quality management activities are proactive and effective, within the limits of the District's jurisdiction. Because the District is not a land use agency, we do not have authority over land uses that have the potential to increase nitrate loading.
>
> As regards Coyote Valley, SNMP projections forecast that average nitrate concentrations will decrease substantially in the 25-year period ending in 2035, because nitrate loading is projected to decrease. Substantial groundwater pumping by Great Oaks Water Company for distribution in the Santa Clara Plain is a key factor that causes nitrate and salt to be removed from Coyote Valley. As groundwater is exported from Coyote Valley, significant quantities of nitrate and other salts are removed as well.
>
> While the District's interpretation of the Recycled Water Policy does not include the need for preparing an implementation plan, the District would like to collaborate with RWQCB on groundwater protection activities in Coyote Valley. As discussed in our April 20th conference call, the District will begin sharing private well nitrate testing data with the Water Board beginning in early May 2016.

Water Board Comment 3:

Is there any effort to better identify the agricultural sources and locations?

> ***SCVWD Response:***
> The District has conducted surveys of nitrate sources and nitrate occurrence in groundwater in the past. Most of these efforts have focused primarily on the Llagas Subbasin, while one has also included Coyote Valley. The findings of nitrate studies conducted by the District, Brown and Caldwell, and Lawrence Livermore Laboratories in the Llagas Subbasin are largely transferrable. The District's conceptual model ascribes the majority of nitrate found in groundwater to known non-point sources, including crop and lawn fertilizers and septic tanks[2]. Possible exceptions may include historic or current composting or food processing operations, and poultry or dairy operations. A list of relevant nitrate occurrence studies is provided below.

---

[2] On a local scale, septic tanks are point sources; on the basin scale, the wide distribution of numerous septic tanks (about 600 in Coyote Valley) manifests as an areal source.

- Brown and Caldwell, 1981. San Martin Area Water Quality Study: Prepared for the County of Santa Clara
- Santa Clara County Health Department, 1988. Santa Clara County Private Well Sampling Program-Final Report
- SCVWD, 1994. Llagas Groundwater Basin Nitrate Study Sample Point Selection Report, 25 p.
- SVCWD, 1993. Llagas Groundwater Basin Nitrate Study Nitrate Data Review, 42 p.
- SCVWD, 1992 (revised 1993). Quality Assurance Project Plan for Laboratory Contract to Provide Services for the Llagas Groundwater Basin Nitrate Study, 29 p.
- SCVWD, 1994. Santa Clara Valley Water District Llagas Groundwater Basin Nitrate Study Nitrate Source Area Identification, December, 1994, 56 p. (Section 205G) grant funds under Assistance Agreement C6009585-91-1 to the State Water Resources Control Board and by Contract No. 1-053-250-0, US EPA).
- SCVWD, 1996. Santa Clara Valley Water District Llagas Groundwater Basin Nitrate Study Final Report. October, 1996, 105 p.
- SCVWD, 1998. Private Well Water Testing Program Nitrate Data Report [Llagas Subbasin and Coyote Valley]. December, 1998.
- LLNL and SWRCB, 2005. California GAMA Program: Sources and transport of nitrate in shallow groundwater in the Llagas Basin of Santa Clara County, California. (UCRL-TR-213705).
- Carle, S., Esser, B., Moran, J., 2005. High-Resolution Simulation of Basin Scale Nitrate Transport Considering Aquifer System Heterogeneity. Geosphere (UCRL-JRNL-214721).

The Water Board expressed interest in understanding cropping patterns and fertilizer loading in Coyote Valley. We are providing 2015 cropping patterns in the Coyote Valley for your reference (see Attachment 1). It should be noted that cropping patterns frequently change from year to year, and multiple crops may be grown on the same field within a calendar year.

Water Board Comment 4:
How is the nitrate loading scenario for agriculture and onsite wastewater treatment systems (OWTS/septic systems) projected to change over time as land use changes?

SCVWD Response:
Per Table 3-23, agricultural fertilizer use was held constant through 2035 for the Santa Clara Subbasin SNMP, including Coyote Valley. Septic leach field volumes are assumed to remain constant. The County's new Onsite Wastewater Treatment System (OWTS) Ordinance could lead to some improvements in septic tank management, potentially decreasing loading from this source. The impacts of the ordinance are subject to many variables, so a constant value was used. These assumptions should conservatively estimate future nitrate loading from these sources.

Water Board Comment 5:
Are there nitrate hotspot areas where there is no access to delivered water or alternative supplies?

SCVWD Response:
The Coyote Valley domestic wells in which nitrate has been detected above the MCL are located in an elongated area extending nearly five miles from the southern border of Coyote Valley, i.e., an area encompassing about 2 square miles that covers more than half the length of Coyote Valley. However, about two-thirds of the wells in the area where most MCL exceedances occur have median nitrate concentrations below the MCL. While the definition of a "hot spot" is subjective, elevated nitrate appears to be more common in the southwest portion of the Coyote Valley. That area is not currently served by a major public water system; however, there are several small mutual water companies that serve groundwater. The District is currently offering rebates for well

users exposed to nitrate above the MCL. This program offers rebates of up to $500 for the installation of treatment units certified for nitrate removal. Rebate program information is sent to thousands of domestic well owners annually. Well owners participating in the District's domestic well testing program receive test results by mail and those with elevated nitrate are given a fact sheet and application for the rebate program. Although it has been in place for several years, the rebate program has had low participation. Most well owners contacted by the District are not participating in the rebate program because they drink bottled water or they have already installed treatment units. The District continues to look for opportunities to expand participation.

We are not aware of any plans to extend service connections from nearby municipal water systems or private water utilities to the unincorporated areas in Coyote Valley.

Water Board Comment 6:

Does the District have any plans to further investigate the nature/extent of the nitrate sources and their longevity?

SCVWD Response:

While we manage the groundwater subbasin, our jurisdictional mandate does not extend to water quality issues arising from land use. We assess current conditions and trends in nitrate, an effort supported by our free domestic well testing program. As described above, we are also working to reduce well owner exposure to nitrate by offering rebates for point of use treatment systems.

In the Llagas Subbasin, which extends from Cochrane Road near Morgan Hill south to the Pajaro River, we are working with the Central Coast Water Board to share information on patterns and trends in nitrate occurrence; however, that work does not extend to identifying sources. The District supports a similar exchange of data and information with the San Francisco Bay Water Board if it is of interest to the Water Board.

ATTACHMENT 1 – NITRATE OCCURRENCE IN COYOTE VALLEY

Nitrate groundwater quality data from wells in the Coyote Valley is available from one well as early as 1949, and in multiple wells from the 1980s and later. Figure 1 provides a summary of past nitrate testing in Coyote Valley wells. Figure 1 includes samples from municipal wells and agricultural wells, but the great majority of wells shown are domestic wells.

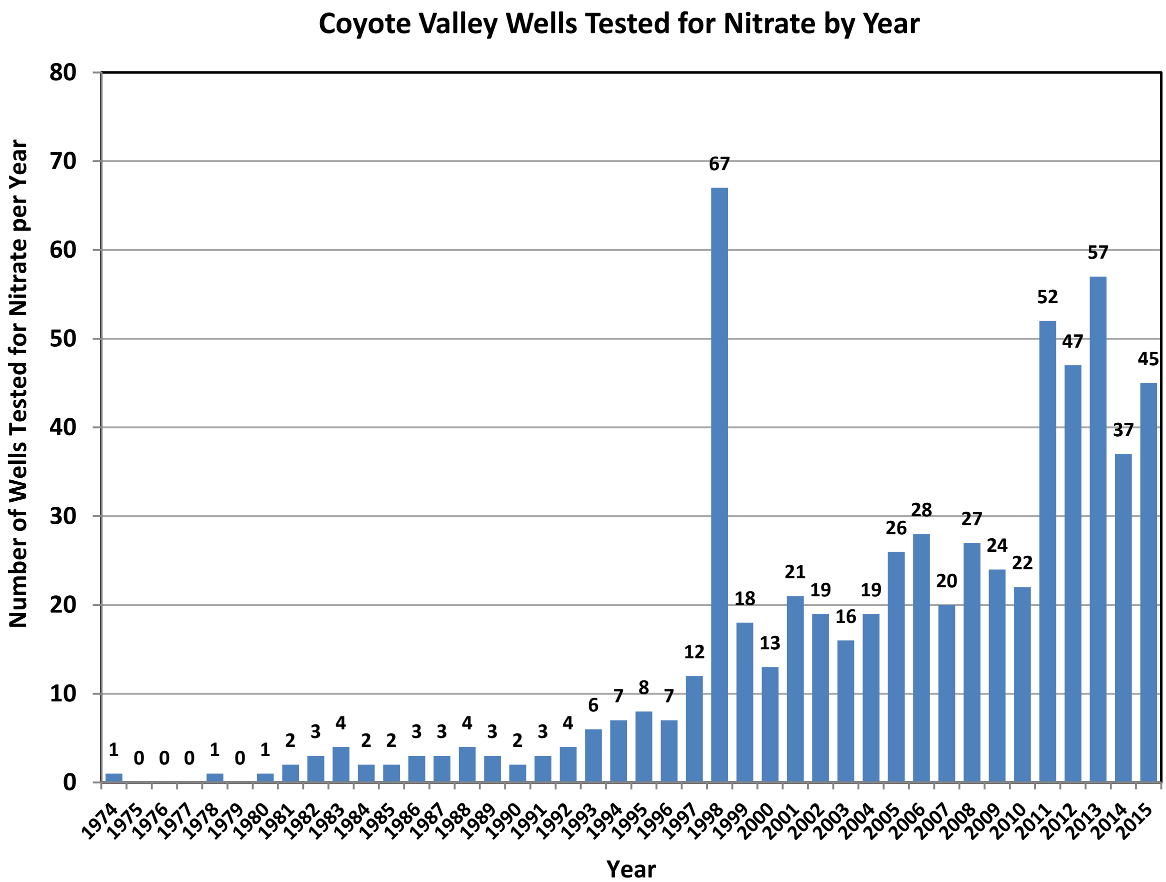


Figure 1 – Number of Coyote Valley Wells Tested for Nitrate per Year

Nitrate concentrations are elevated in some wells in the southwestern portion of Coyote Valley. A summary of nitrate detections with respect to the MCL is provided in Figures 2, 3, and 4, and map of nitrate detections from all wells is provided in Figure 5.

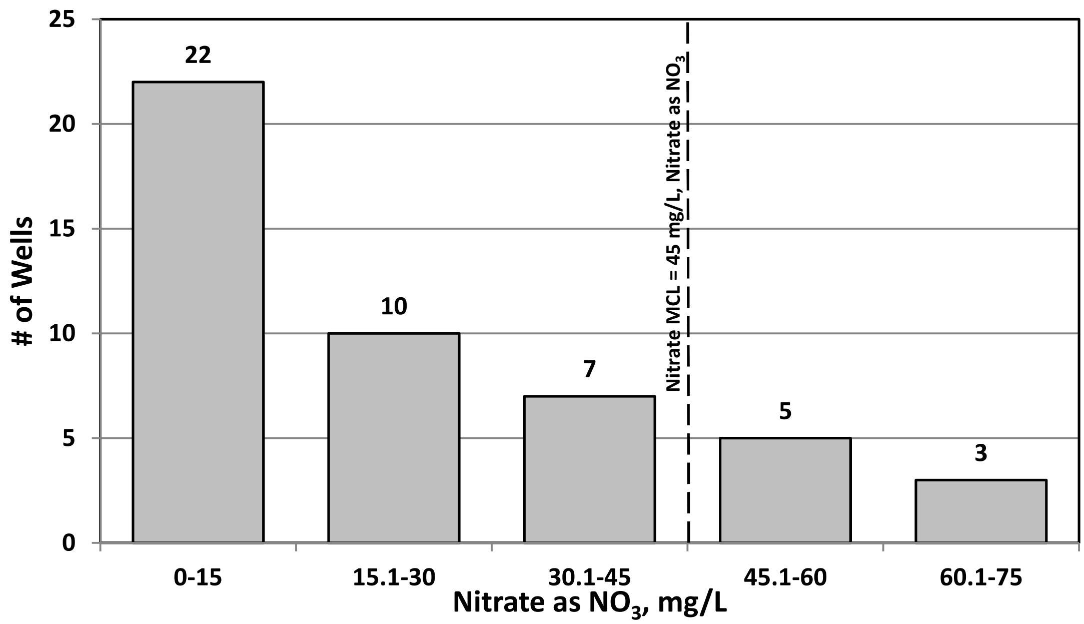


Figure 2 – Median Nitrate Concentrations in Coyote Valley Wells Tested 4 Times or More

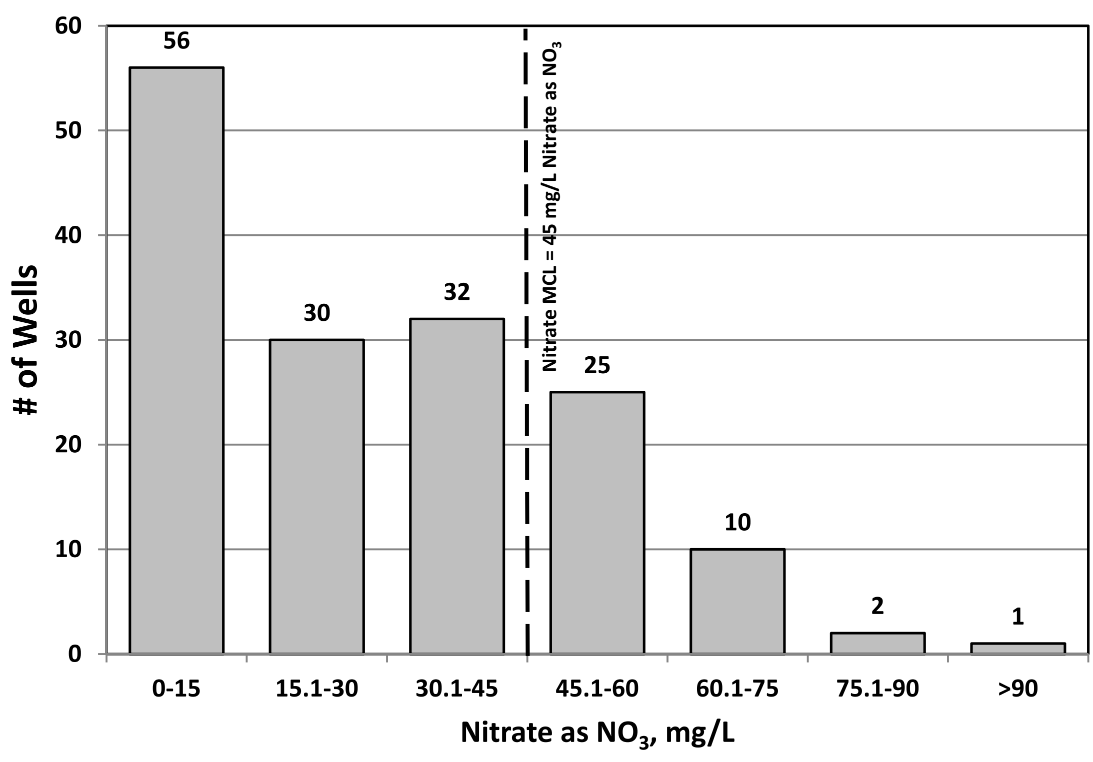
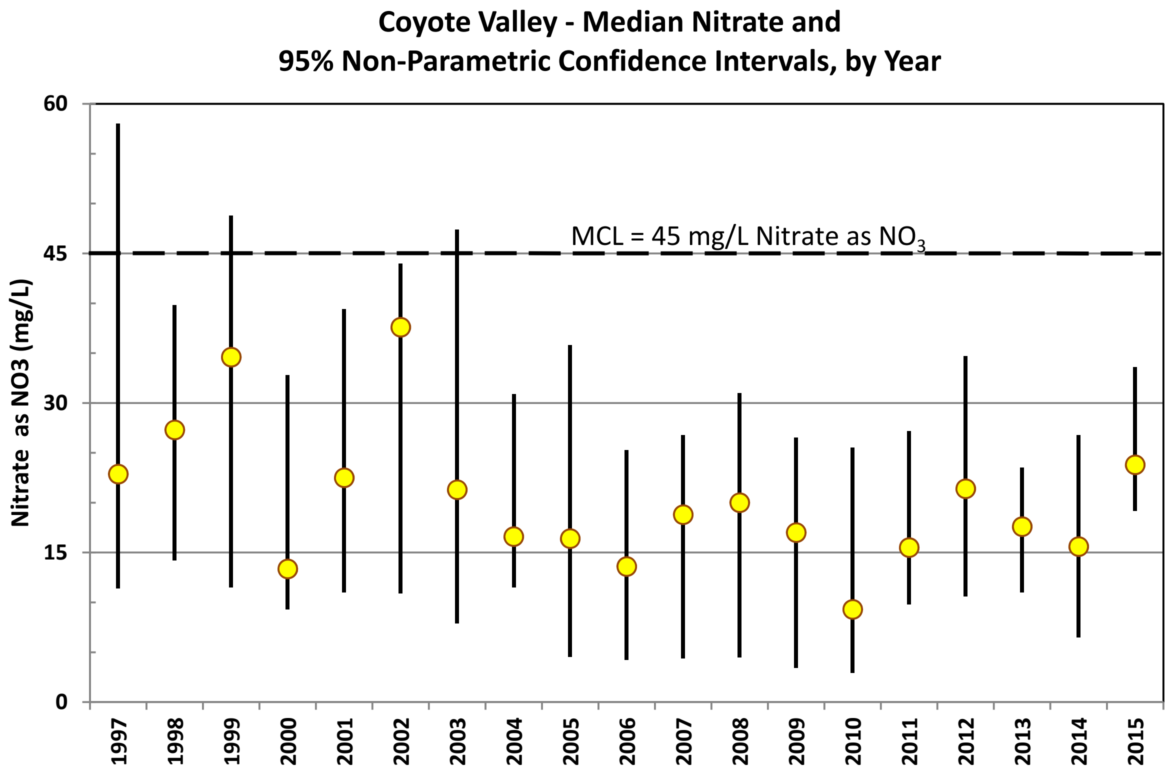
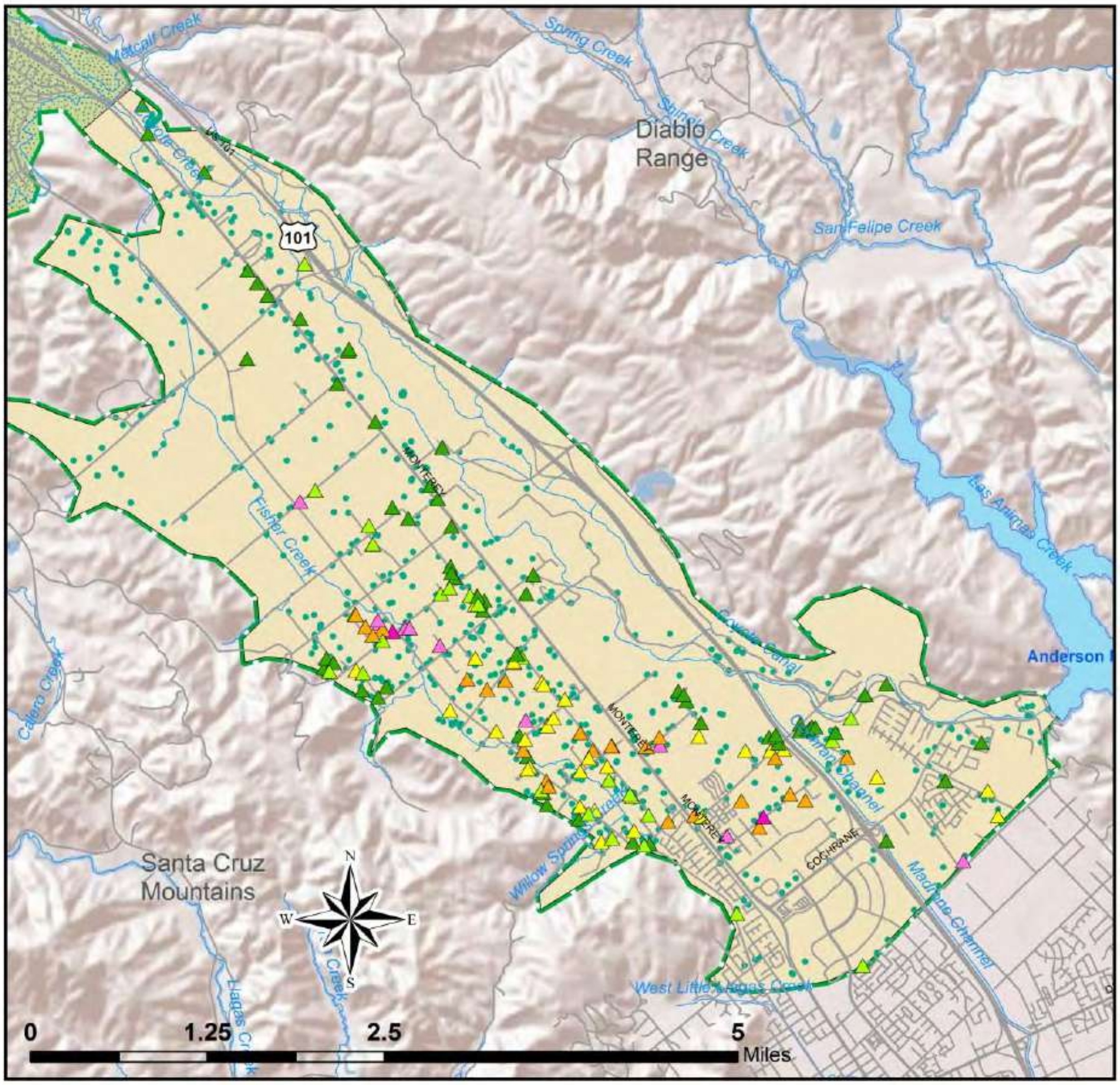


Figure 3 – Average Nitrate Concentration by Well for All Wells Tested in Coyote Valley



Note - data should not be used to interpret a trend. The number of wells sampled varies significantly by year, some wells are close to sources of recharge, and wells are screened at different depths.

Figure 4 –Median Coyote Valley Nitrate Concentration in Years with 10 or More Wells Tested



Median Nitrate as NO3, mg/L, All Years (1949 - 2015)

- 0 -15
- 15 - 30
- 30 -45
- 45 - 60
- 60 - 75
- >75

Coyote Valley Wells - not tested

Santa Clara Subbasin (DWR Basin 2-9.02)

NOTE: Date range is from 1949 to 2015. Some wells have been tested only once and results may be decades old. This map should not be used to interpret current conditions in the Coyote Valley subarea of the Santa Clara Subbasin; it is intended to display spatial extent of past and recent nitrate results.

Figure 5 – Map of All Coyote Valley Nitrate Well Test Results

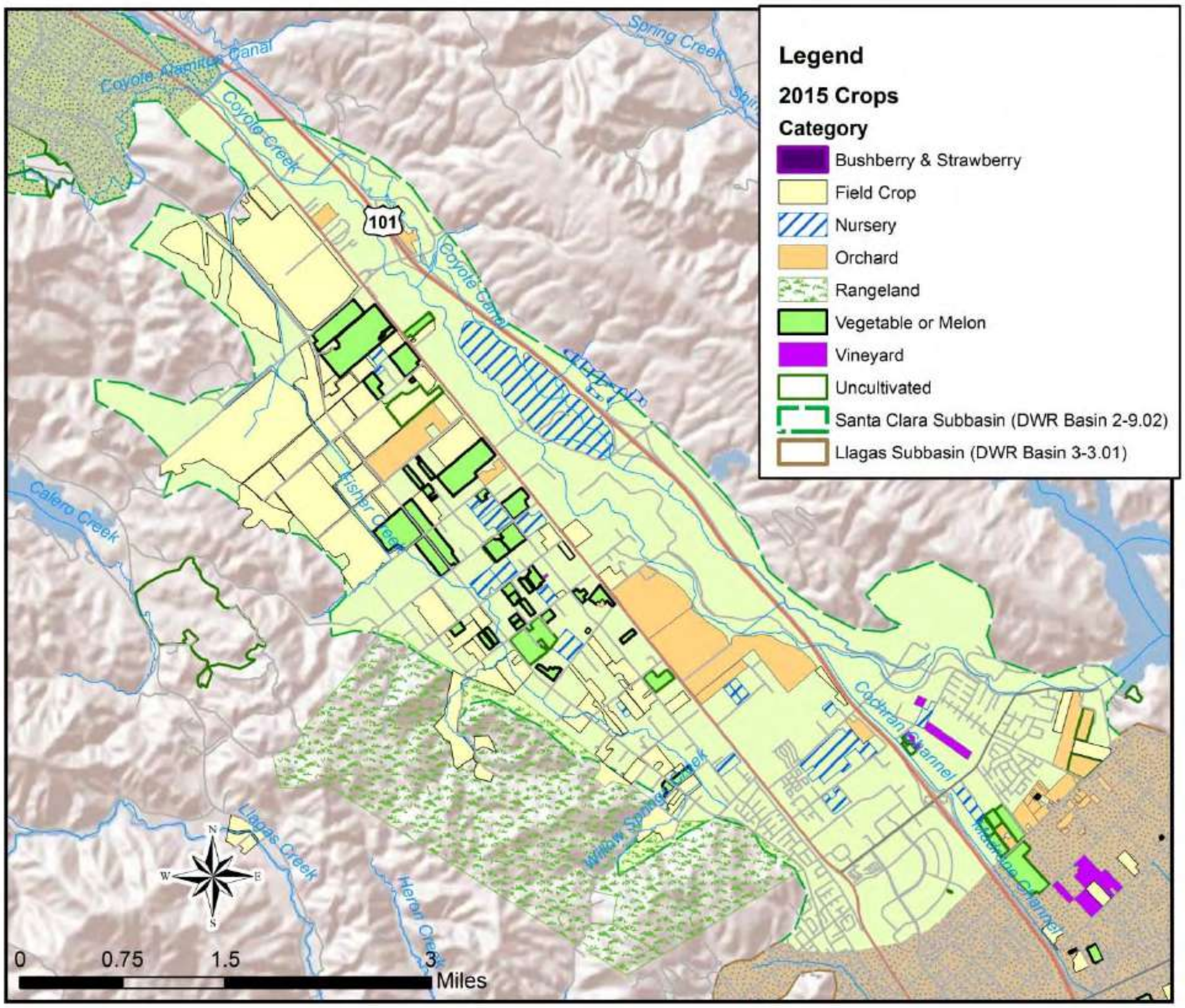


Figure 6 – 2015 Cropping Patterns in Coyote Valley
(Based on Data from the Santa Clara County Agriculture Commissioner's Office)

The SNMP discusses nitrate from fertilizer application in Section 3.3.2.1. The factors used to estimate fertilizer type and use for different crops were obtained from the University of California Cooperative Extension. Factors used and calculations of nitrogen loading are provide in Tables 1 and 2, below, using 2011 crop data obtained from the Santa Clara County Agriculture Commissioner's office.

Commodity	Nitrogen, lbs/acre/yr	lbs NO3/acre /yr, leached	Commodity	Nitrogen, lbs/acre/yr	lbs NO3/acre /yr, leached
ALFALFA	115	178.3	LETTUCE HEAD	190	294.6
ALMOND	200	310.1	LETTUCE LEAF	190	294.6
AMARANTH, EDIBL	75	116.3	LETTUCE ROMAINE	220	341.1
APPLE	21	32.6	MELON	137	212.4
APRICOT	40	62.0	MINT	200	310.1
ARRUGULA	125	193.8	MIZUNA	190	294.6
ARTICHOKE	200	310.1	NAPA CBG TGHT H	180	279.1
ARTICHOKE SEED	200	310.1	NECTARINE	150	232.6
BARLEY	65	100.8	N-GRNHS FLOWER	0	0.0
BASIL	100	155.1	N-GRNHS PLANT	0	0.0
BEAN DRIED	96	148.8	N-OUTDR FLOWERS	0	0.0
BEAN DRIED SEED	96	148.8	N-OUTDR PLANTS	0	0.0
BEAN SPROUT	0	0.0	N-OUTDR TRANSPL	0	0.0
BEAN SUC SEED	96	148.8	OAT	150	232.6
BEAN SUCCULENT	165	255.8	OF-FLWRNG PLANT	0	0.0
BEAN UNSPECIFD	130	201.6	OLIVE	135	209.3
BEET	165	255.8	ONION DRY ETC	180	279.1
BLACKBERRY	60	93.0	OP-FLWRNG PLANT	0	0.0
BOK CHOY LSE LF	175	271.3	OP-FOLIAGE PLNT	0	0.0
BROCCOLI	220	341.1	OP-TURF	100	155.1
BROCCOLI SEED	220	341.1	ORANGE	110	170.6
CABBAGE	180	279.1	OT-PALM	0	0.0
CAULIFLOWER	240	372.1	PASTURELAND	42	65.1
CAULIFLOWR SEED	240	372.1	PEACH	150	232.6
CELERY	200	310.1	PEAR	150	232.6
CHERRY	60	93.0	PEPPER FRUITNG	388	601.6
CHRISTMAS TREE	92	142.6	PEPPERMINT	200	310.1
CHRYSAN GARLAND	0	0.0	PERSIMMON	108	167.5
CILANTRO	148	229.5	PLUM	125	193.8
CORN, FIELD	240	372.1	PRUNE	150	232.6
CORN, HUMAN CON	210	325.6	PUMPKIN	137	212.4
CUCUMBER	190	294.6	RADICCHIO	125	193.8
CUCUMBER SEED	190	294.6	RANGELAND	0	0.0
FORAGE HAY/SLGE	80	124.0	RAPE	175	271.3
FRISEE	180	279.1	RASPBERRY	60	93.0
GAI CHOY LSE LF	180	279.1	RESEARCH COMMOD	0	0.0
GAI LON TGHT HD	180	279.1	SPINACH	60	93.0
GARLIC	200	310.1	SQUASH	317	491.5
GF-CARNATION	0	0.0	STRAWBERRY	150	232.6
GF-CHRYSANTHMUM	0	0.0	SUNFLOWER	95	147.3
GF-FLOWER SEED	0	0.0	SWISS CHARD	180	279.1
GF-FLWRNG PLANT	0	0.0	TOMATO	164	254.3
GF-FOLIAGE PLNT	0	0.0	TOMATO PROCESS	182	282.2
GRAPE	20	31.0	VEGETABLE	104	161.3
GRAPE, WINE	20	31.0	WALNUT	200	310.1
GT-FLWRNG PLANT	0	0.0	WATERCRESS	50	77.5
KALE	180	279.1	WHEAT	100	155.1
KIWI	161	249.6	WHEAT FOR/FOD	100	155.1

Table 1 – University of California Cooperative Extension Crop Factors for Nitrogen Loading. Note: These factors were used to calculate fertilizer loading in Table 3-15 in the SNMP.

	UCCE Crop Factors		Coyote Valley			Santa Clara Plain			Santa Clara Subbasin Total	
Commodity	**Nitrogen, lbs/ acre/ year**	**Nitrate as NO_3 lbs /acre/year , leached**	**Acres**	**Nitrate as NO3 Loading, lbs/yr**	**Salt as TDS Loading, lbs/yr**	**Acres**	**Nitrate as NO3 Loading, lbs/yr**	**Salt as TDS Loading, lbs/yr**	**Nitrate as NO3 Loading, lbs/yr**	**Salt as TDS Loading, lbs/yr**
Alfalfa	115	178	313.3	55,869	36,033				55,870	36,030
Amaranth, Edible	75	116	4.5	525	338				520	340
Apple	21	33	10.5	343	222	2	50	32	390	250
Apricot	40	62	35.9	2,226	1,436	78	4,839	3,121	7,070	4,560
Basil	100	155	2.3	356	229				360	230
Bean Succulent	165	256				1	383	247	380	250
Bean Unspecified	130	202	3.0	602	389				600	390
Bok Choy	175	271	14.1	3,828	2,469				3,830	2,470
Cherry	60	93	378.8	35,243	22,730	11	988	637	36,230	23,370
Corn, retail	210	326	81.9	26,670	17,201	16	5,364	3,459	32,030	20,660
Forage Hay/Silage	80	124				131	16,287	10,504	16,290	10,500
Grape	20	31				0	10	7	10	7
Grape, Wine	20	31	6.5	202	130	56	1,732	1,117	1,930	1,250
Kiwi	161	250	3.7	935	603				930	600
Oat	150	233	121.1	28,172	18,169	240	55,884	36,043	84,060	54,210
Olive	135	209				150	31,484	20,306	31,480	20,310
Op-Turf	100	155	15.7	2,438	1,573				2,440	1,570
Orange	110	171				15	2,528	1,631	2,528	1,631
Pastureland	42	65				150	9,753	6,290	9,753	6,290
Peach	150	233				1	153	99	150	100
Peppers, Fruiting	388	602	71.5	43,024	27,749	2	1,204	776	44,230	28,520
Prune	150	233				3	589	380	590	380
Squash	317	492				1	490	316	490	320
Tomato	164	254				2	509	328	510	330
Walnut	200	310				1	254	164	250	160
Wheat	100	155	172.7	26,782	17,273	136	21,025	13,560	47,810	30,830
Wheat (Fodder)	100	155	37.3	5,784	3,731	11	1,748	1,127	7,530	4,860
TOTAL, tons per year			**1,273**	**116**	**75**	**1,007**	**78**	**50**	**194**	**125**

Table 2 – Calculated Salt and Nitrate Loading from Fertilizer Sources in the Santa Clara Subbasin, Based on 2011 Cropping Patterns (used to calculate values presented in SNMP Table 3-15)

June 1, 2016

Ms. Vanessa de la Piedra
Groundwater Monitoring and Analysis Unit Manager
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118

Sent via Email to vdelapiedra@valleywater.org

SUBJECT: Concurrence with the Salt and Nutrient Management Plan for the Santa Clara Subbasin, Santa Clara County

Dear Ms. de la Piedra:

Thank you for the opportunity to review the Water District's 2014 Salt and Nutrient Management Plan for the Santa Clara Subbasin (SNMP). We're pleased to concur with the SNMP as it provides a solid foundation for guiding decision making and promotes recycled water use in the Santa Clara Valley.

As a result of this process, we've come to better understand groundwater conditions in the Santa Clara and Coyote Valleys, and the challenges the District faces related to the quality and reliability of imported surface water that is used for groundwater recharge. We applaud the innovative solution to use advanced purified water to help manage salt and nutrient contributions to the basin and achieve the District's 10% recycled water goal. We also recognize the District's efforts to address elevated nitrate conditions in the Coyote Valley and provide outreach and solutions to private well owners.

We would like to acknowledge the professionalism and hard work of District staff to address our feedback on earlier SNMP versions. As a result, we are confident that the SNMP will effectively manage salts and nutrients from all sources, and will attain water quality objectives and protect beneficial uses of groundwater. As such, the SNMP meets the requirements of the State Water Resources Control Board's 2009 "Policy for Water Quality Control for Recycled Water".

Water Board staff will continue working cooperatively with District staff to implement the recommendations presented in the SNMP. In particular, we will collaborate with District staff to better understand the nature of elevated nitrate concentrations in groundwater within the Coyote Valley, and how sources can most effectively be addressed to protect domestic use of groundwater.

In the next few months we anticipate bringing a resolution of support for the District's SNMP to our Board and will coordinate with District staff as appropriate.

If you have any questions, please contact Alec Naugle of my staff at (510) 622-2510 or via email at alec.naugle@waterboards.ca.gov.

Sincerely,

Dyan Whyte
Assistant Executive Officer

Cc: Tom Mohr (tmohr@valleywater.org)

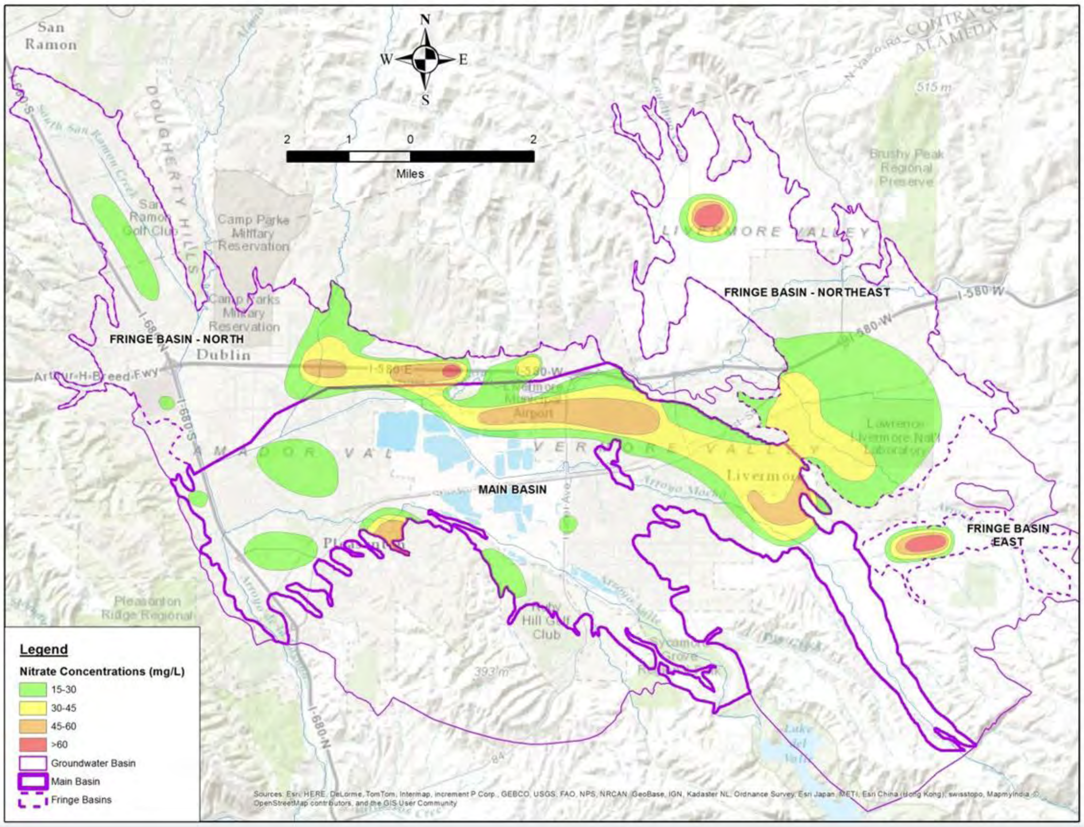
Santa Clara Valley Water District

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3686
Phone: (408) 265-2600
Fax: (408) 266-0271
www.valleywater.org

NUTRIENT MANAGEMENT PLAN

LIVERMORE VALLEY GROUNDWATER BASIN

July 2015



PREPARED BY:

ZONE 7 WATER AGENCY
100 North Canyons Parkway
Livermore, CA 94551
(925) 454-5000

PREPARED BY:

ZONE 7 WATER AGENCY STAFF

Matt Katen, P.G. – *Principal Geologist*
Tom Rooze, P.G. – *Associate Geologist*

Contributors:

Jill Duerig, P.E. – *General Manager*
Kurt Arends, P.E. – *Assistant General Manager*
Jarnail Chahal, P.E. – *Engineering Manager*
Colleen Winey, P.G. – *Assistant Geologist*

ZONE 7
ALAMEDA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT

BOARD OF DIRECTORS

RESOLUTION NO. 15-71

INTRODUCED BY DIRECTOR QUIGLEY
SECONDED BY DIRECTOR PALMER

Approving and Adopting the Nutrient Management Plan

WHEREAS, in 2009 the State Water Resources Control Board adopted a Recycled Water Policy that requires Salt/Nutrient Management Plans (SNMPs) be completed for all groundwater basins in California that did not already have Salt Management Plans; and

WHEREAS, Zone 7 completed a Salt Management Plan (SMP) for the Livermore Valley Groundwater Basin in 2004 that was approved by the Regional Water Quality Control Board – San Francisco Region on September 24, 2004; and

WHEREAS, the Livermore Valley Groundwater Basin is currently subject to a Groundwater Management Plan adopted by Zone 7 pursuant to its authority under the California Groundwater Management Planning Act (Water Code Sections 10750, et seq); and

WHEREAS, Water Code section 10753.7 requires the agency implementing a Groundwater Management Plan to include components relating to the monitoring and management of groundwater quality, and directs agencies to work cooperatively to achieve that objective; and

WHEREAS, Zone 7 recently developed a draft Nutrient Management Plan (NMP) to amend its existing SMP thus satisfying the State requirement for a SNMP with the combination of the two management plans; and

WHEREAS, the NMP was developed with input from the San Francisco Bay Regional Water Quality Control Board (RWQCB), Alameda County Environmental Health (ACEH), Alameda County Community Development Agency (Alameda CDA), Zone 7's Retailers (City of Livermore, DSRSD, City of Pleasanton, California Water Service), local septic tank owners, and other interested parties between 2013 and 2015; and

WHEREAS, the NMP estimates that average nitrate concentrations are below the Basin Objective and are not expected to increase significantly during or following the buildout of the Valley's population; and

WHEREAS, the NMP recommends the continued use of existing "best management practices" for fertilizer application, recycled water irrigation, livestock manure management, and winery wastewater disposal as protective measures; and

WHEREAS, the NMP identifies ten (10) localized 'Areas of Concern' where nitrate concentrations in groundwater exceed the Maximum Contamination Limit (MCL) for drinking water in California and the RWQCB's Basin Plan Objective for the Livermore Valley Groundwater Basin; and

WHEREAS, the NMP recommends that in the development of the Local Area Management Plan (LAMP) ACEH incorporates special onsite wastewater treatment system (OWTS) permit requirements in five (5) of the 'Areas of Concern,' where wastewater disposal continues to be accomplished using OWTS, aimed at reducing the current nutrient loading in these areas over time; and

WHEREAS, a Notice of Exemption per the California Environmental Quality Act (CEQA) guidelines has been prepared and filed for the project.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of Zone 7 of the Alameda County Flood Control and Water Conservation District does hereby approve and adopt the February 2015 Nutrient Management Plan as the basis for Zone 7's nutrient management policy for future activities; and

BE IT FURTHER RESOLVED that the Board amends the existing Groundwater Management Plan for the Livermore Valley Groundwater Basin to incorporate the February 2015 Nutrient Management Plan; and

BE IT FURTHER RESOLVED that the General Manager is authorized to establish a rebate program to offset a portion of the incremental cost of installing an advanced system with nitrogen treatment in the Areas of Concern when no capacity is being added that is consistent with approved budgets.

ADOPTED BY THE FOLLOWING VOTE:

AYES: DIRECTORS FIGUERS, GRECI, McGRAIL, PALMER, QUIGLEY, RAMIREZ HOLMES, STEVENS

NOES: NONE

ABSENT: NONE

ABSTAIN: NONE

I certify that the foregoing is a correct copy of a Resolution adopted by the Board of Directors of Zone 7 of Alameda County Flood Control and Water Conservation District on June 17, 2015.

By: ______________________

President, Board of Directors

Table of Contents

Page

List of Figures Page

Acronyms and Abbreviations

Abbrev	Description	Abbrev	Description
AC	Assimilative Capacity	LWRP	Livermore Water Reclamation Plant
ACEH	Alameda County Environmental Health	MCL	Maximum contaminant level
AF	Acre-feet	mg/L	Milligrams per liter
AF/yr	Acre-feet per year	N	Nitrogen
bgs	Below ground surface	NMP	Nutrient Management Plan
BMO	Basin Management Objective	NO_3	Nitrate Ion
BMP	Best Management Practices	OWTS	Onsite Wastewater Treatment System
BOs	Basin Objectives	PO_4	Phosphate Ion
CASGEM	CA Statewide GW Elevation Monitoring	POTW	Publicly owned treatment works
CDA	Community Development Agency	ROWD	Request of Waste Discharge
CDPH	California Department of Health Services	RRE	Rural Residential Equivalence
CEC	Constituents-of-emerging-concern	SBA	South Bay Aqueduct
CIMIS	California Irrigation Management System	SCVWD	Santa Clara Valley Water District
CEQA	California Environmental Quality Act	SCWA	Sonoma County Water Agency
CWS	California Water Service	SMP	Salt Management Plan
DSRSD	Dublin San Ramon Services District	SNMP	Salt Nutrient Management Plan
DWR	California Department of Water Resources	State Water Board	State Water Resources Control Board
EIR	Environmental Impact Report	SWP	State Water Project
ft	Feet	TAF	Thousand acre-feet
GIS	Geographic information systems	TDS	Total dissolved solids
GWMP	Groundwater Management Plan	TKN	Total Kjeldahl nitrogen
GPQ	Groundwater Pumping Quota	USGS	U.S. Geological Survey
LAFCO	Local Agency Formation Commission	Water Board	Regional Water Quality Control Board
LAMP	Local Agency Management Program	WDR	Waste Discharge Requirements
lbs	Pounds	WWMP	Wastewater Management Plan

ES Executive Summary

ES 1 Background

This Nutrient Management Plan (NMP) was developed for the Livermore Valley Groundwater Basin (California Department of Water Resources [DWR] Basin No. 2-10) by the Zone 7 Water Agency (Zone 7).

The NMP provides an assessment of the existing and future groundwater nutrient concentrations relative to the current and planned expansion of recycled water projects and future development in the Livermore Valley. The NMP also presents planned actions for addressing positive nutrient loads and high groundwater nitrate concentrations in localized Areas of Concern where the use of onsite wastewater treatment systems (OWTS) (i.e., septic tank systems) is the predominant method for sewage disposal.

The NMP was prepared as an addendum to Zone 7's Salt Management Plan (SMP) which was adopted by the Zone 7 Board of Directors in 2004 to address salt loading in the groundwater basin and to fulfill the requirements of the joint Master Water Recycling Permit (Order No. 93-159) and General Water Reuse Order (General Order No. 96-011). Because the SMP was incorporated into Zone 7's Groundwater Management Plan (GWMP) for the Basin in 2005, the NMP is now also incorporated into Zone 7's GWMP. This NMP is exempt from the California Environmental Quality Act, and a notice of exemption has been filed with the Alameda County Clerk-Recorder.

The State Water Resources Control Board (State Water Board) adopted a Recycled Water Policy in 2009 (State Water Board Resolution No. 2009-0011) and an amendment to the policy in 2013 (State Water Board, Resolution No. 2013-0003) to encourage and facilitate the increased use of recycled water statewide. The policy requires among other things, that Salt/Nutrient Management Plans (SNMP) be completed for all groundwater basins in California. With the addition of this NMP, Zone 7's SMP is akin to the SNMP required by the State's Recycled Water Policy.

The NMP was developed with support and input from the San Francisco Bay Regional Water Quality Control Board (Water Board), Alameda County Environmental Health Department (ACEH), Alameda County Community Development Agency (Alameda CDA), Zone 7's Retailers (City of Livermore, City of Pleasanton, Dublin San Ramon Services District [DSRSD], and California Water Service), and other stakeholders and interested public. For this purpose, several meetings were held with these stakeholders between June 2013 and June 2015.

ES 2 Groundwater Basin Characteristics and Nitrate Concentrations

The Livermore Valley Groundwater Basin is an inland alluvial basin underlying the east-west trending Livermore-Amador Valley (Valley) and Livermore Uplands in northeastern Alameda County. For this NMP, the groundwater basin has been divided into four basin areas:

- Main Basin
- Fringe Basin North
- Fringe Basin Northeast
- Fringe Basin East

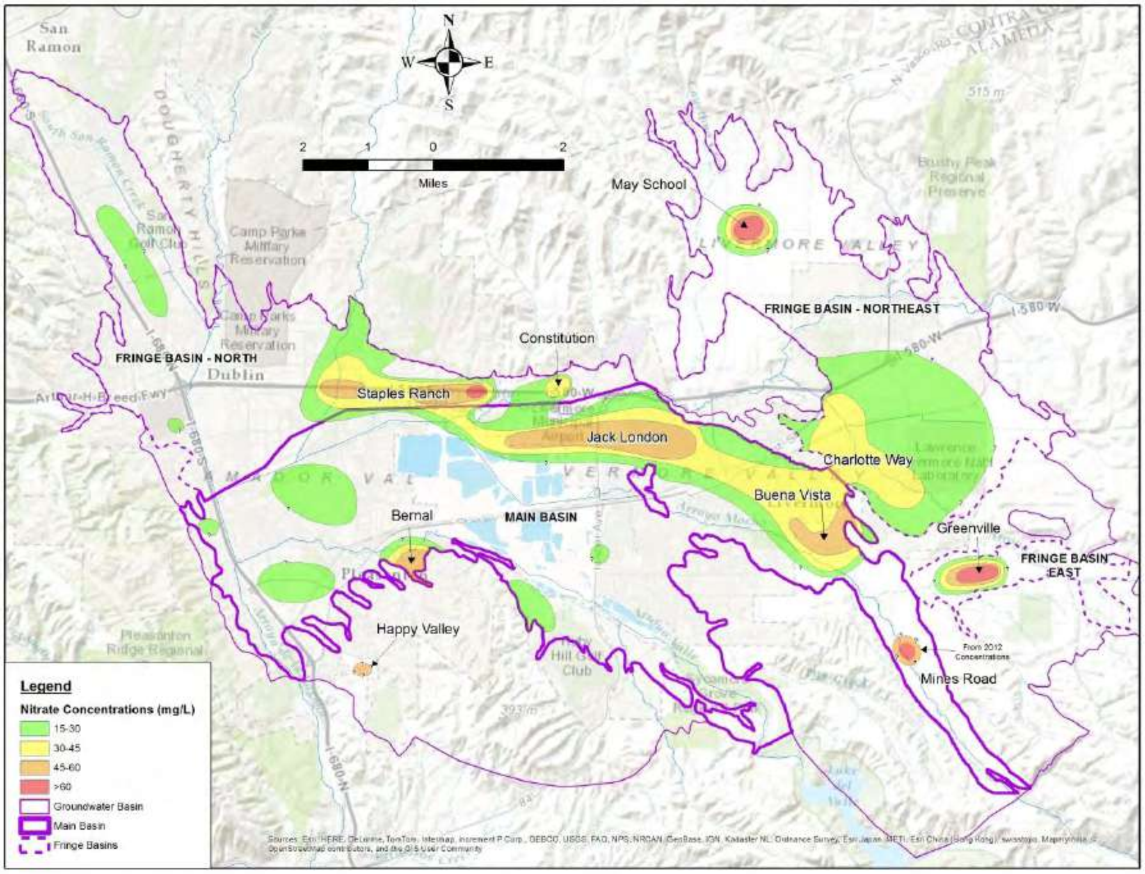
The Main Basin has been further divided into an upper and lower aquifer. The Main Basin is a portion of the groundwater basin that contains the highest yielding aquifers and generally the best quality groundwater. It is an important source of drinking water for the communities that overly it. The fringe basins contain slightly higher salinity water and generally yield low quantities of water to wells. Some groundwater flows from the Fringe Basin North into the Main Basin aquifer where it comingles with Main Basin groundwater, but it is believed that very little of the groundwater in the two eastern fringe basins comingles with Main Basin groundwater. The aquifers beneath the Livermore upland areas south of Livermore and Pleasanton typically only yield small amounts of groundwater to wells, and are not expected to be impacted by existing or planned recycled water projects; therefore, with the exception of the high OWTS use area of unincorporated Happy Valley, the upland portion of the groundwater basin is not addressed in this plan. The locations of the groundwater basin areas and Happy Valley are shown below in Figure ES-1.

Zone 7's GWMP program monitors groundwater quality throughout the basin areas. Of the two main groundwater quality parameters being monitored as nutrient contamination indicators (nitrate and phosphate), only nitrate has been detected at significant concentrations in the basin areas. The Basin Objective (BO) for nitrate in groundwater is 45 mg/L (measured as NO_3) or less for all of the NMP basin areas (*California State Water Board, 2011*). This is the same value adopted by the California Department of Health as the maximum contamination limit (MCL) for drinking water.

Average nitrate concentrations (as NO_3) in the Main and Fringe Basins range from 11 to 15 mg/L. Assimilative capacity, which represents the capacity of a groundwater basin to absorb pollutants, is calculated by subtracting the average concentration from the BO. The assimilative capacities of the basins range from 30 to 34 mg/L. While average nitrate concentrations in the basin areas are below the BO, and ample assimilative capacity exists in each basin area for nitrate, there are ten localized Areas of Concern within the groundwater basin that have nitrate concentrations above the BO (see *Figure ES-1* below). These ten "hot spots" are believed to be vestiges of past agricultural land uses and processes, and former municipal wastewater and sludge disposal practices; however, five of the areas are outside of municipal Urban Growth Boundaries where sewage disposal continues to be by OWTS. They are:

- Happy Valley
- Buena Vista
- Mines Road
- May School
- Greenville

Figure ES-1: Nitrate Concentrations (Upper Aquifer) and Areas of Concern



ES 3 Nutrient Loading Evaluation

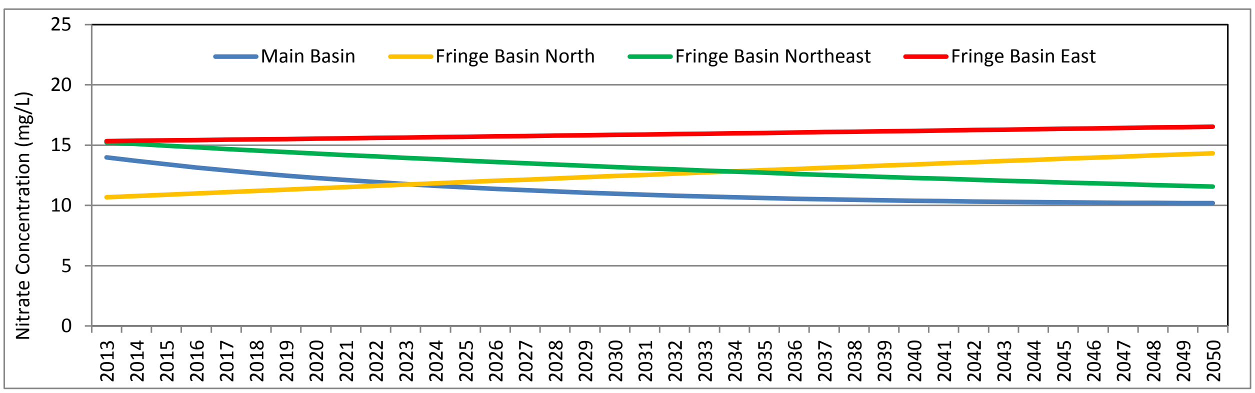
Nitrate contamination in groundwater supplies is typically the result of nitrogen-containing compounds being leached from the surface or soil column and mixing with the ambient groundwater. Nitrogen exists in the environment in many forms and can change forms as it moves through the soil. Sources of nitrogen loading include: fertilizers used on croplands, parks, golf courses, lawns, and gardens; sewage and other wastewaters disposed of onsite; decaying vegetation and other organic materials; animal manure and urine from pastures, animal enclosures, and other livestock boarding facilities; and nitrogen-fixing crops such as alfalfa, clover and vetch.

Within the soil zone, nitrogen compounds readily convert to ammonium and nitrate and/or are lost to volatilization, plant uptake and denitrification processes. Because nitrate is highly leachable and readily moves with water through the soil profile, excessive rainfall or over-irrigation will cause nitrate to leach below the plant's root zone and may eventually mix with groundwater.

Groundwater nitrate concentrations are good indicators of nutrient contamination, and graphing concentrations versus time can indicate whether nitrate conditions are changing or stable; however this NMP uses estimates of nitrogen loading from various identified sources to help evaluate whether nitrate concentrations will increase or decrease in the long-term. For this effort, annual nitrogen loading from each known source was estimated and summed spatially using geographic information systems (GIS) software. The results were then applied to a Zone 7-developed spreadsheet model to predict future nitrate concentrations for each basin area, taking into account planned land use changes and expansions of recycled water use.

The model results predict that average nitrate concentrations will decrease over time in the Main and Northeast Fringe basin areas, and will increase only slightly in the North and East fringe basin areas. The incremental increases in predicted nitrate concentrations due to the planned recycled water use expansions (shown on *Figure 3-14* and *Figure 4-1*) in the Main and Northeast Fringe basin areas are less than 1 mg/L over the 37 year model period, or about 3% of the assimilative capacity for these two areas. The future average total nitrate concentrations as predicted by the Zone 7 model are summarized by basin area in *Figure ES-2* below:

Figure ES-2: Projected Nitrate Concentrations by Basin



ES 4 Antidegradation Analysis

The State Water Board's Recycled Water Policy requires SNMPs to include an antidegradation analysis demonstrating that the recycled water projects included within the plan will collectively satisfy the requirements of State Water Board's "Antidegradation Policy" (Resolution No. 68-16). The antidegradation analysis for the Livermore Valley Groundwater Basin is summarized below in *Figure ES-3*:

Figure ES-3: Antidegradation Assessment

<table>
<tr><th>State Water Board Resolution No. 68-16 Component</th><th>Antidegradation Assessment</th></tr>
<tr><td>Water quality changes associated with proposed recycled water project(s) are consistent with the maximum benefit of the people of the State.</td><td rowspan="3">The irrigation projects will:
• contribute only a minimal increase (<1 mg/L) in groundwater nitrate concentrations at urban buildout.
• not use more than 20% of the available Assimilative Capacity
• not cause groundwater quality to exceed Basin Plan Objectives</td></tr>
<tr><td>The water quality changes associated with proposed recycled water project(s) will not unreasonably affect present and anticipated beneficial uses.</td></tr>
<tr><td>The water quality changes will not result in water quality less than prescribed in the Basin Plan.</td></tr>
<tr><td>The projects are consistent with the use of best practicable treatment or control to avoid pollution or nuisance and maintain the highest water quality consistent with maximum benefit to the people of the State.</td><td>Because all planned recycled water projects over the groundwater basin are landscape irrigation projects, most of the nitrogen from these projects will be removed by plant uptake and volatilization (and some by bacterial denitrification under certain conditions). Additional nitrogen loading will be avoided with the continued use of recycled water and fertilizer use best management practices (BMPs) (Section 6.1)</td></tr>
<tr><td>The proposed project(s) is necessary to accommodate important economic or social development.</td><td>The recycled water projects are crucial for continued sustainability of the Valley's water supply and are part of the urban growth plans for Cities of Dublin, Livermore, and Pleasanton.</td></tr>
<tr><td>Implementation measures are being or will be implemented to help achieve Basin Plan Objectives in the future.</td><td>Both the SMP and the NMP contain measures that have been or will be implemented to address current and future salt and nutrient loading of the Groundwater Basin.</td></tr>
</table>

ES 5 Nutrient Management Goals and Strategies

Although overall basin groundwater quality is not expected to degrade significantly due to ongoing and anticipated future nutrient loading, there is still a need to further assess, reduce or manage, and monitor nutrient loading to make sure that new high nitrate areas are not created by poor waste management practices or over-application of fertilizers and irrigation waters. In general, the NMP's short-term goals are to improve the understanding of current and historical nutrient impacts to the groundwater basin, and to minimize current and future nutrient loading while allowing for a reasonable amount of new loading from rural development and recycled water use increases. The long-term goal is to meet Basin Objectives in all parts of the groundwater basin.

The NMP strategies for achieving these goals include promoting the continued use of "best management practices" (BMPs) requirements aimed at minimizing nutrient loading from certain land uses (i.e., irrigated and fertilized turf and landscapes, confined livestock operations, vineyards and wineries). The NMP also promotes the enforcement of current County OWTS regulations and Zone 7 Wastewater Management policies and the future development and implementation of ACEH's Local Area Management Program (LAMP) to minimize nutrient loading from current and future development in unsewered areas of the basin. In order to address the localized high nitrate conditions in the Areas of Concern, the NMP advocates an adaptive management strategy that begins with:

1) Increasing the understanding of the extent and source(s) of the high nitrate concentrations in the Areas of Concern, and adjusting Area of Concern boundaries as appropriate;

2) Requiring new development projects within the unsewered Areas of Concern to minimize, or when practical, reduce the overall nutrient loading on the project parcel by installing only new, advanced OWTSs with nitrogen–reducing treatment; and

3) Continuing the monitoring of the nitrate concentrations and the success of these actions to reduce them.

Figure ES-4, below, provides a summary of the nutrient loading-specific goals for the active sources and the strategies developed to achieve the specific goals.

FIGURE ES-4
SUMMARY OF GOALS AND STRATEGIES
NUTRIENT MANAGEMENT PLAN

Goals	Strategies
Investigate Areas of Concern	
Goal 1: Obtain additional information in shallow aquifer zones of the Areas of Concern	Strategy 1a: Identify and sample additional existing domestic supply wells.
	Strategy 1b: Encourage additional hydrogeology studies in Areas of Concern as part of new commercial developments.
Fertilizer Application	
Goal 2: Minimize nitrogen loading from fertilizer application using BMPs	Strategy 2a: Promote the use of fertilizer BMPs (*Section 6.1.2*) to avoid over-application of fertilizers. Using results of soil and irrigation water chemical testing to determine the appropriate amount of additional fertilizer to apply is a good way to lessen excess leachable nitrogen in the soil.
	Strategy 2b: Limiting irrigation water application to the crop and landscape plants' agronomic rates will reduce the amount of nutrient-rich leachate that migrates below the vegetation root zone and into the underlying aquifer(s).
Recycled Water Irrigation	
Goal 3: Minimize nitrogen loading from recycled water irrigation projects	Strategy 3a: Follow Recycled Water Policy guidance for landscape irrigation projects. Minimize recharge of nitrogen by irrigating landscapes to the prescribed agronomic rates. Account for the nitrogen content of the recycled water when determining how much fertilizer to apply.
	Strategy 3b: Maintain low levels of nitrogen in the produced recycled water by keeping the nitrogen concentrations in the source water low and/or optimize low nitrogen levels in recycled water production.
Livestock Manure Management	
Goal 4: Minimize nitrogen loading from concentrated livestock facilities such as horse boarding, training, and breeding facilities	Strategy 4: Promote the use of BMPs (*Section 6.1.4*) such as manure management and controlling site drainage to prevent nutrient contamination of rainfall runoff and irrigation return flows that may percolate to groundwater and/or flow into surface water bodies.
Winery Process Wastewater	
Goal 5: Minimize nitrogen loading from onsite disposal of winery process wastewater	Strategy 5a: Require local wine producers and bottlers to apply for and comply with RWQCB WDRs for the proper treatment and disposal of winery process waste streams.
	Strategy 5b: Develop guidance document(s) to assist both project proponents and RWQCB staff with Report of Waste Discharge (ROWD) and WDR development and evaluations.
Septic Tanks - Outside Areas of Concern	
Goal 6: Minimize nitrogen loading from new onsite wastewater treatment systems (OWTS), e.g., septic tank systems.	Strategy 6a: Continue applying Zone 7 policies and County Ordinance and Regulation provisions, e.g., 1 Rural Residential Equivalence (RRE)/5 Ac max.
	Strategy 6b: Continue to work with ACEH to ensure that: 1) they are aware of groundwater nitrate issues in the Livermore Valley Groundwater Basin; 2) variance requests are given the appropriate scrutiny; and 3) their OWTS approvals are consistent with adopted NMP goals and objectives.
Septic Tanks - Inside Areas of Concern	
Goal 7: Reduce nitrogen loading from OWTS in Areas of Concern	Strategy 7a: Increase understanding of existing conditions and causes, and set realistic management goals and apply adaptive management as necessary.
	Strategy 7b: Require new development projects utilizing OWTS in the Areas of Concern to reduce and/or minimize the overall nitrogen loading to the property.
	Strategy 7c: On at least an annual basis, assess performance of wastewater treatment systems, estimate area-wide nitrogen loading, and monitor groundwater quality beneath the Areas of Concern.
Enhanced Attenuation	
Goal 8: Increase capture and infiltration of stormwater recharge to dilute and attenuate nitrate concentrations in groundwater	Strategy 8: Promote the use of Low Impact Development (LID) BMPs to capture and infiltrate rainfall runoff and irrigation return flow

ACEH = Alameda County Enviromental Health
BMPs = Best Management Practices
RWQCB = Regional Water Quality Control Board

ES 6 Plan Implementation

Zone 7 plans to simultaneously refine the extent of the Areas of Concern and minimize nitrogen loading from existing sources. To further characterize the range and size of nitrate contamination, Zone 7 will work with ACEH and CDA on encouraging or requiring hydrogeologic studies as part of new commercial developments, and with existing well owners to sample existing shallow wells for nitrate, and with permitees planning new wells or soil borings near Areas of Concern to include electronic logs (elogs) and/or groundwater sampling in their construction plans.

To minimize nitrogen loading from existing sources, the NMP encourages continued use of existing BMPs to minimize groundwater impacts from fertilizer and recycled water applications, livestock manure, and winery wastewater. Landscape and agriculture management industries promote careful metering of fertilizers and irrigation water as cost saving measures as well as environmental preservation measures. The State's Recycled Water Policy has built-in prohibitions for over application and runoff of recycled water. Permitted livestock facilities, such as commercial equine boarding facilities, typically have requirements for active manure management conditioned in their County-issued Conditional Use Permits (CUP). Likewise, onsite treatment and disposal (or recycling) of industrial wastewater, such as that generated by winemaking processes, requires a waste discharge permit from the Water Board which often contains provisions for minimizing and monitoring the nutrient loading from the onsite operations. The NMP also encourages continued use of existing Low Impact Development (LID) BMPs to increase the capture and infiltration of stormwater in order to help attenuate nitrate concentrations in groundwater. With continued implementation of these BMPs, future nitrate concentrations are projected to remain below 20% of the assimilative capacities calculated for each of the four Livermore Valley Groundwater Basin areas.

Continued application of these BMPs also helps to minimize nutrient loading in the high nitrate Areas of Concern. In the five Areas of Concern that are within sewered areas, fertilizer and recycled water use BMPs are important for keeping nitrogen loading low, whereas fertilizer use and manure management BMPs and Waste Discharge Requirements for wineries help prevent nitrate concentrations from worsening in the five Areas of Concern that are in the unincorporated portions of the Valley. However, because there is potential for onsite disposal of residential and commercial sewage to be a significant nitrogen loading component in the five unincorporated Areas of Concern, the NMP recommends implementing additional OWTS performance measures that will, at a minimum, prevent nitrogen loading from OWTS from increasing, and in the long term, should help decrease the loading in these nitrate "hot spots."

The recommended OWTS design criteria for new development in the five Areas of Concern that are outside municipal urban growth boundaries are summarized below in *Figure ES-5*. These criteria are designed to minimize nitrogen loading from new OWTS use and reduce existing loading in the five Areas of Concern over time by replacing conventional OWTS with new treatment systems when the opportunities arise.

The NMP recommends that the special OWTS permit requirements described in *Figure ES-5* be incorporated into the LAMP, which ACEH anticipates completing a draft in 2016, and finalizing it by 2018.

Figure ES-5: Proposed OWTS Requirements Inside Areas of Concern

OWTS Scenario	Parcel Size	New Requirement	Max Nitrogen Loading Rate[2]
New, upgraded, or replacement OWTS required by County OWTS Ordinance[1]	*≤ 7 acres*	*Must install/upgrade/replace with code-compliant nitrogen-reducing system(s).*	*23.8 lbs/year Per Parcel*
	> 7 acres	*Total nitrogen loading on the parcel must not exceed the Maximum Nitrogen Loading Rate. Commercial uses must also install/upgrade/replace with code-compliant nitrogen-reducing system(s).*	*3.4 lbs/year Per Parcel Acre*
		OR	
		Prepare hydrogeologic study that assesses current groundwater nitrate conditions beneath the site and demonstrates that nitrate concentration of total onsite recharge[3] *does not exceed 36 mg/L (80% of MCL) or the maximum concentration at the site, whichever is lower.*	*6.8 lbs/year Per Parcel Acre*

[1] Does not apply to existing, properly-working, and properly-sized OWTS.
[2] Loading rates calculated based on 1 RRE = 34 lbs/yr.
[3] Assume that 18% of rainfall naturally recharges to groundwater unless study demonstrates otherwise.

Zone 7 has a comprehensive water resources monitoring program in place as part of its GWMP. Monitoring elements include groundwater level monitoring, groundwater quality sampling, and climatological, surface water, land use, and wastewater and recycled water monitoring. Zone 7 will continue to use the data collected as part of these monitoring program elements to refine the nitrate concentration maps, Area of Concern boundaries, and the extent of the special OWTS permitting areas.

Zone 7 will identify data gaps and suggested locations and depths for new monitoring wells and/or soil borings for expedited groundwater sampling in the Areas of Concern. Zone 7 will provide this information to property owners and developers to assist in developing efficient strategies for fully characterizing nitrate concentrations and nitrogen loading for projects inside Areas of Concern. Zone 7 will also work with ACEH to develop an OWTS monitoring plan that may require that owners and developers install additional monitoring wells up-gradient and down-gradient of the high nitrate areas.

NMP-related monitoring results will be reported along with other groundwater sustainability and management information in Zone 7's annual Groundwater Management Program reports. Minor updates to the SMP/NMP will also be reported in the annual reports. As the assigned Groundwater Sustainability Agency for the groundwater basins located within its service areas, Zone 7 plans to incorporate the then current SMP/NMP into a Sustainable Groundwater Management Plan for the Livermore Valley Groundwater Basin before the due date of January 31, 2022.

1 Background

1.1 Introduction

Zone 7 Water Agency (Zone 7) has actively managed the Livermore Valley Groundwater Basin (California Department of Water Resources [DWR] Basin No. 2-10) for over 50 years. Zone 7 prepared a Salt Management Plan (SMP) in 2004 to address the increasing level of total salts in the Main Basin of the Livermore Valley Groundwater Basin. The SMP was designed to protect the long-term water quality of the Main Basin and is a permit condition of the Master Water Recycling Permit, Regional Water Quality Control Board (Water Board) Order No. 93-159, issued jointly to Zone 7, the City of Livermore, and the Dublin San Ramon Services District (DSRSD). The SMP was approved by the Water Board in October 2004 and was incorporated into Zone 7's Groundwater Management Plan (GWMP) in 2005. The status of salt management is updated in Zone 7's annual GWMP reports, copies of which are submitted to the Water Board to satisfy associated permit reporting requirements.

The State Water Resources Control Board (State Water Board) adopted a Recycled Water Policy in February 2009 (State Water Board Resolution No. 2009-0011) to encourage and facilitate the increased use of recycled water statewide. The policy requires among other things, that Salt/Nutrient Management Plans (SNMPs) be completed for all groundwater basins. The policy was amended in January 2013 (State Water Board Resolution No. 2013-0003) to include provisions regarding the monitoring of Chemicals of Emerging Concern (CECs). Because there is already an approved SMP for the Livermore Valley Groundwater Basin, a new SNMP is not required. However, to make the existing SMP comparable to the SNMP described in the Recycled Water Policy, Zone 7 has prepared this Nutrient Management Plan (NMP) as an addendum to its 2004 SMP, and, by extension, its GWMP. This plan does not cover other groundwater basins within the Zone 7 Service Area (Sunol Valley, San Joaquin – Tracy Subbasin) because there are no recycled water projects planned in those basins.

This report is organized into the following sections:

- **Section 1: Introduction** – provides an overview of the report.
- **Section 2: Livermore Valley Groundwater Basin Characteristics** – provides an overview of the groundwater basin including groundwater inventory and basin water quality.
- **Section 3: Basin Nutrient Evaluation** – describes how Zone 7 manages the groundwater basin for storage and water quality.
- **Section 4: Proposed Projects and Antidegradation Analysis** – describes the proposed recycled water irrigation projects and how this plan addresses the State's antidegradation policy (State Water Board Resolution Number 68 – 16).
- **Section 5: Goals and Strategies** – describes the nutrient management options and strategies and outlines the nutrient management goals for groundwater, wastewater, and recycled water.
- **Section 6: Plan Implementation** – describes the implementation measures and provides an overview of the basin monitoring program.
- **Section 7: References** – a list of reports and documents that were used to prepare this report.

1.2 Purpose and Management Objectives

This NMP summarizes Zone 7's approach to managing nutrient loading in the Livermore Valley Groundwater Basin. The main purposes of this nutrient management plan are to:

- Provide an assessment of the existing and future groundwater nutrient concentrations;
- Address the additional nutrient loading anticipated from the planned expansion of recycled water use over the groundwater basin; and
- Identify specific high groundwater nitrate areas and describe the planned management actions developed to address these impacted areas.

Zone 7's primary groundwater Basin Management Objective (BMO) is to provide for the control, protection and conservation of groundwater for future beneficial uses. The Water Board's Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) designates the following beneficial uses for groundwater in the Livermore Valley Groundwater Basin:

- Municipal and Domestic Supply
- Industrial Service and Process Supply
- Agricultural Supply

The Basin Plan also specifies Groundwater Quality Objectives for total dissolved solids (TDS) and nitrate for the Livermore Valley Groundwater Basin as follows:

Central Basin

TDS:	Ambient or 500 milligrams per liter (mg/L), whichever is lower
Nitrate (as NO_3):	45 mg/L

Fringe Subbasins

TDS:	Ambient or 1,000 mg/L, whichever is lower
Nitrate (as NO_3):	45 mg/L

Upland and Highland Areas

California domestic water quality standards set forth in California Code of Regulations, Title 22 and current county standards.

Waters designated for use as domestic or municipal water supply shall not contain concentrations of chemicals in excess of natural concentrations or the limits specified in California Code of Regulations, Title 22, Chapter 15, particularly Tables 64431-A and 64431-B of Section 64431, Table 64444-A of Section 64444, and Table 4 of Section 64443.

This "living" NMP incorporates adaptive management strategies. Regular updates will be provided in Zone 7's GWMP Annual Reports.

1.3 Regulatory Framework

1.3.1 Master Water Recycling Permit and Salt Management Plan

In 1993, the Water Board issued a joint Master Water Recycling Permit (Master Permit) (Order No. 93-159) to Zone 7, DSRSD, and the City of Livermore authorizing the three agencies to produce, distribute and manage recycled water throughout the Livermore-Amador Valley (Valley). The Master Permit required that an SMP be developed to fully offset both current salt loading from natural sources and operations and any future salt loading associated with new recycled water projects before any extensive water recycling projects could be implemented in the Valley.

Between 1994 and 1999, Zone 7 developed a draft SMP for the Livermore Valley Groundwater Basin through a collaborative process with its retail water supply customers and the public. The SMP was finalized and approved by the Water Board in 2004, and later incorporated into Zone 7's GWMP.

DSRSD and the City of Livermore have since filed for, and have been granted, coverage under a regional General Water Reuse Order (General Order No. 96-011) to administer their current and future landscape irrigation recycled water projects within their individual jurisdictions. As with the Master Permit, the General Order requires that an SMP be developed and approved. The Master Permit has been kept active by the Water Board at the request of DSRSD and Livermore only to address potential future groundwater recharge projects.

The City of Pleasanton has applied for permit coverage for their planned recycled water use projects under the same general order that DSRSD and City of Livermore's recycled water programs are operating under (General Order No. 96-011), and references Zone 7's approved SMP in its application to satisfy the order's SMP requirement.

1.3.2 State Recycled Water Policy

In 2009, the State Water Board adopted a Recycled Water Policy (State Water Board Resolution No. 2009-0011) which requires that SNMPs be completed for all groundwater basins using recycled water in California. However, since an approved SMP already exists for the Livermore Valley Groundwater Basin, a new SNMP is not required.

In June 2014, the State Water Board adopted General Water Quality Order No. 2014-0090-DWQ to promote and regulate landscape irrigation recycled water projects within the state. This general order was written to be consistent with the State's Recycled Water Policy in that it requires an SNMP be prepared and adopted by the Water Board. This NMP will be submitted to the Water Board as an amendment to the previously adopted SMP, and by extension Zone 7's GWMP.

1.3.3 Onsite Wastewater Treatment Systems (OWTS)

In June 2012, the State Water Board adopted a new policy that establishes siting, design, operation, and maintenance criteria for OWTS statewide. The purpose of this policy is to allow the continued use of OWTS by providing local agencies a streamlined regulatory tool with clear criteria and a flexible alternative for protecting water quality and public health from OWTS impacts where local conditions call for special requirements to be implemented. The OWTS Policy gives the Regional Water Boards the principal responsibility to oversee implementation, and calls for incorporating the OWTS Policy requirements into all Basin Plans. The San Francisco Bay Water Board adopted a Basin Plan amendment in June 2014 that incorporates the State's new OWTS Policy.

Alameda County Environmental Health (ACEH) enforces the State Water Board's policies for the operation, installation, alteration, and repair of individual onsite wastewater treatment systems (OWTS), (i.e., septic tank systems) in all of Alameda County under the authority of Chapter 15.18 of the Alameda County General Ordinance. The County's 2007 Onsite Wastewater Treatment Systems and Individual/Small Water Systems Regulations were developed in collaboration with the Water Board and Zone 7, and include special provisions for the Upper Alameda Creek Watershed, above Niles; such as a moratorium for new OWTS in unincorporated Happy Valley and a 5-acre minimum parcel size requirement for new OWTS in the remainder of the watershed.

The recent OWTS Policy allows for local agencies such as ACEH to implement or continue additional requirements like these that address local conditions and special concerns, but mandates that they be detailed in a Local Area Management Program (LAMP) developed in consultation with the Water Board. As such, ACEH is planning to work with Water Board staff and other local entities to develop an LAMP for Alameda County. ACEH anticipates completing a draft LAMP by 2016 and finalizing it by 2018. More information on the LAMP provisions envisioned for the areas overlying the Livermore Valley Groundwater Basin is provided in *Section 6.2.5.*

1.3.4 Zone 7 Wastewater Management Plan

In 1982, Zone 7 adopted its Wastewater Management Plan for the Unsewered, Unincorporated Area of Alameda Creek Watershed above Niles (WWMP) (*Zone 7, 1982*), which provides wastewater management policies intended to prevent further degradation of water quality from onsite wastewater disposal systems in the Livermore Valley, Sunol Valley, and Niles Cone groundwater basins. An additional policy was added in 1985 that limited the use of OWTS for new commercial development (Zone 7 Resolution 1165).

Although ACEH issues permits for OWTS in Alameda County, Zone 7 requires special approval for any of the following OWTS located within the Valley:

- Any new OWTS constructed, partially or fully, for a commercial or industrial use;
- Any conversion of a residential OWTS to a commercial or industrial use; or
- Any new residential OWTS that discharges greater than one rural residential equivalence of wastewater (i.e., greater than an annual average of 320 gallons/day) per 5 acres.

1.3.5 Groundwater Management Plan and Annual Reports

In 2005, Zone 7 compiled and documented all of its groundwater management policies, objectives, and programs, including its WWMP and SMP, into its comprehensive GWMP for the Livermore Valley Groundwater Basin, which the DWR recognizes as a SB1938-compliant GWMP. Zone 7's GWMP provides a detailed description of the groundwater management goals and practices used for the Livermore Valley Groundwater Basin, as well as detailed descriptions of the subbasin boundaries, hydrologic settings, historical groundwater use and overdraft, practices and measures used to prevent future overdraft and groundwater quality degradation, and stakeholder involvement during the development of the GWMP. Another significant portion of the GWMP addresses the numerous monitoring programs and protocols employed by Zone 7 to quantify, manage and protect the basin's groundwater supplies.

The GWMP itself is intended to be a "living document," and as such, undergoes periodic reevaluations and updates as conditions and management goals may change. Periodic adjustments to the GWMP are noted in the Annual Reports for the Groundwater Management Program (years 2005 to 2013), available online at www.zone7water.com. Major revisions are handled through a formal revision or addendum process that involves collaboration between Zone 7, the Water Board, Zone 7's retailers, and other stakeholders in an open public process.

In 2014, California passed three new bills (Senate Bills 1168 and 1319, Assembly Bill 1739) designed to achieve sustainable groundwater management in the state within the next 20 years. In SB 1168, Zone 7 was deemed the exclusive local agency to manage groundwater within its statutory boundaries with powers to comply with this new part of the Water Code.

1.4 Stakeholder Involvement

This NMP was developed with cooperation and input from regulatory agencies (e.g., Water Board, ACEH, Alameda County Community Development Agency [Alameda CDA]), property owners, Zone 7's Retailers (City of Livermore, DSRSD, City of Pleasanton, California Water Service), and other interested parties. The following meetings took place from June 2013 to June 2015 to discuss the calculation methods, results, and proposed actions:

- June 2013: Meeting at the Water Board with Sonoma County Water Agency (SCWA), RMC, Santa Clara Valley Water District (SCVWD) also in attendance.

- July 2013: Status meetings with Zone 7 Retailers.
- October 2013: Status meeting with Zone 7 Retailers
- October 2013: Public meeting with presentation to Zone 7's Board Water Resources Committee discussing preliminary results.
- January 2014: Follow-up public meeting and presentation to Zone 7's Board Water Resources Committee.
- March 2014: Progress meeting with the Water Board, SCVWD, SCWA.
- April 2014: Public stakeholder meeting with property owners and residents in May School, Buena Vista and Greenville Areas of Concern. Staff from ACEH and Alameda CDA were also in attendance.
- July 2014: Progress meeting with the Water Board, ACEH and Alameda CDA
- October 2014: Progress meeting with Zone 7 Retailers to discuss final results.
- November 2014: Progress meeting with the Water Board, ACEH, and Alameda CDA to discuss final results.
- November 2014: Public meeting with presentation to Zone 7's Board Water Resources Committee to discuss final results.
- February 2015: Public meeting with presentation to Zone 7's Board to present draft report.
- March 2015: Meeting with the Water Board to discuss comments on draft report.
- April 2015: Follow-up meeting with the Water Board to further discuss proposed revisions to draft report.
- May 2015: Follow-up meeting with the Water Board and ACEH staff to review changes to draft report. A copy of the draft NMP report was also provided to CDA for comments.
- June 2015: Public meeting with presentation to Zone 7's Board Water Resources Committee to discuss draft report.

In addition, a webpage was created on Zone 7's website at www.zone7water.com and maintained for the NMP project. Public meeting announcements, meeting presentation slides, and draft NMP documents were posted on the webpage or elsewhere on the website during the development and review of the draft NMP.

1.5 CEQA Considerations

This Nutrient Management Plan is exempt from the California Environmental Quality Act (CEQA). A notice of exemption has been filed with the Alameda County Clerk-Recorder. This Plan is an addendum to the existing Groundwater Management Plan, which in 2005 was also found to be exempt from CEQA.

The NMP provides a focused assessment of current and anticipated issues and concerns relating to nitrate concentrations in the groundwater basin. Best management practices are identified – focused primarily on minimizing nitrogen loading over the groundwater basin. The BMPs are inherently protective measures for the environment, and therefore no significant impacts will occur as a result of implementation of the Plan.

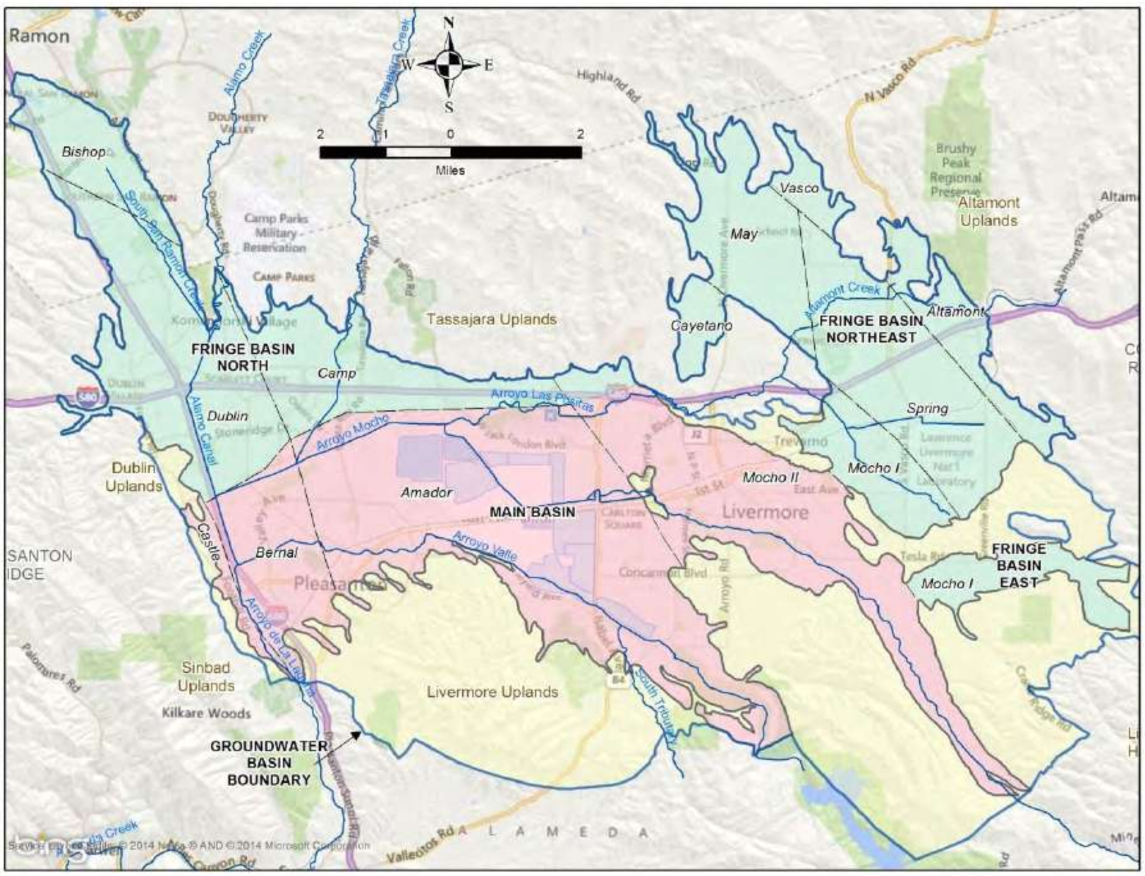
The plan does not identify the need for new or modified infrastructure. Should Zone 7 wish to undertake such a project in the future to help meet NMP related goals, it would require project-specific analysis under CEQA.

2 Basin Characteristics and Nitrate Concentrations

2.1 Groundwater Basin Overview

This section provides a brief summary of the hydrogeologic setting of the Livermore Valley Groundwater Basin. A more detailed description can be found in Zone 7's GWMP (*Zone 7, 2005a*). The Livermore Valley Groundwater Basin (*Figure 2-1*) is an inland alluvial basin underlying the east-west trending Livermore-Amador Valley (Valley) in northeastern Alameda County.

Figure 2-1: Map of Livermore Valley Groundwater Basin and Subbasins (DWR, 1974)



The Main Basin is a portion of the Livermore Valley Groundwater Basin that contains the highest yielding aquifers and generally the best quality groundwater. The Fringe Basins consist primarily of shallow, lower-yielding alluvium containing relatively poor quality groundwater. The upland area portions of the groundwater basin consist primarily of lower-yielding bedrock of the Livermore, Tassajara, and Green Valley Formations.

Six principal streams flow into and/or through the Main Basin and join in the southeast where the Arroyo de la Laguna flows out of the Valley. The five arroyos shown in *Figure 2-1* and listed below are essentially tributaries to the Arroyo de la Laguna:

- Arroyo Valle,
- Arroyo Mocho,
- Arroyo Las Positas,
- South San Ramon Creek,
- Tassajara Creek, and
- Alamo Creek/Canal.

Average precipitation ranges from 14 inches per year at the eastern edge of the Valley to over 20 inches per year in the western portion.

2.1.1 Geology

The Valley and portions of the surrounding uplands overlie groundwater-bearing materials. These materials consist of deposits from alluvial fans, streams, and lakes (of Pleistocene-Holocene age; less than about 1.6 million years old) that range in thickness from a few feet along the margins to nearly 800 feet (ft) in the west-central portion. The alluvium consists of unconsolidated gravel, sand, silt, and clay. The southeastern region of the Valley is the most important groundwater recharge area and consists mainly of sand and gravel that was deposited by the ancestral and present Arroyo Valle and Arroyo Mocho.

The Livermore Formation (Pleistocene age; 11,000 to 1.6 million years old), found below the majority of the alluvium in the groundwater basin, consists of beds of clayey gravels and sands, silts, and clays that are unconsolidated to semi-consolidated. However, the contact between the overlying alluvium and the Livermore Formation is nearly impossible to discern from drill cuttings and electrical logs. This formation is estimated to be 4,000 ft thick in the southern and western portion of the basin. These sediments tend to have low-yielding groundwater in the upland areas.

The Tassajara and Green Valley Formations, located in the Tassajara Uplands north of the Valley, are roughly Pliocene in age (1.6 to 5.3 million years old). They basically consist of sandstone, tuffaceous sandstone/siltstone, conglomerate, shale, and limestone. Water movement from these formations to the alluvium of the fringe and Main Basins is minimized by faults and angular unconformities or by stratigraphic disconformities along the formation-alluvium contacts.

The lateral movement of groundwater is restricted by the presence of geologic structures which create boundaries. These include the Parks Boundary (which was initially considered to be fault-related, but may be a depositional boundary between recent alluvium and older material), as well as the Livermore, Pleasanton, Calaveras, and Greenville faults.

2.1.2 Main and Fringe Basins

The Main Basin and Fringe Basins (shown on *Figure 2-1*) are comprised of the subbasins listed below:

Main Basin	**Fringe Basin North**	**Fringe Basin Northeast**	**Fringe Basin East**
• Castle	• Bishop	• Altamont	• Mocho I (southern portion)
• Bernal	• Camp	• Cayetano	
• Amador	• Dublin	• May	
• Mocho II		• Spring	
		• Vasco	
		• Mocho I (northern portion)	

All of the Valley's municipal supply wells are completed in the Main Basin aquifers, which have the highest transmissivity in the Valley. *Figure 2-2* (from *Zone 7, 2014*) shows the recharge area for the Main Basin. The most relevant of the Fringe Basins to the NMP is the Fringe Basin North due to its connectivity with the Main Basin (*Section 2.1.3.1*) and because of the amount of recycled water use, both existing and proposed, in that portion of the basin.

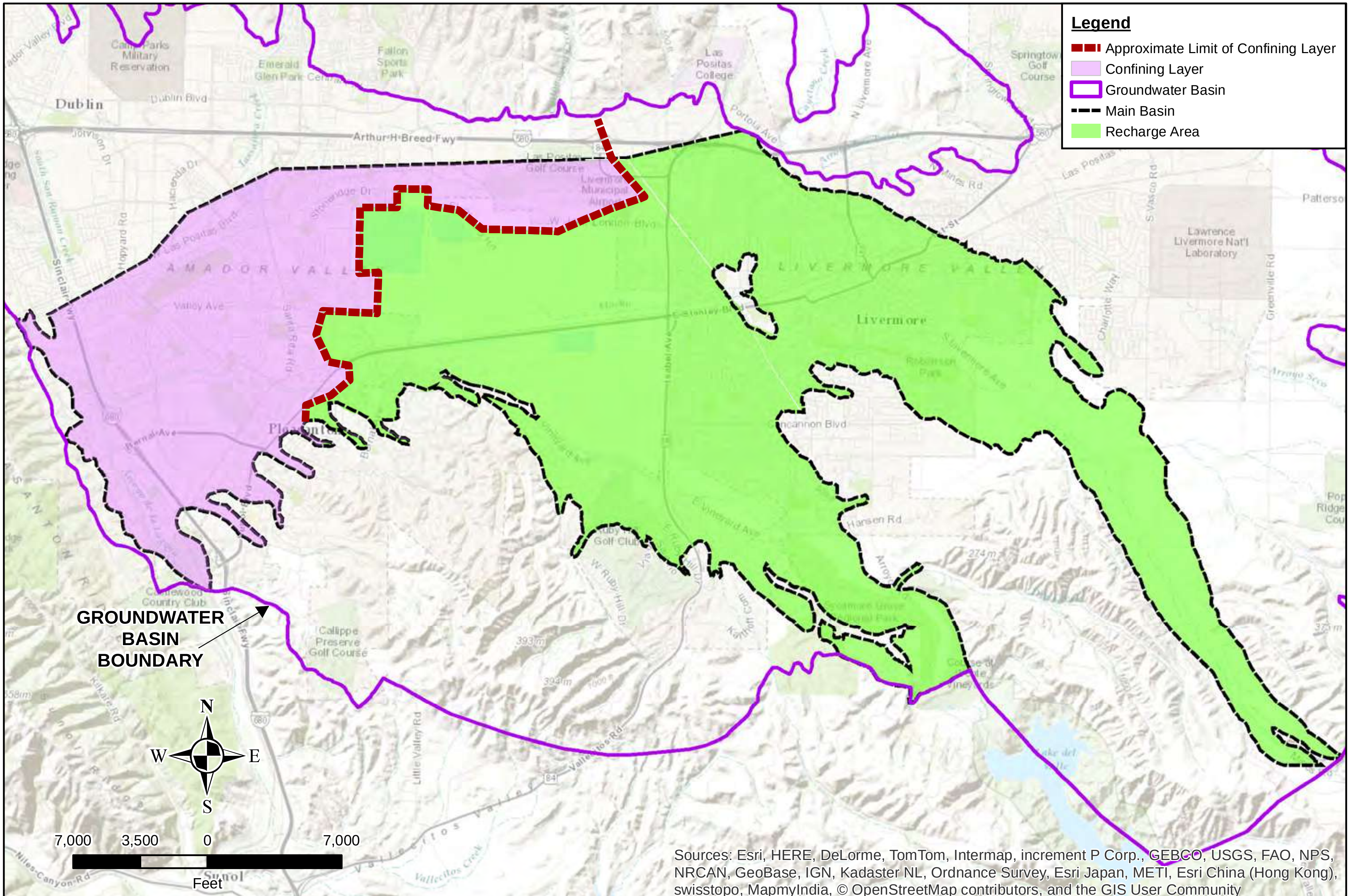
2.1.3 Aquifer Zones

2.1.3.1 Overview

Water levels in the Main Basin typically vary with seasonal recharge and extraction. The highest water levels usually are found at the end of the rainy season and lowest water levels at the end of the high demand summer/fall seasons; however, this trend can change during periods of extended drought or multi-year storage replenishment (*Section 2.2.1*). Zone 7 maintains a system of Key Wells that is used to monitor general conditions in each of the Main Basin's Subbasins.

Although multiple aquifers have been identified in the Main Basin alluvium, wells have been classified generally as being in one of two aquifer zones (upper or lower), separated by a relatively continuous silty-clay aquitard up to about 50 ft thick. Groundwater in both the upper and lower aquifer zones generally follows a westerly flow pattern, similar to the surface water streams, along the structural central axis of the valley toward municipal pumping centers.

The Main Basin is connected to the fringe areas primarily through the shallow alluvium, especially across the northern boundaries of the Main Basin. Subsurface inflow into the deeper portions of the Main Basin from the fringe subbasins is considered to be minor. The deeper aquifers of the Main Basin are primarily recharged through vertical migration of groundwater within the Main Basin itself.

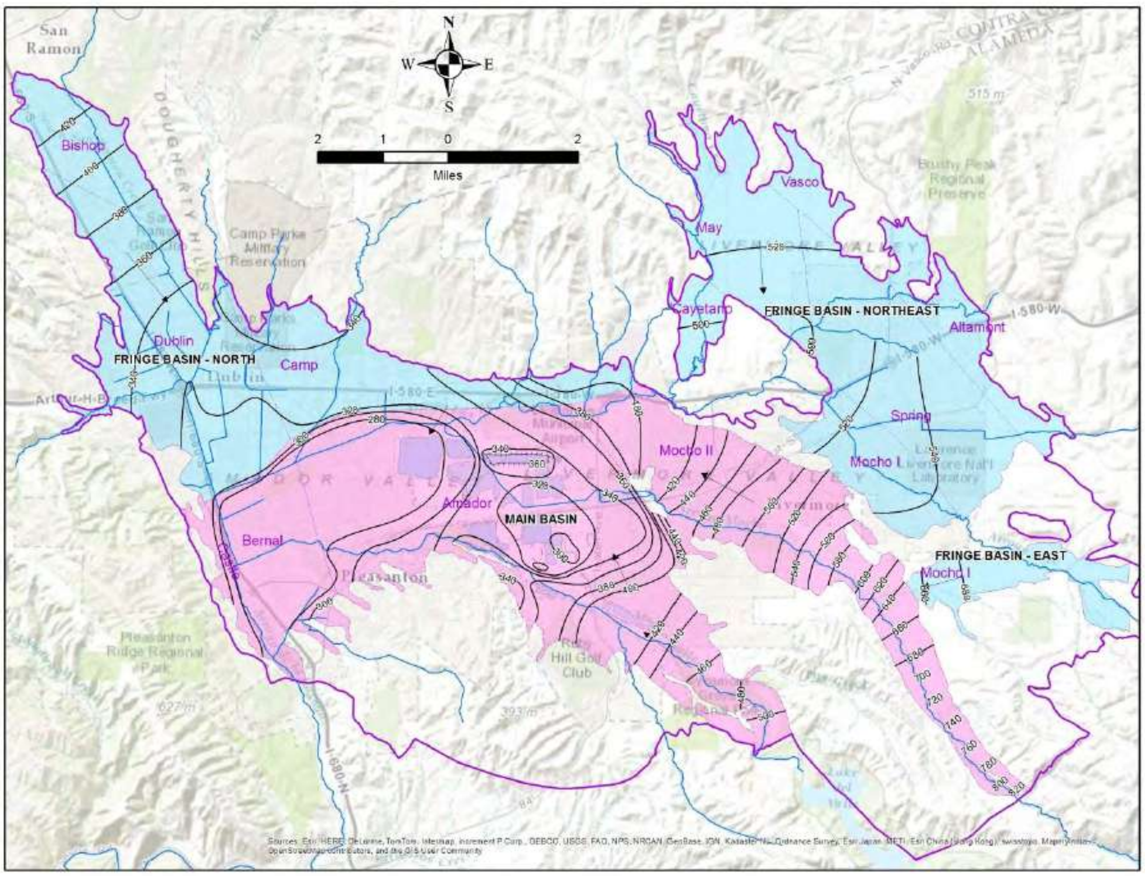


ZONE 7 WATER AGENCY 100 North Canyons Parkway, Livermore, CA	DRAWN: TR/CW	Scale: 1 " = 7,000 ft	**Figure 2-2** **Recharge Area and Confining Layer Above Upper Aquifer**
	REVIEWED: MK	Date: Oct 3, 2014	
	File: E:\PROJECTS\SNMP Update\Report\Figures\NMPFig2-02-RechargeMap.mxd		

2.1.3.2 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 a confining surficial clay layer typically 5 to 70 ft below ground surface [bgs] in the west and exposed at the surface in the east. The base of the upper aquifer zone ranges from 80 to 150 ft bgs. Groundwater in this zone is generally unconfined; however, when water levels are high, portions of the Upper Aquifer Zone in the western portion of the Main Basin can become confined.

Figure 2-3: Gradient in Upper Aquifer, October 2013

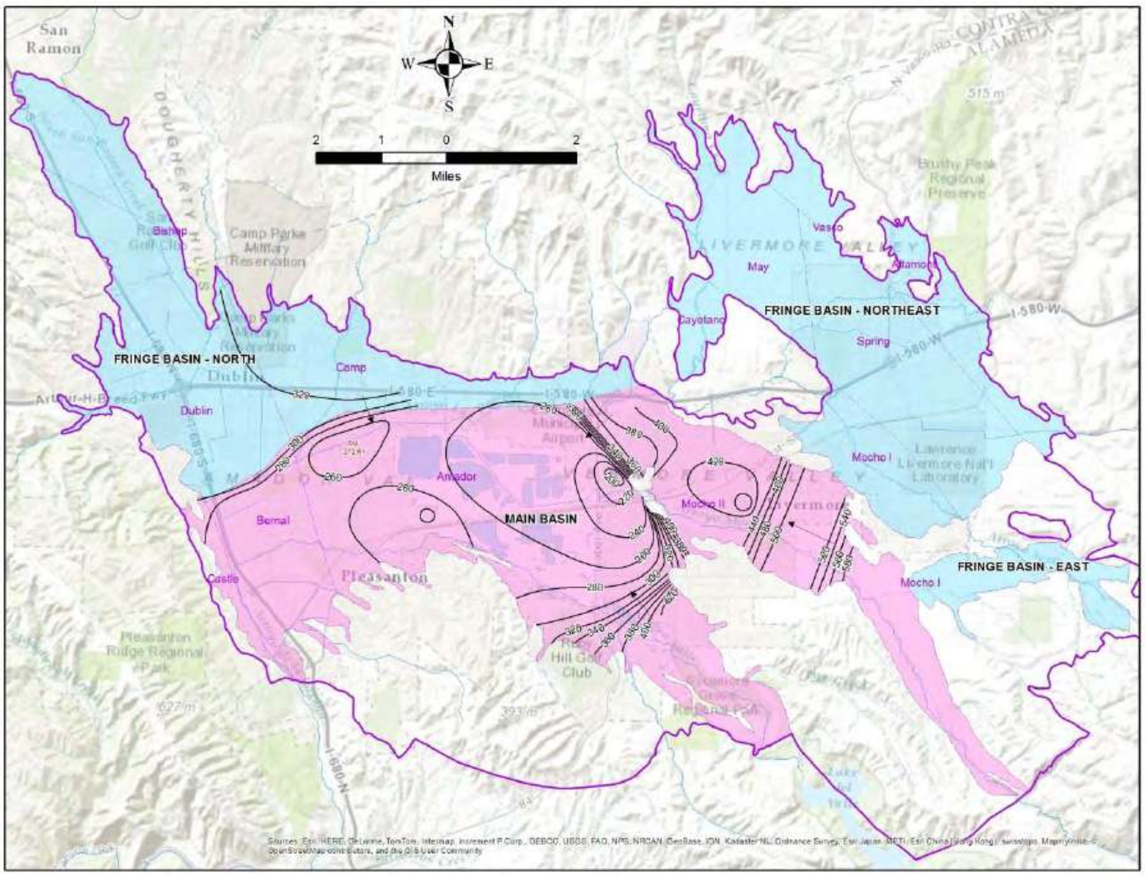


The groundwater gradient in the Upper Aquifer is generally from east to west towards the Bernal Subbasin, then to the south where groundwater flows out of the Main Basin (see *Figure 2-3* and *Figure A-1*). The gradient typically ranges from 0.005 to 0.025 with isolated areas of flatter or steeper gradients, especially near subbasin boundaries.

2.1.3.3 Lower Aquifer Zone

All sediments encountered below the clay 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, coarse-grained, water-bearing units interbedded with relatively low permeability, fine-grained units. It is believed that the Lower Aquifer Zone derives most of its water from the Upper Aquifer Zone through the leaky aquitard(s) when groundwater heads in the upper zone are greater than those in the lower zone.

Figure 2-4: Gradient in Lower Aquifer, October 2013



In the Lower Aquifer, the groundwater gradient within the Mocho II and Amador Subbasins ranges from 0.001 to 0.05 with groundwater flowing generally westward along the longitudinal axis of the Livermore-Amador Valley (see *Figure 2-4* and *Figure A-2*). In the Bernal Subbasin, the gradient (typically less than 0.006) is slightly to the north and east towards the Hopyard and Mocho Wellfields. Typically, the lowest elevations correspond to the municipal pumping wellfields within each subbasin.

There are two major subsurface structural features that act as partial barriers to the lateral movement of groundwater in the Lower Aquifer. These features define the sub-basin boundaries between the Mocho II and Amador Subbasins, and between the Dublin and Camp fringe basins and the Main Basin. Groundwater levels are significantly higher on the up-gradient sides of these partial barriers, but it is believed that groundwater cascades across these linear features providing some subsurface recharge for the adjacent subbasin.

2.1.4 Land Use

The majority of the land use over the Main and Fringe Basins is considered urban (60%), 7% is dedicated to gravel mining, 6% is used for irrigated agriculture, and the remaining areas are open space (27%).

Zone 7 has an established Land Use Monitoring Program that identifies changes in land use with an emphasis on changes in impervious areas and the volume and quality of irrigation water that could impact the volume or quality of water recharging the Main Basin. Land use data are derived from aerial photography, permit applications, field observations, and City and County planning documents. The current land use categories are:

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

The source of the water that supplies each of the land use polygons is also catalogued. The sources of water are identified as:

- Delivered (municipal) water
- Groundwater
- Recycled water

Land use and source water information are used to calculate rainfall and applied water recharge and salt and nutrient loading. Current and future land uses and their associated loading contributions are discussed in more detail in *Section 3*.

2.2 Groundwater Inventory

2.2.1 Conjunctive Use

Zone 7 imports extra surface water from the State Water Project's (SWP) South Bay Aqueduct (SBA) and artificially recharges it in the Main Basin (currently using stream percolation in losing reaches). This recharged SWP water is then available to Zone 7 for pumping during dry years. In normal years, Zone 7 operates its wells to augment production during demand peaks and whenever a shortage or interruption occurs in surface water supply or treatment. However, Zone 7 has also pumped groundwater as a salt management strategy. The decision of which well(s) to pump first is based on pumping costs, pressure zone needs, delivered aesthetic water quality issues, operational status, and demineralization facility capacity. Although reduced groundwater pumping may have a positive impact on groundwater storage and delivered water quality, increased groundwater pumping has a beneficial impact on the basin's salt loading because much of the salt in the pumped groundwater eventually leaves the basin as wastewater export.

2.2.2 Groundwater Storage

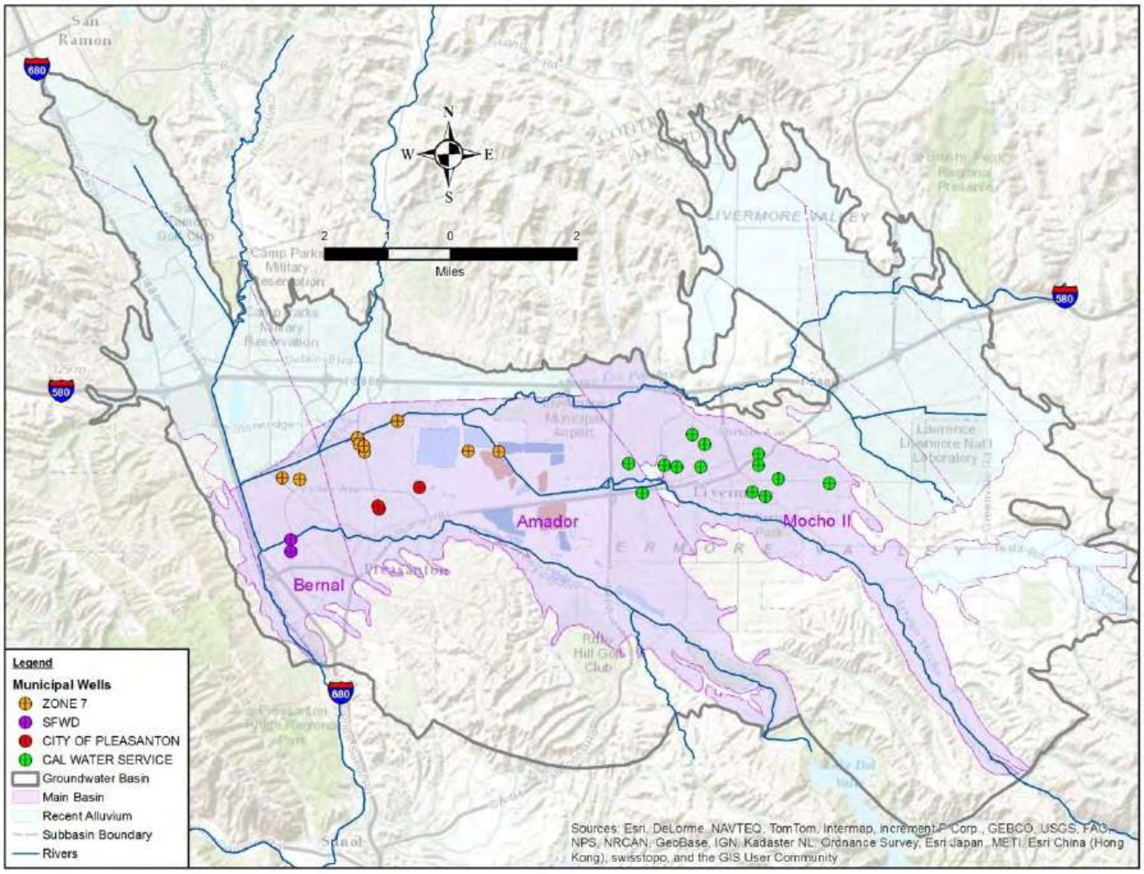
The Main Basin is estimated to hold up to 254 thousand acre-feet (TAF) whereas the fringe basins are estimated to hold 243 TAF. Zone 7 quantifies the total groundwater storage of the Main Basin by averaging the values computed by two independent methods: a groundwater elevation method and a hydrologic inventory method. Additional information on these two methods can be found in Zone 7's annual GWMP reports.

One of Zone 7's groundwater basin management objectives is to maintain water levels above historical lows to minimize the risk of inducing land subsidence. Therefore, not all of the total groundwater storage is considered accessible. "Operational" or "Available" Storage is the approximate amount of storage available above the historical low groundwater surface (about 126 TAF). The remainder (approximately 128 TAF) is estimated reserves stored below historical lows.

2.2.3 Groundwater Production

Zone 7 provides water resources management services to about 220,000 residents of the Valley. Zone 7 integrates management of both surface and groundwater supplies for conjunctive use and reliability of water supplies. Groundwater typically makes up 15-25% of the water supplied by Zone 7 to its retail water supply agencies; however, higher groundwater use can occur during droughts and surface water outages. In addition, two of the four retailers independently operate supply wells, as do other domestic and agricultural users, so the total amount of groundwater makes up a higher percentage of the total regional supply (typically 20-40%). All of the Valley's municipal supply wells are completed in Main Basin aquifers (*Figure 2-5*).

Figure 2-5: Map of Municipal Wells



2.2.4 Groundwater Sustainability

Zone 7 strives to manage the basin's groundwater sustainably. To assure sustainability, Zone 7 quantifies the supply and demand components (*Figure 2-6*) and their calculated annual volumes each year and makes sure that the long-term averages do not indicate overdraft conditions. The results are presented in Zone 7's Annual Reports for the GWMP (see *Zone 7, 2014* for the most recent example).

The Main Basin's "natural," sustainable, groundwater yield is defined as the amount of water that can be pumped from the groundwater basin and replenished by long-term average, natural supply. The long-term, natural sustainable yield is calculated based on local precipitation and natural recharge over a century of hydrologic records and projections of future recharge conditions. Applied water recharge has been historically included in the "natural" sustainable yield because of its sustainable contribution to groundwater recharge.

Figure 2-6: Groundwater Supply and Demand Components

Inflow and Outflow Components	Normal Water Year (AF/yr)
Natural Sustainable Yield Supply	
Natural Stream Recharge	5,700
Arroyo Valle Prior Rights	900
Rainfall Recharge	4,300
Applied (Irrigation) Water Recharge	1,600
Subsurface Inflow	1,000
Basin Overflow	-100
Inflow Total	**13,400**
Natural Sustainable Yield Demand	
Municipal pumping by Retailers	7,214*
Other groundwater pumping	1,186
Agricultural pumping	400
Mining Area Losses	4,600
Outflow Total	**13,400**
Managed Supply	
Artificial Stream Recharge	
Inflow Total	**Varies**†
Managed Demand	
Municipal Pumping by Zone 7	
Outflow Total	**Varies**†

**Retailer Groundwater Pumping Quota (GPQ) for a Calendar Year*

†*Artificial stream recharge and Zone 7 pumping amounts are determined by the availability of surface water*

The long-term, natural sustainable yield in the Main Basin was estimated to be about 13,400 acre-feet (AF) annually (*Zone 7, 1992*). While the natural sustainable yield approximates long-term-average natural recharge, the actual amount of natural recharge varies from year to year depending on the amount of local precipitation and irrigation during the year.

Zone 7's artificial recharge operations allow the groundwater basin to yield additional water, which is as sustainable as the supply of imported surface water. Zone 7 contracts with the SWP to import water that is released from the SBA or from Lake Del Valle (an SWP reservoir also operated by the California Department of Water Resources) into the arroyos for the purpose of augmenting the natural stream recharge.

Historically, Zone 7's annual groundwater pumping has varied with the availability of imported surface water and the capacity to treat that surface water. However, Zone 7 also operates its wells for salt management, to supply short-term demand peaks, and to compensate for treatment and conveyance system interruptions. The decision of which well(s) to pump is based on groundwater elevations, pumping costs, pressure zone needs, delivered aesthetic water quality issues, salt management needs, operational status, and groundwater demineralization facility capacity. Although reduced groundwater pumping may have a positive impact on groundwater storage and delivered water quality, increased groundwater pumping has a beneficial impact on the basin's salt loading because much of the salt in the pumped groundwater eventually leaves the basin as wastewater export. Annual variability can be accommodated as long as the long-term average groundwater demands don't exceed the sustainable average recharge.

2.3 Basin Water Quality (Nutrients)

2.3.1 Overview

In addition to managing the basin for supply sustainability, Zone 7 manages the basin for 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. Zone 7's annual GWMP reports (see *Zone 7, 2014* for the 2013 report) present more details of the groundwater quality monitoring and management programs for the basin.

The nutrient constituent of concern for this plan is nitrate since it is the only nutrient that has had a significant impact on groundwater quality. The Basin Objective (BO) for nitrate is 45 mg/L (measured as NO_3) for both the Main and Fringe Basins (*California State Water Board, 2011*). Phosphate is also monitored as part of the GWMP, but is encountered in concentrations well below the water quality standards and is not considered a significant nutrient of concern for the Livermore Valley Groundwater Basin. *Figure 2-7* below shows the maximum concentrations encountered in each of the basin areas.

Figure 2-7: Maximum Concentration of Nutrients in Basin Areas

		Concentration Max (2001-2014)			
	Standard	Main Basin	Fringe North	Fringe Northeast	Fringe East
Nutrient	mg/L	mg/L	mg/L	mg/L	mg/L
Nitrate (as NO_3)	45 *(1)*	95	340 *(2)*	190	163
Phosphate (as PO_4)	5 *(3)*	2.85	3.65	1.93	0.34

(1) MCL from CDPH and BO from the Water Board
(2) Only 2 sample results above 100 mg/L
(3) Recommended limit from World Health Organization

2.3.2 Nitrate Concentrations

The results from Zone 7's annual groundwater sampling are used to prepare nitrate concentration maps each year for Zone 7's Groundwater Management Program annual reports. Where data gaps exist, Zone 7 uses historical data and geologic expertise to estimate the extent of nitrate concentrations. The nitrate concentration contours maps from the upper and lower aquifers from the 2013 Annual Report (*Zone 7, 2014*) are shown in *Figure 2-8* and *Figure 2-9* below, and in more detail in *Figure A-3* and *Figure A-4* in Appendix A:

Figure 2-8: Nitrate Concentrations in Upper Aquifer

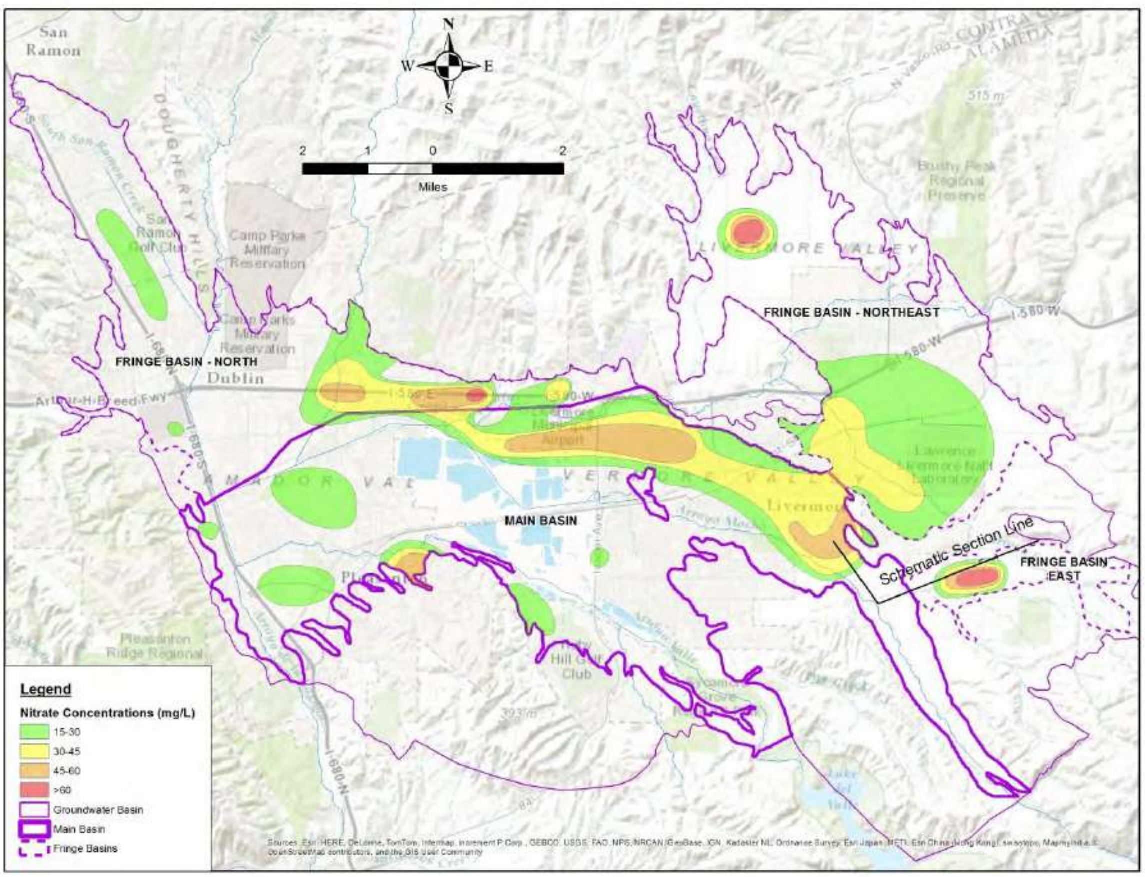
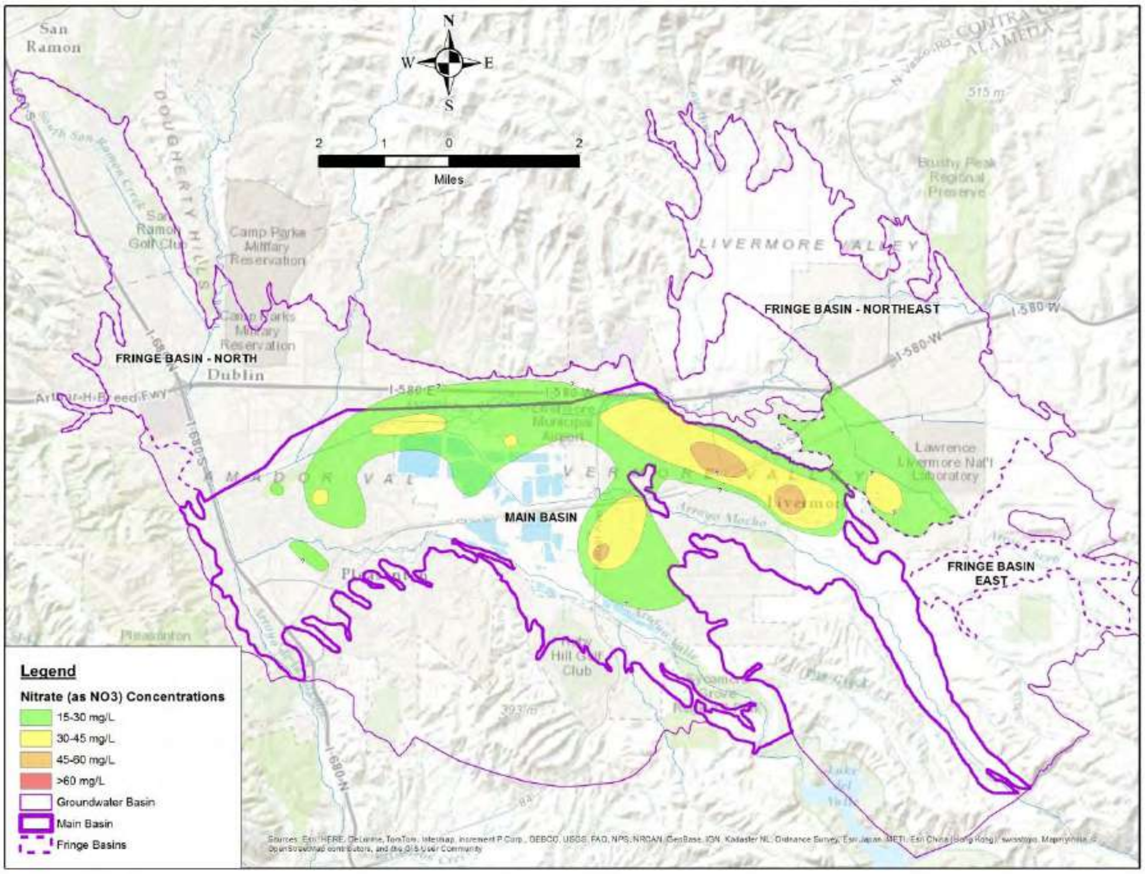
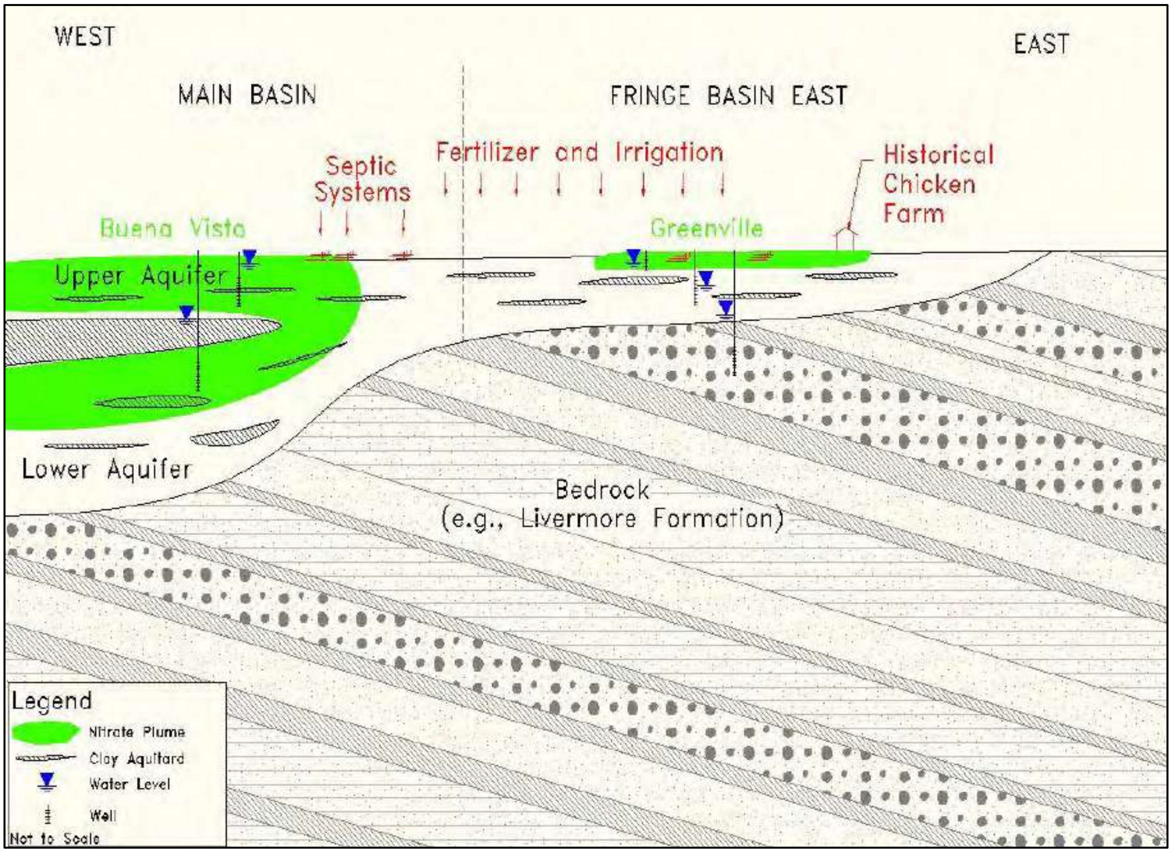


Figure 2-9: Nitrate Concentrations in Lower Aquifer



A conceptual cross section through the Fringe Basin East and southeast portion of the Main Basin is shown in *Figure 2-10* below.

Figure 2-10: Schematic Cross Section



To calculate Main Basin groundwater storage for Zone 7's Annual Groundwater Management Plan reports, Zone 7 uses polygonal subareas originally developed by DWR (California DWR, 1974) and referred to as nodes. The groundwater storage of each node is calculated using the nodal thickness, average groundwater elevations from the fall semiannual measuring event, storage coefficient, and total area of each node (see *Figure A-5* for the values used for each node). The fringe basin nodes only have upper aquifer zones whereas the Main Basin nodes have upper and lower aquifer zones. The total Main Basin groundwater storage is equal to the sum of all the nodal storage values for the 22 nodes in the Main Basin.

Groundwater basin storage varies considerably spatially, especially in the Main Basin. Therefore, Zone 7 calculated a volume-weighted average nitrate concentration for each of the basins using the nodal storage volumes used in the Zone 7's 2013 annual GWMP report (*Zone 7, 2014*). Zone 7 used *ArcGIS's Spatial Analyst* to calculate the average nitrate concentration for each groundwater storage node from the nitrate concentration maps (shown in *Figure 2-8* and *Figure 2-9*, and in detail in *Figure A-3* and *Figure A-4*). These average nodal concentrations were then averaged by the nodal storage volume to calculate the volume-weighted, average nitrate concentration of each basin. *Figure 2-11* shows the layout of the nodes, and the average upper or upper and lower aquifer nitrate concentrations for each node from the 2013 monitoring well sampling results (*Zone 7, 2014*).

Figure 2-11: Nitrate Concentrations by Node

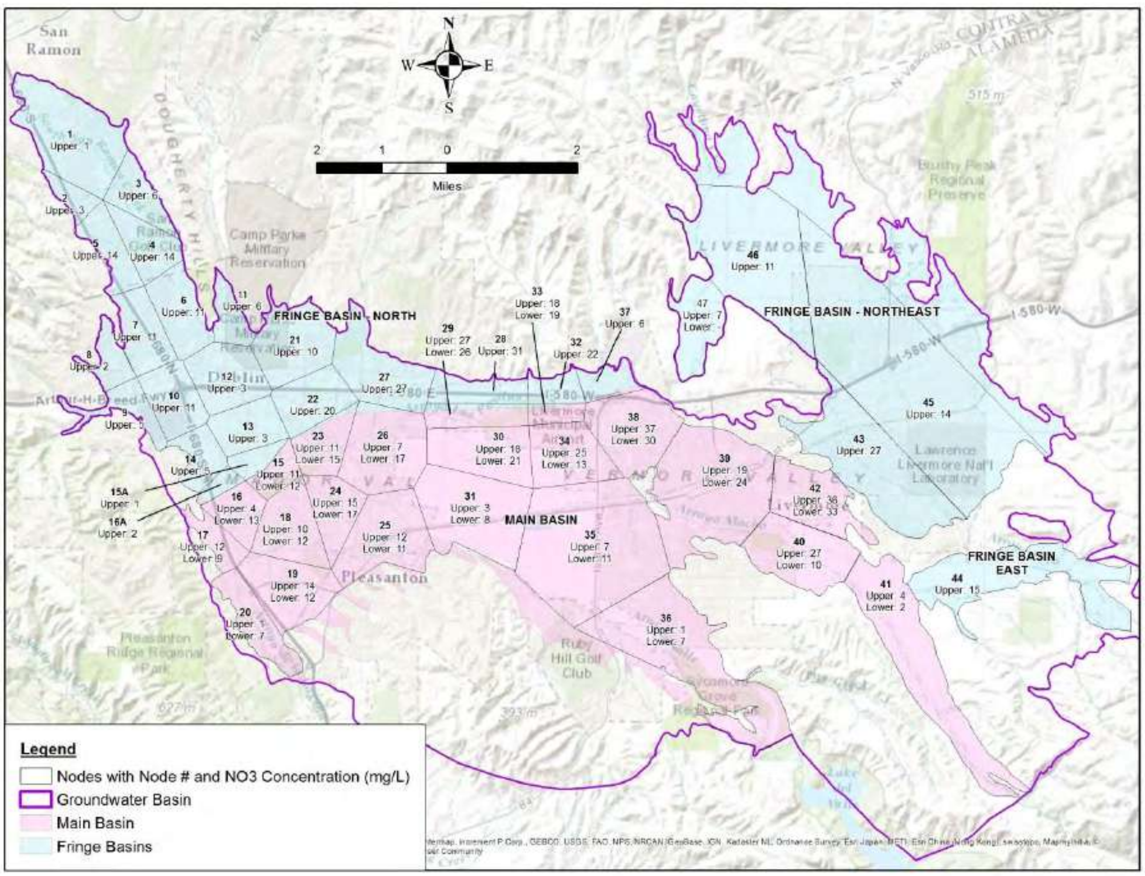


Figure 2-12 below shows the storage volume of each node from the 2013 annual report, average nitrate concentrations, and assimilative capacity (AC) by node, aquifer, subbasin, and basin areas (see *Section 2.3.3* for discussion on how assimilative capacity is calculated).

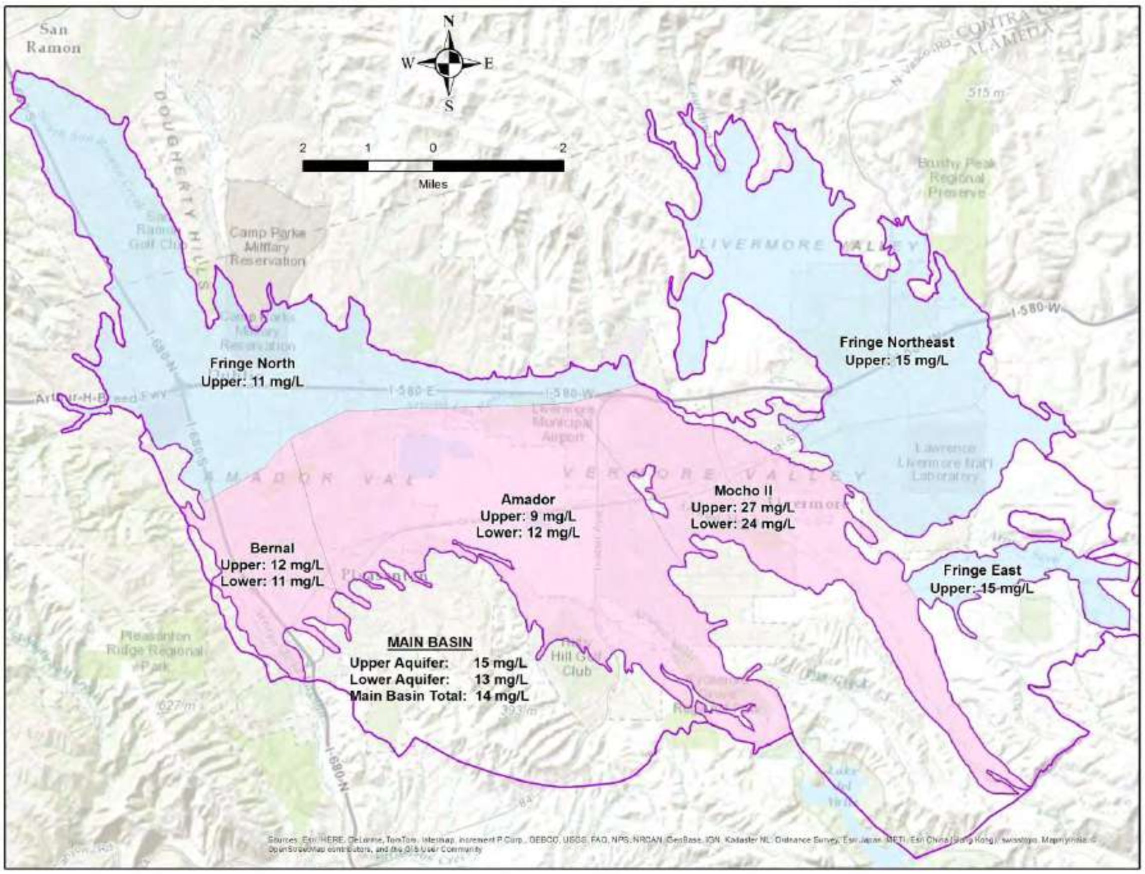
Figure 2-12: Storage (AF), Nitrate Concentrations (as NO_3 in mg/L) and Assimilative Capacity (mg/L) by Node, Subbasin, and Basin Area

			Upper			Lower			Total Basin		
NODE	**Basin**	**Subbasin**	**Storage**	**NO_3**	**AC**	**Storage**	**NO_3**	**AC**	**Storage**	**NO_3**	**AC**
NODE 1	FBN		28,888	1	44	-	-	-	28,888	1	44
NODE 2	FBN		3,363	3	42	-	-	-	3,363	3	42
NODE 3	FBN		6,303	6	39	-	-	-	6,303	6	39
NODE 4	FBN		6,236	14	31	-	-	-	6,236	14	31
NODE 5	FBN		5,914	14	31	-	-	-	5,914	14	31
NODE 6	FBN		7,349	11	34	-	-	-	7,349	11	34
NODE 7	FBN		6,825	11	34	-	-	-	6,825	11	34
NODE 8	FBN		4,263	2	43	-	-	-	4,263	2	43
NODE 9	FBN		5,119	5	40	-	-	-	5,119	5	40
NODE 10	FBN		7,219	11	34	-	-	-	7,219	11	34
NODE 11	FBN		4,918	6	39	-	-	-	4,918	6	39
NODE 12	FBN		10,142	3	42	-	-	-	10,142	3	42
NODE 13	FBN		8,035	3	42	-	-	-	8,035	3	42
NODE 14	FBN		5,495	5	40	-	-	-	5,495	5	40
NODE 15A	FBN		106	1	44	-	-	-	106	1	44
NODE 16A	FBN		96	2	43	-	-	-	96	2	43
NODE 15	MB	Bernal	535	11	34	1,771	12	33	2,306	12	33
NODE 16	MB	Bernal	600	4	41	2,654	13	32	3,253	11	34
NODE 17	MB	Bernal	1,499	12	33	1,602	9	36	3,100	11	34
NODE 18	MB	Bernal	2,649	10	35	5,457	12	33	8,106	12	33
NODE 19	MB	Bernal	3,784	14	31	5,579	12	33	9,363	13	32
NODE 20	MB	Bernal	913	1	44	3,656	7	38	4,569	6	39
NODE 21	FBN		17,445	10	35	-	-	-	17,445	10	35
NODE 22	FBN		11,837	20	25	-	-	-	11,837	20	25
NODE 23	MB	Amador	2,129	11	34	2,812	15	30	4,942	13	32
NODE 24	MB	Amador	2,660	15	30	2,993	17	28	5,653	16	29
NODE 25	MB	Amador	7,483	12	33	6,979	11	34	14,462	12	33
NODE 26	MB	Amador	8,884	7	38	8,923	17	28	17,807	12	33
NODE 27	FBN		17,655	27	18	-	-	-	17,655	27	18
NODE 28	FBN		7,814	31	14	-	-	-	7,814	31	14
NODE 29	MB	Amador	4,620	27	18	1	26	19	4,621	27	18
NODE 30	MB	Amador	7,216	18	27	5,735	21	24	12,951	19	26
NODE 31	MB	Amador	8,402	3	42	15,010	8	37	23,412	6	39
NODE 32	FBN		1,024	22	23	-	-	-	1,024	22	23
NODE 33	MB	Amador	639	18	27	479	19	26	1,118	19	26
NODE 34	MB	Amador	2,755	25	20	5,618	13	32	8,373	17	28
NODE 35	MB	Amador	8,831	7	38	22,775	11	34	31,607	9	36
NODE 36	MB	Amador	10,863	1	44	1	7	38	10,865	1	44
NODE 37	MB	Amador	209	6	39	0	12	33	209	6	39
NODE 38	MB	Mocho II	4,915	37	8	1,629	30	15	6,544	35	10
NODE 39	MB	Mocho II	10,011	19	26	4,251	24	21	14,263	21	24
NODE 40	MB	Mocho II	10,930	27	18	2,267	10	35	13,197	24	21
NODE 41	MB	Mocho II	10,889	4	41	1	2	43	10,890	4	41
NODE 42	MB	Mocho II	7,647	36	9	1,759	33	12	9,406	35	10
NODE 43	FBNE		8,622	27	18	-	-	-	8,622	27	18
NODE 44	FBE		6,830	15	30	-	-	-	6,830	15	30
NODE 45	FBNE		62,141	14	31	-	-	-	62,141	14	31
NODE 46	FBNE		-	11	34	-	-	-	-	11	34
NODE 47	FBNE		-	7	38	-	-	-	-	7	38
Bernal			9,981	11	34	20,717	11	34	30,698	11	34
Amador			64,692	10	35	71,326	12	33	136,018	11	34
Mocho II			44,392	22	23	9,908	24	21	54,299	22	23
Main Basin			**119,064**	**15**	**30**	**101,951**	**13**	**32**	**221,015**	**14**	**31**
FB-North			**166,046**	**11**	**34**				**166,046**	**11**	**34**
FB-Northeast*			**70,762**	**15**	**30**				**70,762**	**15**	**30**
FB-East			**6,830**	**15**	**30**				**6,830**	**15**	**30**
TOTAL*			**362,702**	**13**	**32**	**101,951**	**13**	**32**	464,653	**13**	**32**

** not including Nodes 46 and 47 (no storage info available)*
Storage in AF, NO_3 Concentration in mg/L, AC = Assimilative Capacity

The average volume-weighted concentrations were then calculated for each subbasin, aquifer, and basin area; and the results are as shown in *Figure 2-13* below.

Figure 2-13: Nitrate Concentrations by Subbasin, Aquifer, and Basin Area



The 2013 total average nitrate concentration in the upper aquifer is 15 mg/L, with all subbasins between 9 mg/L and 27 mg/L. The average nitrate concentration in the lower aquifer is 13 mg/L, with all subbasins between 11 mg/L and 24 mg/L. The overall concentration for the Main Basin is 14 mg/L. The average concentrations in the Fringe Basins (which only consist of an upper aquifer) ranged between 11 mg/L and 15 mg/L. All average basin concentrations are well below the BO (45 mg/L); however, there are Areas of Concern (described in *Section 2.4*) where local nitrate concentrations do exceed the BO.

2.3.3 Assimilative Capacity

Assimilative Capacity, the natural capacity of the groundwater basin to absorb pollutants, is the difference between the BO (45 mg/L) and the average concentration of the basin with a relatively conservative contaminant like nitrate. The assimilative capacity estimated for each of the nodes and basins are shown in *Figure 2-14* and are summarized below by basin area.

Figure 2-14: Average Nitrate Concentrations and Assimilative Capacities by Basin Area

BASIN AREA	**Average NO_3** (mg/L)	**Basin Objective** (mg/L)	**Assimilative Capacity** (mg/L)
Main Basin	14	45	31
Upper Aquifer	*15*	*45*	*30*
Lower Aquifer	*13*	*45*	*32*
Fringe Basin – North*	11	45	34
Fringe Basin – Northeast*	15	45	30
Fringe Basin – East*	15	45	30

* Fringe Basins consist of only an upper aquifer

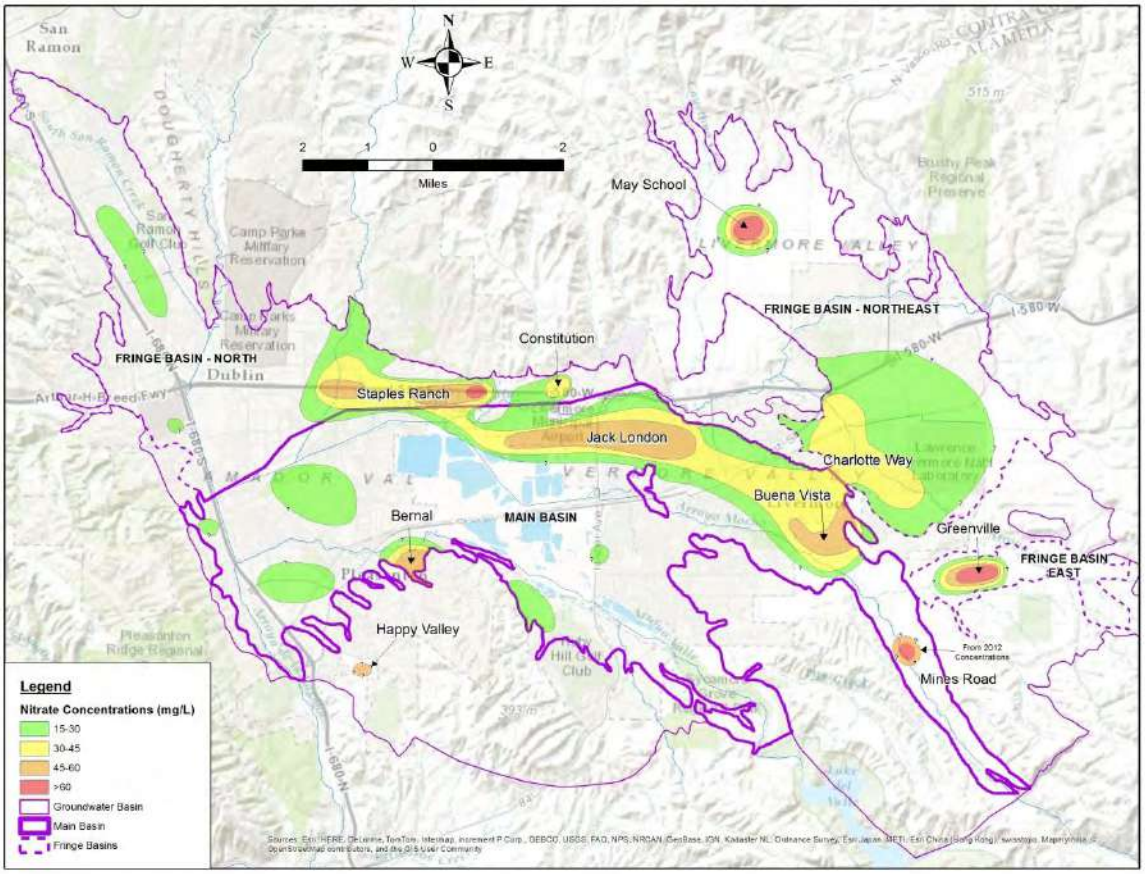
The average nitrate concentrations on which the assimilative capacity was calculated are based on nitrate concentration contours and nodal storage volumes calculated for the 2013 Annual Report. Where data gaps existed, Zone 7 used historical data (for example 2008 data in the May School area, *Section 2.4*) and geologic expertise to estimate the extent of nitrate concentrations contours.

2.4 Areas of Concern

Average nitrate concentrations are well below the BO (45 mg/L) in all four groundwater basin areas in the Livermore Valley Groundwater Basin, however there are ten local areas where nitrate concentrations are above the BO. These “Areas of Concern” are shown in orange and red on *Figure 2-15* and *Figure 2-16* and are described below, roughly from West to East.

Five of the ten Areas of Concern have a higher-than-average density of OWTS in use, which has led to the development of special requirements for new OWTS applications in these areas. The OWTS management goals and strategies and associated implementation plan for these five Areas of Concern are discussed in detail in *Sections 5.3.5* and *6.2.5.*

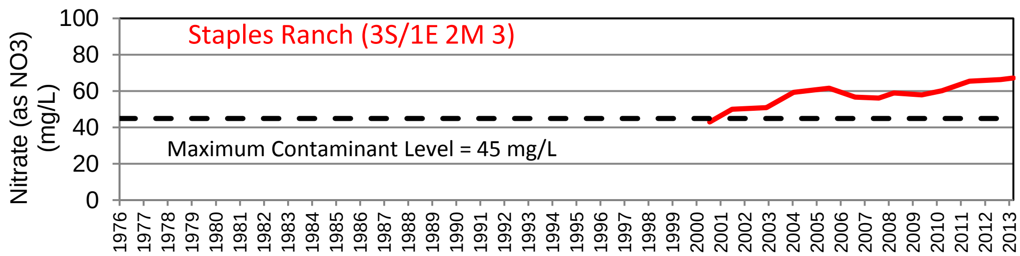
Figure 2-15: Nitrate Areas of Concern



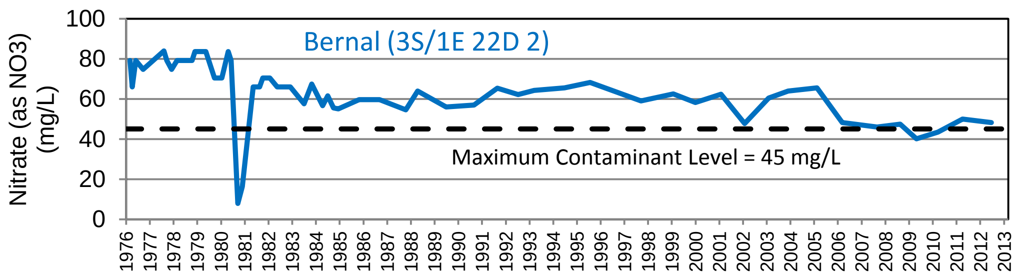
1. **Happy Valley** – This unincorporated, unsewered area has been subdivided into 1 to 5 acre lots and developed with rural residences relying on domestic wells for water supply. There are currently about 100 OWTS in use in Happy Valley. Very little additional development has been planned for the Happy Valley because Alameda County has placed a moratorium on new OWTS construction in the Happy Valley area due to high nitrate detections in some of the domestic wells. There are no dedicated monitoring wells in the area; however, many of the domestic wells have been tested for nitrate since 1973. In 2013, Zone 7 and ACEH conducted voluntary testing of water samples from domestic wells in Happy Valley. Seven of the 31 wells had nitrate concentrations that exceeded the maximum contaminant level (MCL) of 45 mg/L, with one reaching 124 mg/L. Most of the high nitrate occurrences were detected in the central portion of this enclosed sub-basin, which consists of only one upper aquifer. The results of this study have not yet been finalized as of the date of this plan, however, the approximate extent of nitrate concentrations above 45 mg/L are shown in *Figure 2-15*. In a

letter dated October 3, 2014, the Local Agency Formation Commission (LAFCO) has asked the City of Pleasanton to report back within six months to the commission on the results of a study to identify how water and sewer services will be provided to the Happy Valley area.

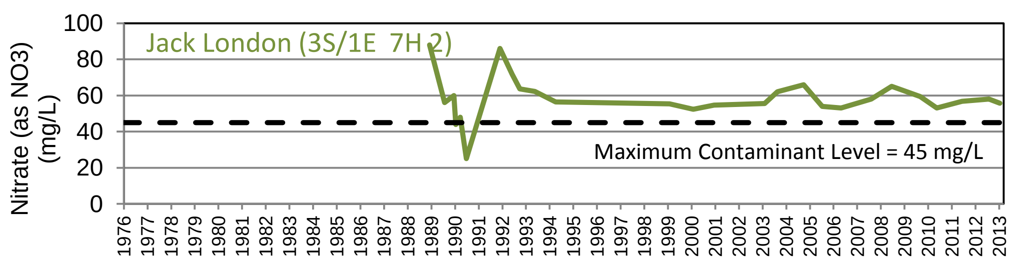
2. **Staples Ranch** – This elongated Area of Concern runs from west to east in the southern portion of the Camp Subbasin in the eastern portions of Dublin and Pleasanton. This area was heavily farmed in the past, and then left largely as undeveloped open space until recently. It is now planned for low- to medium-density residential and commercial development with connections to the municipal sewer, water, and recycled water. While only two monitoring wells in the upper aquifer (3S/1E 5K 6 and 3S/1E 2M 3) currently have nitrate concentrations above 45 mg/L, several surrounding wells in both the upper and lower aquifers have nitrate concentrations above the average. Concentrations have been slowly rising in monitoring well 3S/1E 2M 3 to a maximum concentration 66.43 mg/L in the 2013 Water Year (see graph below). The contamination is likely a remnant of past agricultural operations that included row crops, alfalfa cultivation, small dairy operations, and OWTS clusters. There is still some dry farming of hay in the area and a golf driving range in the eastern part with approximately 16 acres of irrigated turf. The future planned commercial development may effectively cap any potential buried nutrient sources from the historical agricultural land use, minimizing their leaching during rainfall events.



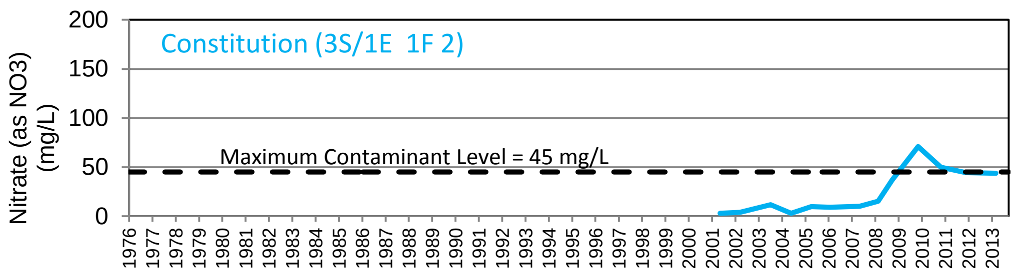
3. **Bernal** – This Area of Concern is based on nitrate concentrations from one well (3S/1E 22D 2) in the southern portion of the upper aquifer of the Amador West Subbasin. The long-term trend of concentrations in this well (see graph below) has been slowly declining; however, recently concentrations have been fluctuating around the MCL. This area is primarily sewered, and developed as medium-density residential (about 2 to 8 dwellings per acre) with no future additional development planned. The source of high nitrate and the reason for the fluctuating concentrations has not been identified, but it is speculated that the nitrate may have been entering the Main Basin as hill-front recharge and/or subsurface inflow from the neighboring Livermore Uplands to the south. These sources are likely diminishing as urban development spreads into the Upland area.



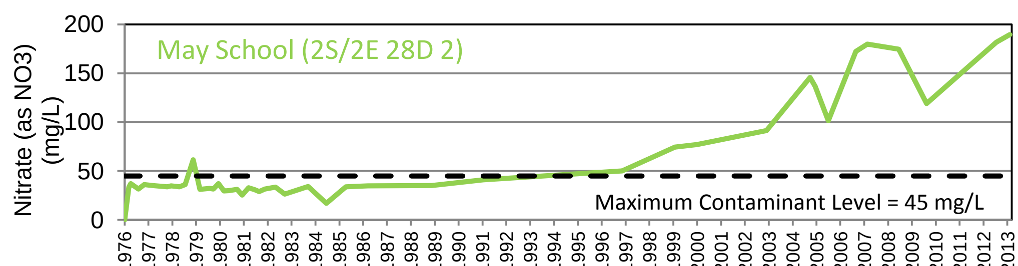
4. **Jack London** – This Area of Concern extends from the eastern portion of the Mocho II Subbasins to the northeastern portion of the Amador Subbasin. The eastern portion is primarily sewered medium-density residential while the western portion is sewered commercial (including the Livermore airport) with little future development currently planned. A horse boarding facility operates in the most western part. Portions of this nitrate plume date back to at least the 1960s. Two wells in the upper aquifer have consistently had concentrations above the 45 mg/L (3S/1E 11G 1 and 3S/2E 7H 2), however several surrounding wells in both the upper and lower aquifers also have elevated nitrate concentrations. Nitrate concentrations appear to have stabilized in 3S/1E 7H 2 at just above the MCL (see graph below). The most significant nutrient contributor is believed to have been the historical municipal wastewater disposal that was practiced at several locations along this nitrate plume before the LAVWMA wastewater export pipeline was constructed. Historical and current agricultural practices, and current recycled water use are other potential nutrient loading sources for this area, although considered to be less significant.



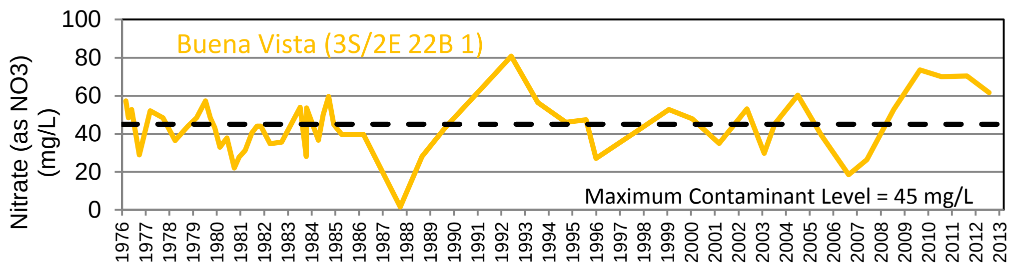
5. **Constitution** – This Area of Concern exists near the boundary of the Mocho II, Camp, and Amador Sub-basins and is up-gradient from the Las Positas Golf Course in Livermore. This area is primarily sewered commercial with little future land use development. Nitrate concentrations above the 45 mg/L have only been detected in 3S/1E 1F 2 (see graph below), which shows an upward trend; however, elevated concentrations have also been detected in downgradient monitoring well 3S/1E 2R 1 (see *Figure 2-16*). The source of the nitrate is unconfirmed, but may be from historical OWTS use and agricultural practices, and current landscape fertilizer application and/or recycled water use.



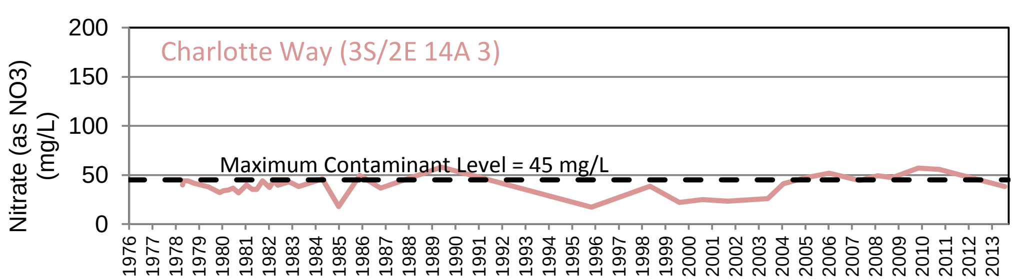
6. **May School** - The highest nitrate concentration detected in the groundwater basin is located near May School Rd in the upper aquifer of the May Subbasin. There currently is only one Zone 7 monitoring well in this Area of Concern (2S/2E 28D 2), and it had a nitrate concentration of 189 mg/L in 2013 (see graph below). However, in the 2008 WY, as part of a "snapshot" water quality assessment for this area, Zone 7 sampled and analyzed several domestic wells to determine the extent of the nitrate contamination. These results, presented in the 2008 Annual Report for the Groundwater Management Program, *Zone 7, 2009,* (see *Figure A-6*) suggested that the nitrate appeared to be relatively localized, with the highest concentration in the vicinity of 2S/2E 28D 2. The source of high nitrate was not identified; however, it likely comes from agricultural land use in that area. Also, this unsewered area has a concentration of rural residences on Bel Roma Rd that are served by OWTS. There are no known future development plans for the area.



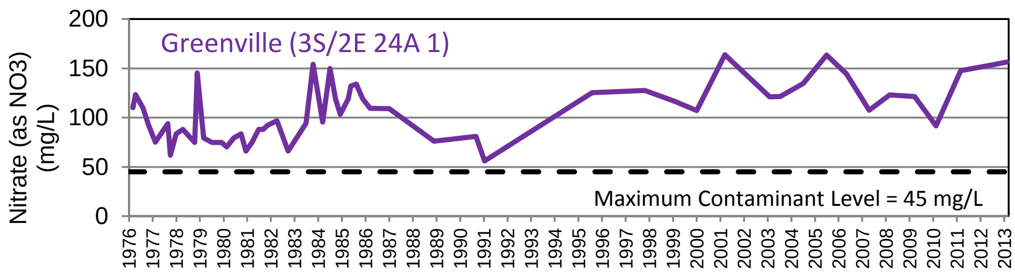
7. **Buena Vista** - This nitrate plume is defined by several wells in the central and eastern portion of the Mocho II Subbasin in both the upper and lower aquifers. This area is primarily unsewered low- to medium-density residential, vineyard and winery land uses with some future vineyard and winery development planned. *Figure 2-10* shows a schematic cross-section that includes the southeastern portion of this Area of Concern. The concentration in 3S/2E 22B 1 (see graph below), near the proximal end of the plume, fluctuates above and below the MCL, but has been above the MCL for the last few years (61.56 mg/L in the 2013 WY). The potential sources of the nitrate are existing OWTS and historical agricultural practices, livestock manure, and composting vegetation. There are over 100 OWTS still in use near the proximal end of the plume, documented historical poultry ranching, and crop and floral farming along Buena Vista Avenue. There are also numerous wineries in the area.



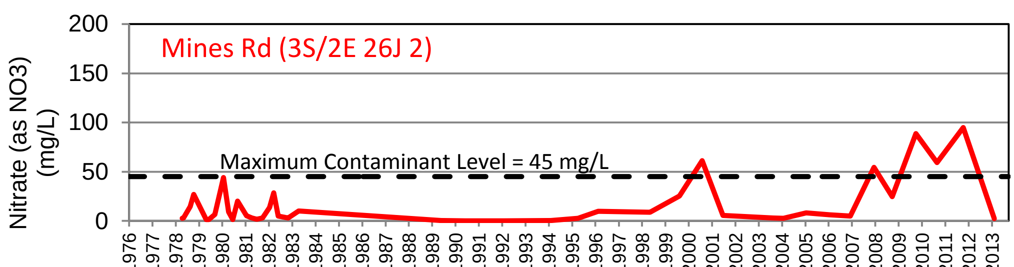
8. **Charlotte Way**- This Area of Concern exists in the western portion of the Mocho I Subbasin and may commingle with the Buena Vista Area of Concern in the eastern portion of the Mocho II Subbasin. The area is primarily sewered and developed as medium-density residential. There is no future development planned for the area. Elevated nitrate concentrations have been detected in at least three wells, but have historically been greatest in the upper aquifer monitoring well 3S/2E 14A 3 (see graph below). Concentrations in this well have fluctuated above and below 45 mg/L, but dropping below the MCL to 38.31 mg/L in the 2013 WY. The cause is believed to be historical OWTS, fertilizer applications, and other agricultural land uses that no longer exist in the area, but continue to have impact on groundwater quality.



9. **Greenville** – This Fringe Basin East Area of Concern is represented by a single monitoring well in the upper aquifer located on Greenville Road, near the corner of Tesla Road (3S/2E 24A 1). This area is primarily developed as unsewered low-density residential, vineyard, and wineries with future additional vineyard and winery uses planned. *Figure 2-10* above shows a schematic cross-section through the Greenville and southeastern portion of the Buena Vista Areas of Concern. The highest concentration of nitrate recorded for the monitoring well was 163.90 mg/L in 2001 Water Year. The 2013 WY concentration was 156.33 mg/L (see graph below). The source of nitrate in this well is unconfirmed, but may be from historical chicken farming, and other agricultural land uses located up-gradient of the monitoring well. There is concern for the potential increase in onsite wastewater disposal from future commercial development planned for this area.



10. **Mines Road** – This Area of Concern, which is also represented by a single well; 3S/2E 26J 2 (see graph below). It is located in the southern portion of the Main Basin upper aquifer along Mines Road. Nitrate concentrations in this well have fluctuated widely, ranging from non-detect to a maximum of 94.77 mg/L in October 2011. The reason for the fluctuations are unknown, but may be related to agriculture and changes in precipitation. This area is primarily unsewered low-density residential with little future development planned.



NITRATE AREAS OF CONCERN AND TRENDS

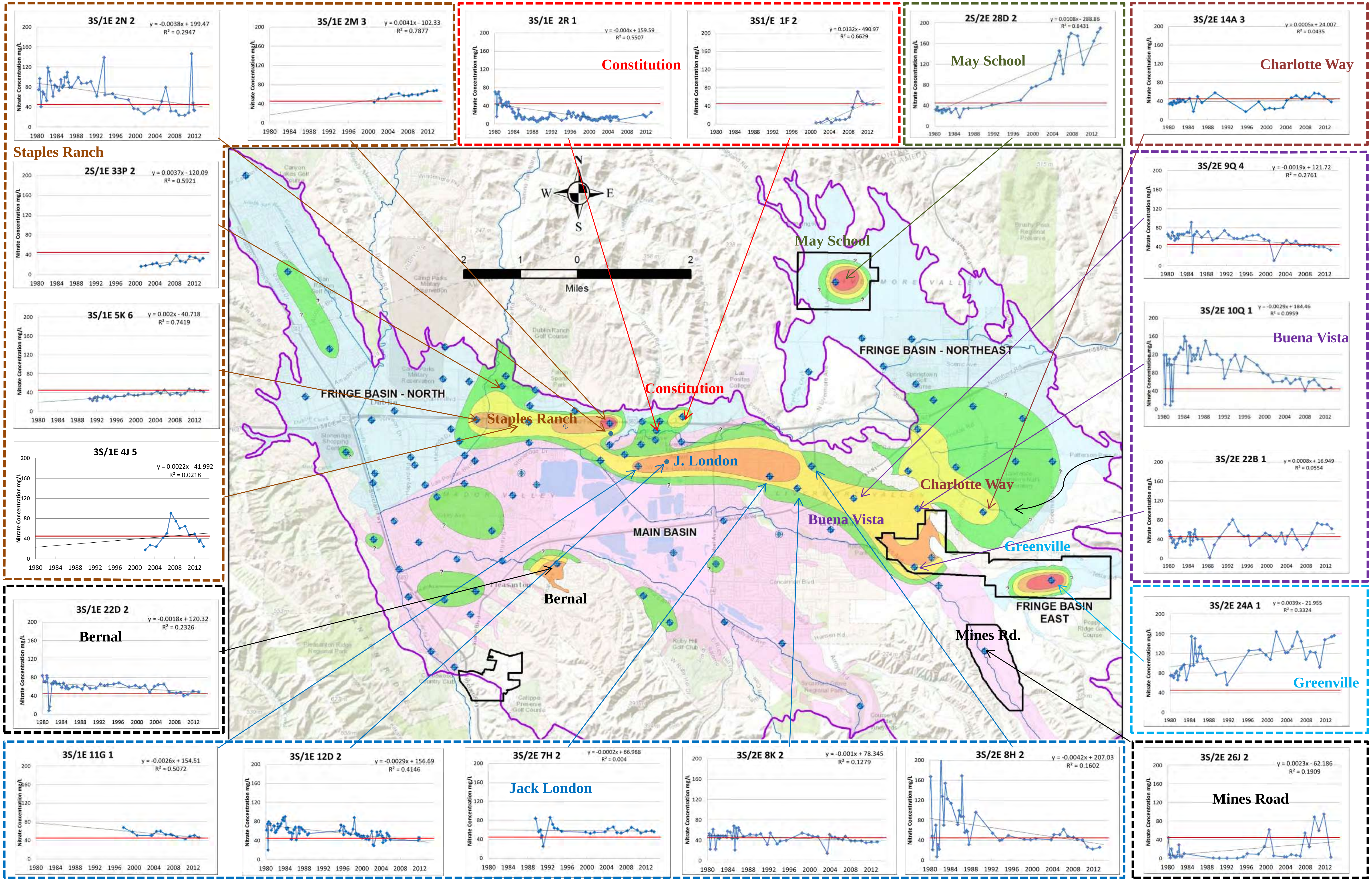


FIGURE 2-16

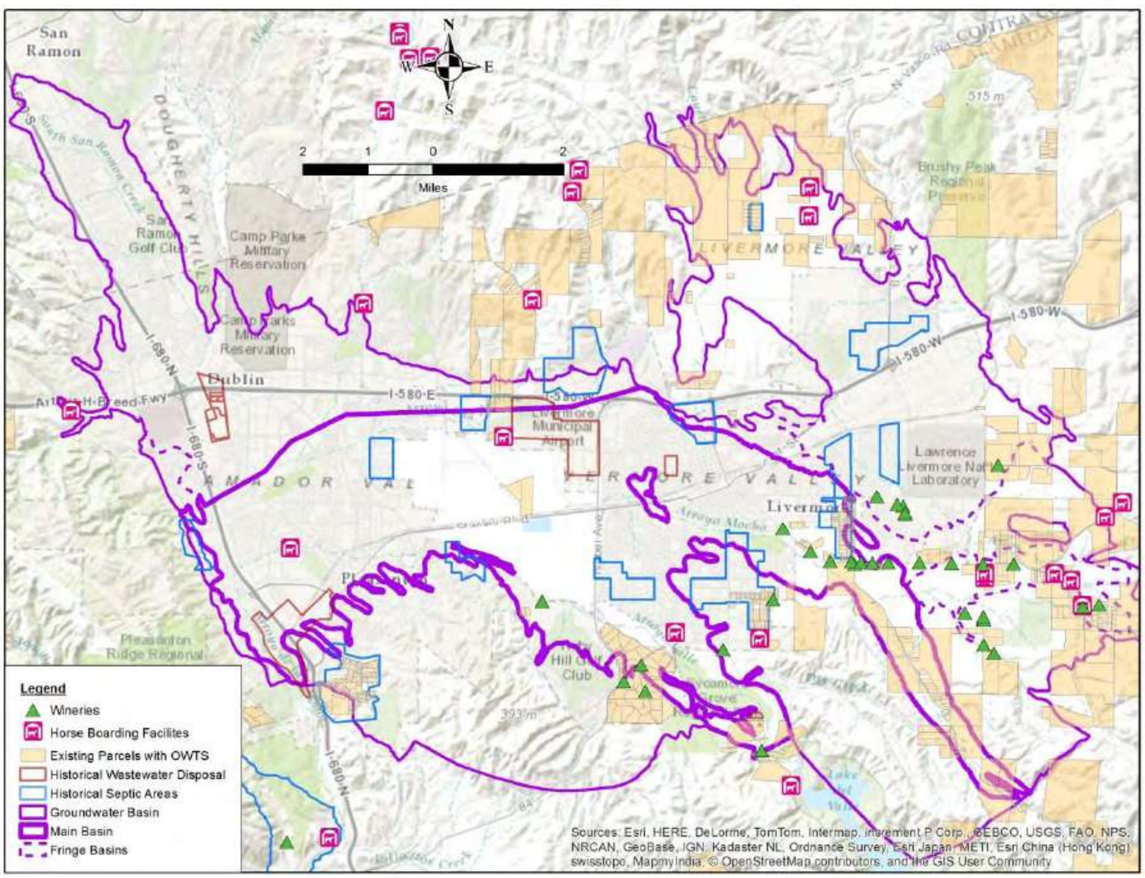
3 Nutrient Loading Evaluation

3.1 Historical Sources of Nitrate

The most significant historical sources of nitrate in the basin (shown in *Figure 3-1*) are from:

- Decaying vegetation (buried and surficial)
- Municipal wastewater and sludge disposal
- OWTS (i.e., septic systems)
- Concentrated animal boarding/ranching (horse boarding, chicken and/or cattle ranching)
- Applied fertilizers (crops and landscape)

Figure 3-1: Historical and Existing Sources of Nitrate



Several of these historical sources are no longer active, but appear coincident with or are slightly up-gradient from several Areas of Concern as described in *Section 2.4*. The nitrogen loading from these inactive historical sources is difficult to estimate due to the uncertainties about the original nature of the source (e.g., location, size, time frame, nitrogen loading rates). Most of these historical sources ceased several decades ago and are likely to already be in equilibrium with the groundwater basin. Therefore the current nitrogen loading from these inactive historical sources is assumed to be negligible. However, some of the historical nutrient loading processes are still active today (e.g., fertilizer application, onsite wastewater disposal, livestock manure production), albeit in much smaller quantities. These are addressed in the following sections.

Since a complete database of active and historical nutrient sources such as existing wineries, concentrated livestock operations, OWTS, and historical municipal wastewater disposal areas was not available for this study, some assumptions were made for their quantities and locations. Computer searches and aerial photo review were performed to identify the active (or recent) wineries and equine facilities shown in *Figure 3-1*. The areas shown as "Existing Parcels with OWTS" in *Figure 3-1* were synthesized using the county tax assessment roll and ArcGIS. Parcels containing structures in the unincorporated, unsewered areas were assumed to be served by an OWTS and therefore shaded accordingly in the figure. The historical OWTS and wastewater disposal areas were taken from figures and exhibits contained in Zone 7's Wastewater Management Plan (Camp, et al, 1983) and Land Application of Wastewater and Its Effect on Ground-water Quality in the Livermore-Amador Valley (USGS, 1983). Fertilizer application areas are not shown in *Figure 3-1* because they are assumed to be widespread and a function of land use.

3.2 Conceptual Model

3.2.1 Fate and Transport of Nitrate

To determine if groundwater nitrate concentrations will rise or drop over the long-term, one must calculate the net nitrate loading on the groundwater basin. However, net nitrate loading is difficult to calculate because nitrate readily converts to and from other nitrogen compounds (e.g., nitrite, ammonia, elemental nitrogen) in the unsaturated soil zone. Therefore, it is common to use total nitrogen as the metric for determining potential net nitrate loading.

The fate and transport of nitrogen compounds in the unsaturated zone is complex, with transformation, attenuation, uptake, and leaching in various environments. The following excerpt is from *Moran, et al, 2011*.

> *Nitrogen may be applied to crops in various forms such as animal manure, anhydrous ammonia, urea, ammonium sulfate, calcium nitrate, or ammonium nitrate, but all forms may eventually be converted to nitrate and transported away from the shallow soil zone to streams or groundwater. Denitrification, which converts nitrate to nitrogen or nitrous oxide gas, can mitigate nitrate loading to streams and groundwater, and can occur in any zone where certain geochemical conditions are met, viz. low oxygen, the presence of an electron donor such as organic carbon or reduced sulfur, and a population of*

denitrifying bacteria. The hyporheic zone of streams, riparian buffer zones, poorly drained soils, and saturated zones with low dissolved oxygen are all environments where bacteria are generally present and conditions favorable for denitrification may exist.

However, once in the saturated groundwater zone, nitrogen is relatively stable, and primarily exists as nitrate. Some denitrification can occur in the saturated zone, but not readily in the oxygen-rich conditions that are so common in the shallow aquifers of the Livermore Valley Groundwater Basin. Since nitrate is soluble in water, it is transported with the groundwater through the aquifers.

3.2.2 Methodology

3.2.2.1 Introduction

To calculate the net nitrogen loading, Zone 7 sums the current nitrogen loading from all the sources and removal components, which are shown in *Figure 3-2* below.

Figure 3-2: Existing Nitrogen Sources and Removal

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

In most cases, current nitrogen loading from each component above (e.g., stream recharge, rainfall recharge, pipe leakage, etc.) can be quantified by multiplying water volume, which Zone 7 calculates annually as part of its groundwater inventory, by the concentration of nitrogen compounds in the water. For example, to calculate the nitrogen loading from stream recharge, the volume of stream recharge is multiplied by the average nitrate concentration in the stream water. Nitrogen loading from historical sources is assumed to have already occurred, and therefore it is considered to have negligible consequence to the current loading (*Section 3.1*).

3.2.2.2 Manure, OWTS, and Wastewater

To calculate the nitrogen loading from horse boarding facilities, rural properties with OWTS, and wineries; Zone 7 calculated the number of facilities or properties from aerial photographs and land use data and then applied a nitrogen loading rate obtained from literature review as shown on *Figure 3-3* below.

Figure 3-3: Nitrogen Loading Rates from Horse Boarding, Rural Properties, and Wineries

LAND USE CATEGORY	Annual Nitrogen Loading
Horse Boarding (Manure)[1]	75 lbs/acre
Rural (OWTS and Manure)[2]	49 lbs/parcel
Wineries (OWTS & process water)[2]	
Small	54 lbs/facility
Medium	200 lbs/facility
Large	355 lbs/facility

[1] *From RMC 2012, RMC 2013*
[2] *From RMC 2002*

3.2.2.3 Irrigation and Fertilizer Application

Nitrogen loading from fertilized irrigation or "fertigation" includes the nitrogen from the fertilizer as well as the irrigation source water, and the assumed removal due to soil processes (evapotranspiration, denitrification, soil absorption) and plant uptake. It was calculated using the following formula (where N = nitrogen):

Leached N to Groundwater = N from Applied Fertilizer + N in Source Water – (N lost to Soil + Plant Uptake)

Where *N from Applied Fertilizer* is calculated using land use estimates for irrigated acreage, irrigation season, and fertilizer application rates as follows:

N from Applied Fertilizer = Percentage Irrigated Area x *Percentage of Year Irrigated* x *N Application Rate*

The land use values for irrigation are listed below in *Figure 3-4*:

Figure 3-4: Nitrogen Loading Rates from Fertilized Irrigation by Land Use

LAND USE CATEGORY	Irrigation Constants		Applied Nitrogen in Fertilizer Application[2] lbs N/irr acre
	Irrigated Area[1] %	Irrigation Season Months	
Agriculture - Other	72%	Apr - Sep	133
Agriculture - Vineyard	48%	Apr - Sep	29
Golf Course	60%	Oct - Sep	91
Mining Area Other	0%	NA	0
Mining Area Pit	0%	NA	0
Mining Area Pond	0%	NA	0
Open Space	0%	NA	0
Public (Schools, Government Bldgs, etc.)	10%	Oct - Sep	91
Roads	0%	NA	0
Rural Residential	1%	Oct - Sep	91
Urban Commercial and Industrial	10%	Oct - Sep	91
Urban Park	49%	Oct - Sep	91
Urban Residential High Density	27%	Oct - Sep	91
Urban Residential Low Density	8%	Oct - Sep	91
Urban Residential Medium Density	32%	Oct - Sep	91
Water	0%	NA	0

[1] *Pervious Area x Irrigated Portion of Pervious Area, adapted from NHC, 2007.*
[2] *Adapted from RMC, 2012.*

N from Source Water, which is the nitrogen that is already in the irrigation water before fertilizer is added, is calculated using estimated water application rates by land use and source water concentration. Zone 7 calculated average water application rates by land use (see *Figure 3-5* below, in units per acre of land use and per acre of irrigated area) using its areal recharge spreadsheet model, which calculates applied water recharge (along with rainfall recharge and unmetered groundwater pumping) for the Main Basin and Fringe Basin North. The model uses rainfall, evaporation, soil type, irrigation efficiency, pervious area, pervious area irrigated, and irrigation season to calculate applied water rates for 500 ft by 500 ft cells that correspond to those used in Zone 7's groundwater model.

Figure 3-5: Source Water Application Rates from Irrigation by Land Use

LAND USE CATEGORY	Water Application Rate AF/acre	Water Application Rate AF/irr acre
Agriculture - Other	0.7	1.0
Agriculture - Vineyard	0.6	1.3
Golf Course	1.1	1.8
Public (Schools, Government Bldgs, etc.)	0.5	5
Rural Residential	0.6	6
Urban Commercial and Industrial	0.3	3
Urban Park	1.1	2.2
Urban Residential High Density	0.7	2.6
Urban Residential Low Density	0.4	5
Urban Residential Medium Density	1.0	3.1

The concentration of the source water was calculated using data collected as part of Zone 7's groundwater annual monitoring programs. The concentration ranges for the last ten years and the average used in the calculations is presented below in *Figure 3-6*.

Figure 3-6: Nitrate Concentrations in Irrigation Source Water

Water Type	NO_3 Range mg/L	NO_3 Average mg/L
Delivered (municipal)	ND-19.8	3.6
Groundwater (supply wells)	ND-147	23.3
Recycled water*	108-196	152

**All nitrogen from NO_3, NO_2, and TKN assumed to convert to nitrate.*
ND = Not Detected above the Detection Limit

Nitrate concentrations for recycled water in the Valley are usually below detection limits, however other compounds (nitrite, ammonia, and organic nitrogen) contain nitrogen and can be converted to nitrate in the subsurface. Zone 7 assumed that all the nitrogen from these compounds has the potential to convert to nitrate. This is likely not the case, but provides a conservative upper limit of possible nitrate accumulation in the groundwater basin. Also, for this evaluation, it was assumed that for certain land uses (e.g., commercial, agriculture), professional landscapers will reduce the volume of applied fertilizer to account for the nitrogen in the source water.

For this study, the *N Lost in Soil* includes losses due to evapotranspiration, denitrification, soil absorption, and plant uptake, and is assumed to be 87% of the total nitrogen applied (*Horsley Witten Group, 2009,* Executive Summary included in *Figure A-8*).

3.3 Nitrogen Loading Calculations

3.3.1 Current Nitrogen Loading

To calculate current nitrogen loading, Zone 7 applied the methodology described in *Section 3.2.2* using the following data sets:

- Daily precipitation for an average year
- Daily evaporation for an average year
- 2013 Land-Use (shown in *Figure 3-7*)
- 2013 Source Water Distribution (shown in *Figure 3-8*)

Figure 3-7: 2013 Land Use

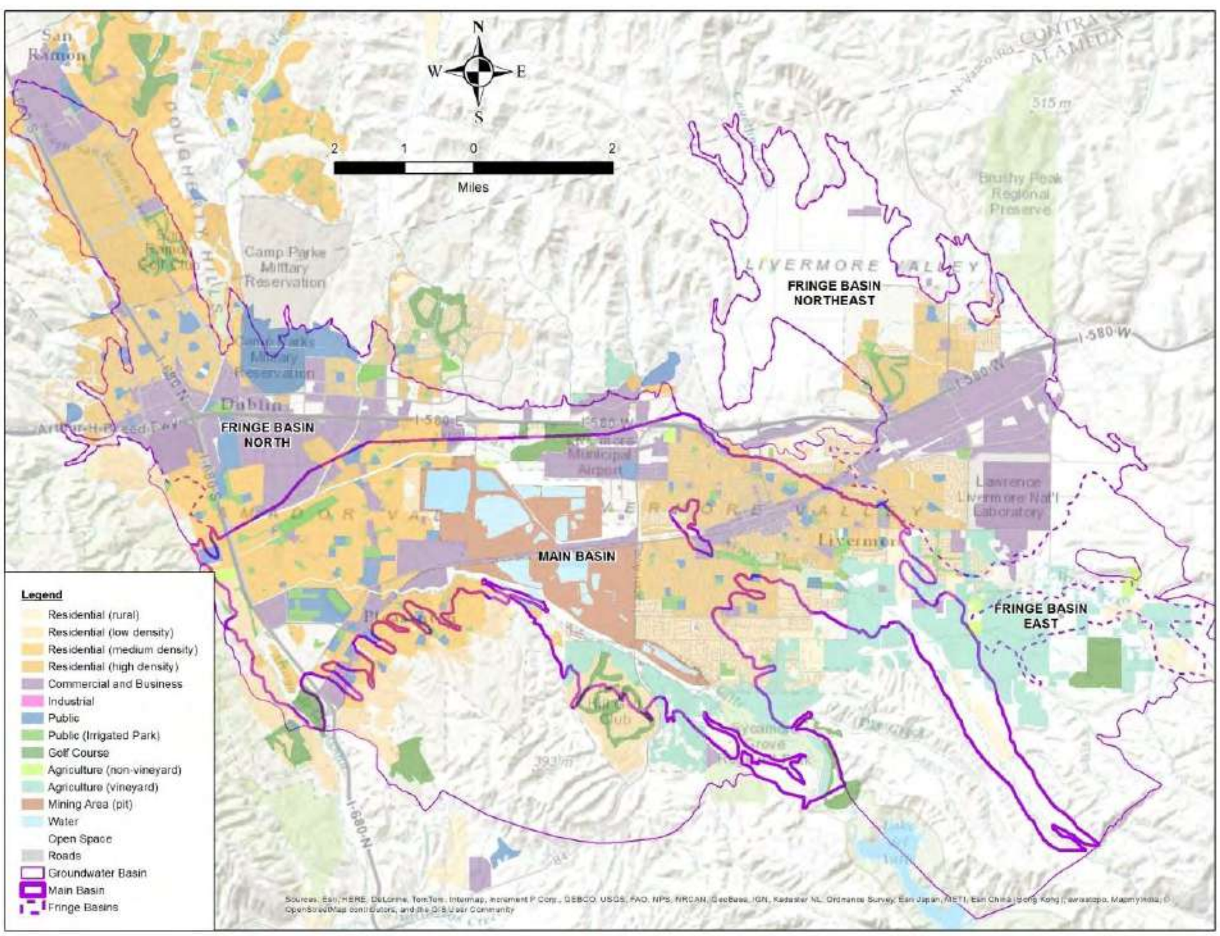
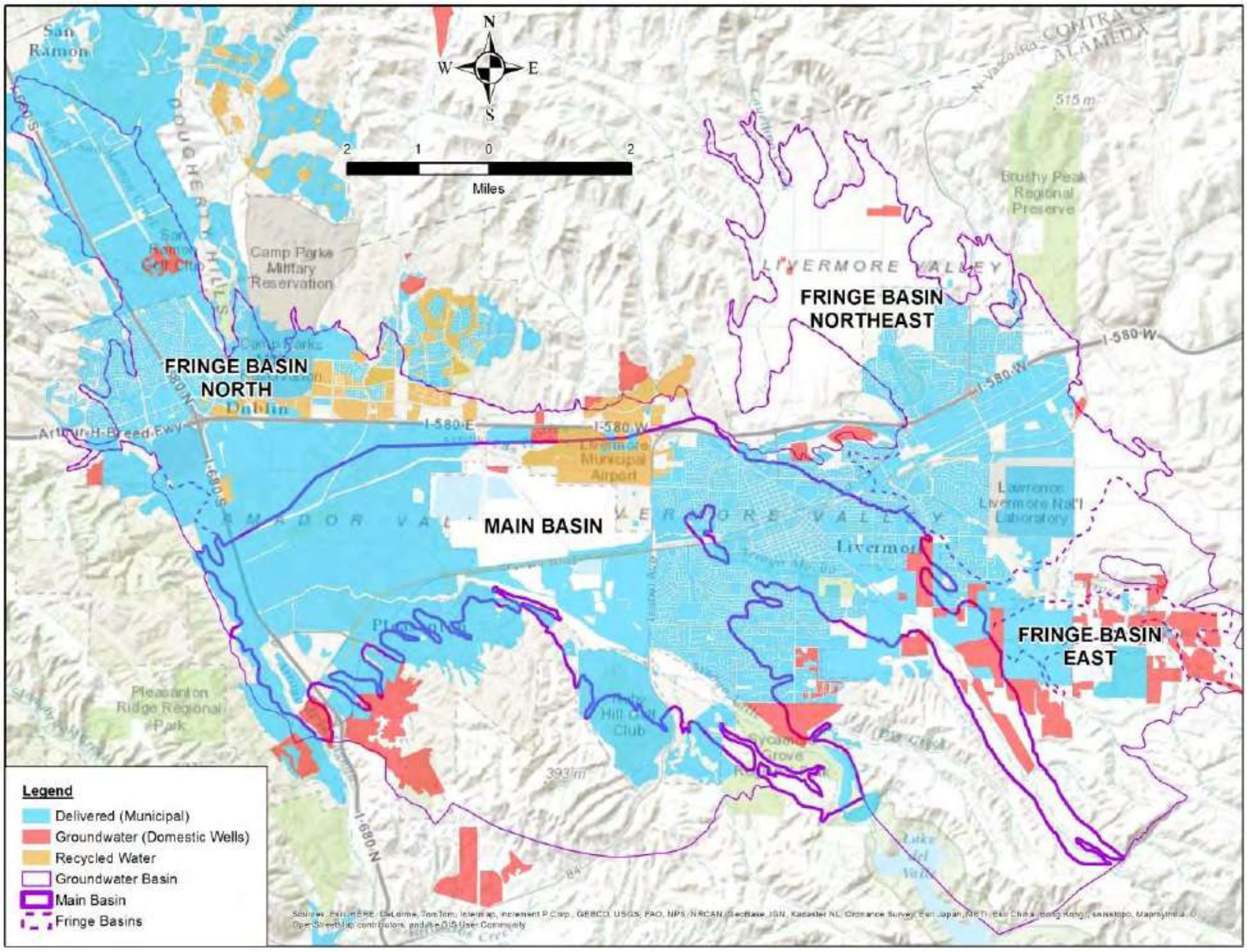
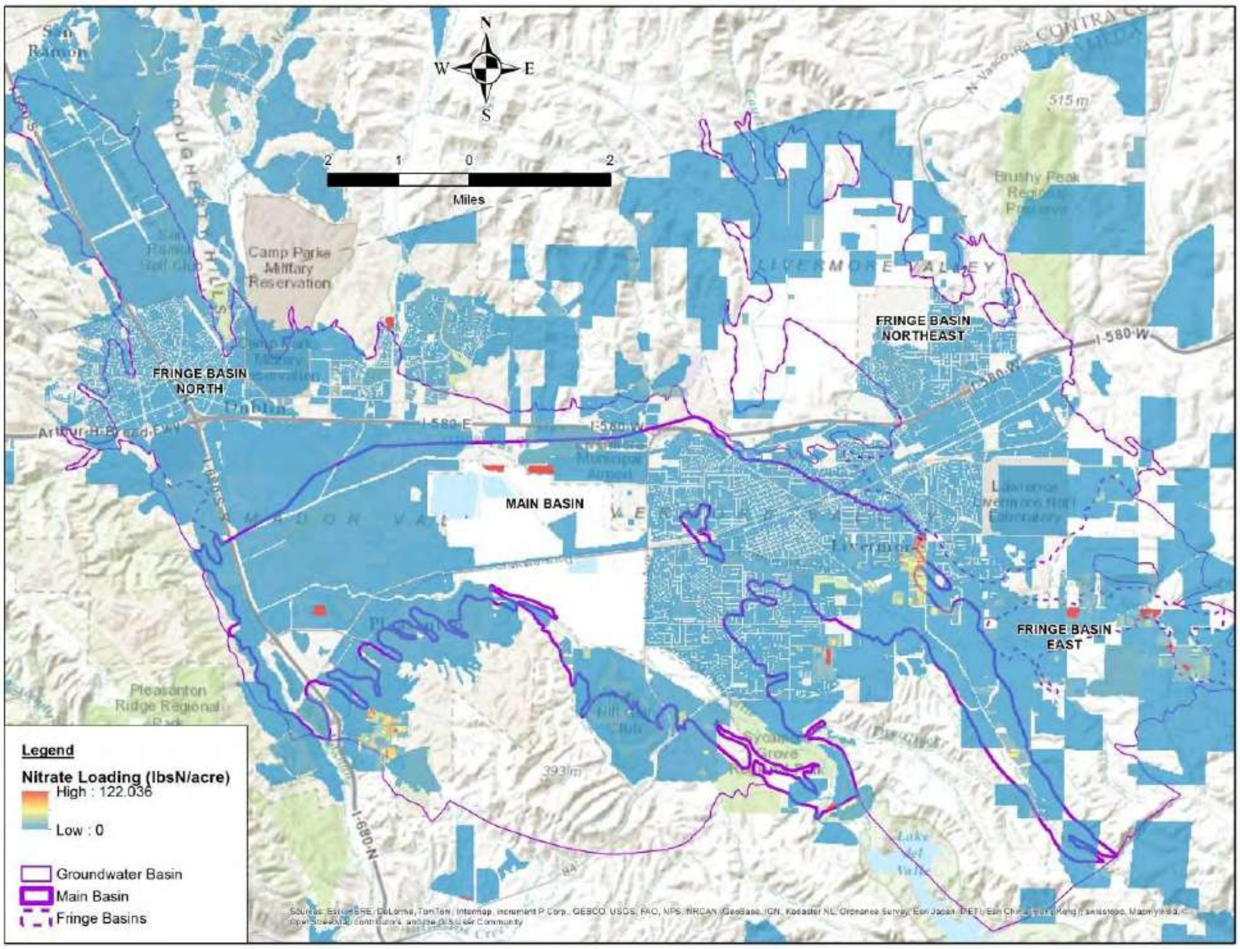


Figure 3-8: 2013 Source Water Distribution



The resulting total current nitrogen loading from all sources is shown on the map in *Figure 3-9* below.

Figure 3-9: Total Nitrate Loading (in lbs N/acre)



The net nitrogen loading from each component (loading and removal) is shown by basin area in *Figure 3-10* and is summarized in *Figure 3-11* below:

FIGURE 3-10
NET NITROGEN LOADING BY BASIN
CURRENT LAND USE WITH AVERAGE RAINFALL

COMPONENTS	MAIN BASIN					FRINGE BASIN (NORTH)					FRINGE BASIN (NORTHEAST)					FRINGE BASIN (EAST)				
	Units		Concentration or Rate		N Loading lbs N/yr	Units		Concentration or Rate		N Loading lbs N/yr	Units		Concentration or Rate		N Loading lbs N/yr	Units		Concentration or Rate		N Loading lbs N/yr
LOADING	**18,795**	**AF**	**7**	**mg/L**	**81,520**	**3,300**	**AF**	**14**	**mg/L**	**28,426**	**3,105**	**AF**	**6**	**mg/L**	**12,249**	**517**	**AF**	**24**	**mg/L**	**7,723**
Stream Recharge	10,895	AF	1	mg/L	8,398	150	AF	4	mg/L	326	1,049	AF	1	mg/L	668	100	AF	1	mg/L	62
Nat Stream Recharge	*5,700*	*AF*	*0.94*	*mg/L*	*3,315*	*150*	*AF*	*3.50*	*mg/L*	*326*	*999*	*AF*	*1.00*	*mg/L*	*619*	*100*	*AF*	*1.00*	*mg/L*	*62*
AV Prior Rights	*900*	*AF*	*1.58*	*mg/L*	*881*															
Art Stream Recharge	*4,295*	*AF*	*1.58*	*mg/L*	*4,202*						*50*		*1.58*	*mg/L*	*49*					
Rainfall Recharge	4,300	AF	0.50	mg/L	1,333	1,486	AF	0.50	mg/L	461	960	AF	0.50	mg/L	298	276	AF	0.50	mg/L	86
Leakage	1,000	AF	21	mg/L	13,020	485	AF	21	mg/L	6,309	50	AF	21	mg/L	651	10	AF	21	mg/L	130
Applied Water	1,600	AF	46	mg/L	45,735	1,180	AF	29	mg/L	21,331	1,046	AF	16	mg/L	10,632	130	AF	92	mg/L	7,445
Irrigation (fertilizer)					*30,757*					*20,792*					*7,834*					*1,109*
Horse Boarding	*52*	*acre*	*75*	*lbs/acre*	*3,914*	*0*	*acre*	*75*	*lbs/acre*	*0*	*0*	*acre*	*75*	*lbs/acre*	*0*	*40*	*acre*	*75*	*lbs/acre*	*2,978*
Rural Septic/Manure	*186*	*properties*	*49*	*lbs/prop*	*9,114*	*11*	*properties*	*49*	*lbs/prop*	*539*	*56*	*properties*	*49*	*lbs/prop*	*2,744*	*63*	*properties*	*49*	*lbs/prop*	*3,087*
Winery Large	*3*	*wineries*	*355*	*lbs/winery*	*1,065*	*0*	*wineries*	*355*	*lbs/winery*	*0*	*0*	*wineries*	*355*	*lbs/winery*	*0*	*0*	*wineries*	*355*	*lbs/winery*	*0*
Winery Medium	*2*	*wineries*	*200*	*lbs/winery*	*400*	*0*	*wineries*	*200*	*lbs/winery*	*0*	*0*	*wineries*	*200*	*lbs/winery*	*0*	*0*	*wineries*	*200*	*lbs/winery*	*0*
Winery Small	*9*	*wineries*	*54*	*lbs/winery*	*486*	*0*	*wineries*	*54*	*lbs/winery*	*0*	*1*	*wineries*	*54*	*lbs/winery*	*54*	*5*	*wineries*	*54*	*lbs/winery*	*270*
Subsurface Inflow	1,000	AF	21.02	mg/L	13,034	0	AF	0.44	mg/L	0	0	AF	0.44	mg/L	0	0	AF	0.44	mg/L	0
REMOVAL	**-18,795**	**AF**	**10**	**mg/L**	**-122,235**	**-3,300**	**AF**	**8**	**mg/L**	**-17,236**	**-3,105**	**AF**	**14**	**mg/L**	**-26,777**	**-517**	**AF**	**15**	**mg/L**	**-4,804**
Zone 7 Pumping	-5,940	AF	18.30	mg/L	-67,390															
Retailer Pumping	-6,570	AF	10.78	mg/L	-43,921															
Ag Pumping	-400	AF	9.32	mg/L	-2,310	-133	AF	0.44	mg/L	-36	-53	AF	15.00	mg/L	-493	-21	AF	15.00	mg/L	-195
Other Pumping	-1,185	AF	11.17	mg/L	-8,205															
Mining Losses	-4,600	AF	0.13	mg/L	-382															
Subsurface Outflow	-100	AF	0.44	mg/L	-27	-3,166	AF	8.76	mg/L	-17,200	-3,052	AF	13.89	mg/L	-26,284	-496	AF	15.00	mg/L	-4,608
Subsurface to Streams						*-2,166*	*AF*	*3.10*	*mg/L*	*-4,166*	*-3,052*	*AF*	*13.89*	*mg/L*	*-26,284*	*-496*	*AF*	*15.00*	*mg/L*	*-4,608*
Subsurface to MB						*-1,000*	*AF*	*21.02*	*mg/L*	*-13,034*										
NET NITROGEN LOADING					**-40,715**					**11,190**					**-14,528**					**2,919**

Figure 3-11: Summary of Current Total Nitrogen Loading and Removal

BASIN AREA	N LOADING lbs N/yr	N REMOVAL lbs N/yr	NET N LOADING lbs N/yr
Main Basin	81,520	- 122,235	-40,715
Fringe Basin North	20,426	-17,236	11,190
Fringe Basin Northeast	12,249	- 26,777	-14,528
Fringe Basin East	7,723	- 4,804	2,919

The percentage of loading from each source in each basin area is shown in *Figure 3-12* below:

Figure 3-12: Percentage Loading by Source - Current Conditions

Nitrogen Source	Main Basin	Fringe Basin North	Fringe Basin Northeast	Fringe Basin East
Recharge	12%	3%	8%	2%
Leakage	16%	22%	5%	2%
Irrigation/Fertilizer	38%	73%	64%	14%
Animal Boarding	5%	0%	0%	39%
OWTS	11%	2%	22%	40%
Winery	2%	0%	0%	3%
Subsurface Inflow	16%	0%	0%	0%

The largest source of nitrogen for the basin areas is irrigation (38% to 73% of total loading), with the exception of the Fringe Basin East, where nitrogen loading from irrigation is only 14% of total loading. In the Fringe Basin East, nitrogen loading is predominantly from horse boarding facilities (39%) and OWTS (40%). OWTS also contribute a significant source of nitrogen (22%) in the Fringe Basin Northeast. The largest removal of nitrogen in the Main Basin is from groundwater pumping (99.7%). In the Fringe Basin areas, where there is little groundwater pumping, the majority of nitrogen removal is from subsurface outflow (95% to 99.8%). However, because there are no wells down-gradient of the Fringe Basin East, the nitrate concentration of the subsurface outflow is unknown. For the calculations presented in *Figure 3-10*, Zone 7 used the average concentration of the basin.

In the Main Basin the net nitrogen loading is negative because of nitrogen removal by groundwater pumping. In the Fringe Basin Northeast the net nitrogen loading is also negative primarily because of high nitrate concentrations in the subsurface outflow into the Arroyo Las Positas. However, the net annual nitrogen loading is increasing in the Fringe Basin North and Fringe Basin East because there is little groundwater pumping or subsurface outflow and no other major nitrogen removal mechanisms.

3.3.2 Future Nitrate Loading

The planning horizon for this study is 2050, which is close to when "buildout" of the cities is currently projected. At buildout, the following land use changes are expected to be completed:

- Aggregate mining activities, converting to other uses.
- Urban development per Municipal General Plans
- South Livermore Plan development
- Recycled water project expansions currently planned by the Cities of Dublin, Livermore and Pleasanton.

To calculate nitrogen loading at buildout, Zone 7 applied the methodology described in *Section 3.2.2* using the following datasets:

- Daily precipitation for an average year
- Daily evaporation for an average year
- Land-Use at buildout (shown in *Figure 3-13* below)
- Source Water Distribution at buildout (shown in *Figure 3-14* below)

Figure 3-13: Land Use at Buildout

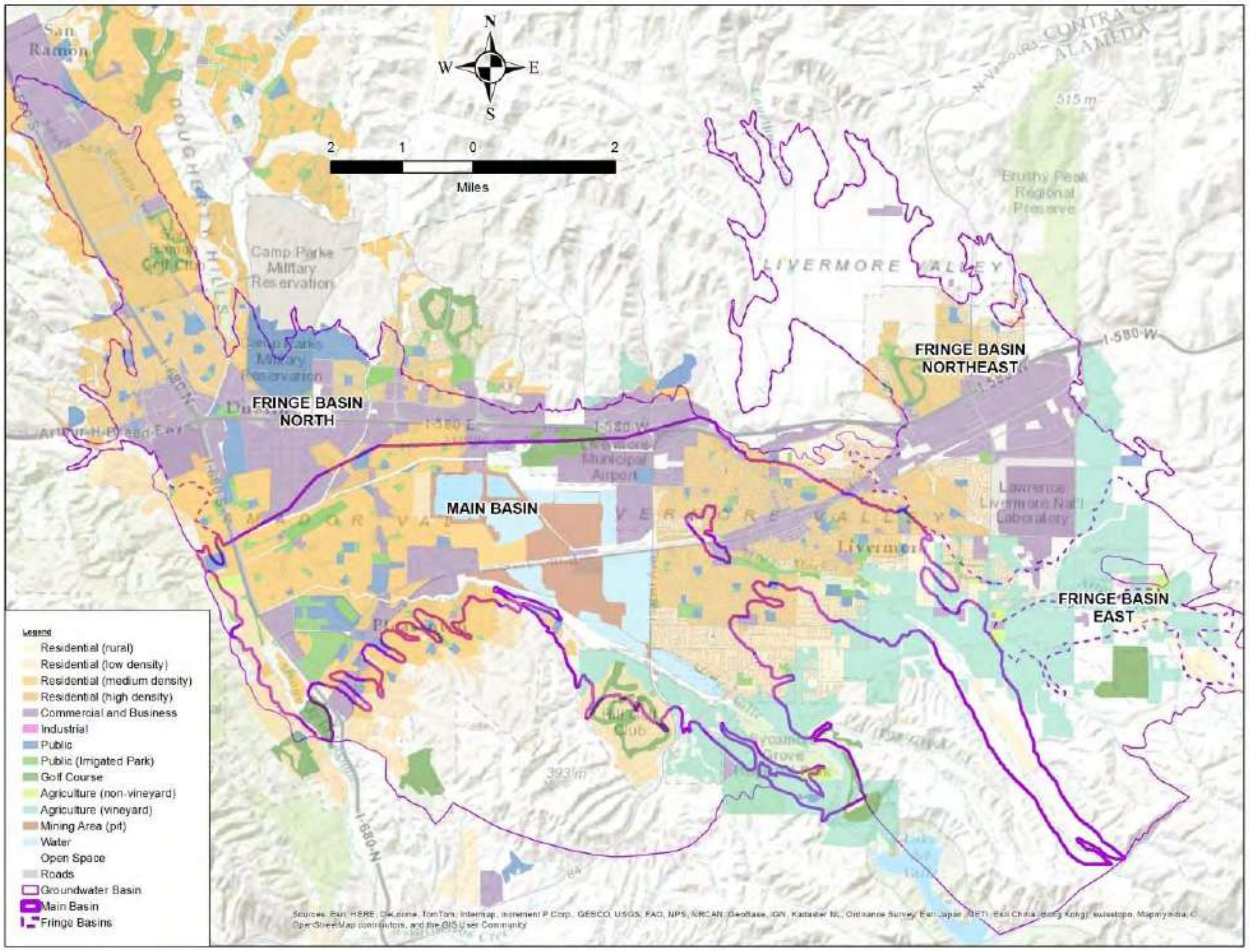
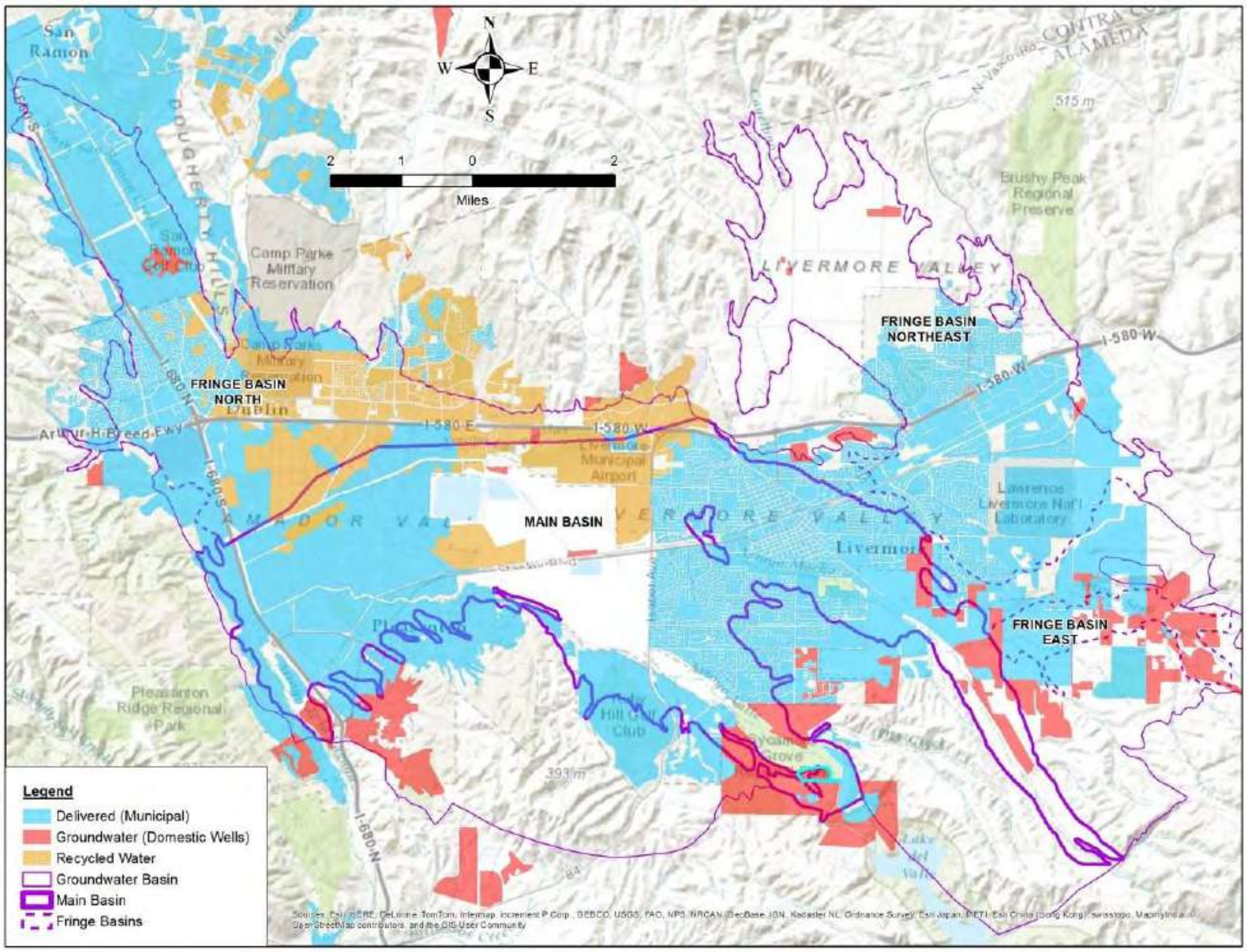


Figure 3-14: Source Water Distribution at Buildout



The net nitrogen loading estimated for each component (loading and removal) at build out for each basin area is shown in *Figure 3-15*, and summarized in *Figure 3-16* below.

FIGURE 3-15
NET NITROGEN LOADING BY BASIN
LAND USE AT BUILDOUT WITH AVERAGE RAINFALL

	MAIN BASIN					FRINGE BASIN (NORTH)					FRINGE BASIN (NORTHEAST)					FRINGE BASIN (EAST)				
COMPONENTS	**Units**		**Concentration or Rate**		**N Loading lbs N/yr**	**Units**		**Concentration or Rate**		**N Loading lbs N/yr**	**Units**		**Concentration or Rate**		**N Loading lbs N/yr**	**Units**		**Concentration or Rate**		**N Loading lbs N/yr**
LOADING	**17,395**	**AF**	**8**	**mg/L**	**87,642**	**3,300**	**AF**	**16**	**mg/L**	**32,283**	**3,105**	**AF**	**7**	**mg/L**	**13,789**	**517**	**AF**	**28**	**mg/L**	**8,905**
Stream Recharge	9,495	AF	1	mg/L	7,028	150	AF	4	mg/L	326	1,049	AF	1	mg/L	668	100	AF	1	mg/L	62
Nat Stream Recharge	*5,700*	*AF*	*0.94*	*mg/L*	*3,315*	*150*	*AF*	*3.50*	*mg/L*	*326*	*999*	*AF*	*1.00*	*mg/L*	*619*	*100*	*AF*	*1.00*	*mg/L*	*62*
AV Prior Rights	*900*	*AF*	*1.58*	*mg/L*	*881*															
Art Stream Recharge	*2,895*	*AF*	*1.58*	*mg/L*	*2,833*						*50*		*1.58*	*mg/L*	*49*					
Rainfall Recharge	4,300	AF	0.50	mg/L	1,333	1,486	AF	0.50	mg/L	461	960	AF	0.50	mg/L	298	276	AF	0.50	mg/L	86
Leakage	1,000	AF	21	mg/L	13,020	485	AF	21	mg/L	6,309	50	AF	21	mg/L	651	10	AF	21	mg/L	130
Applied Water	1,600	AF	54	mg/L	53,227	1,180	AF	34	mg/L	25,187	1,046	AF	19	mg/L	12,172	130	AF	107	mg/L	8,627
Irrigation (fertilizer)					*38,248*					*24,648*					*8,344*					*1,262*
Horse Boarding	*52*	*acre*	*75*	*lbs/acre*	*3,914*	*0*	*acre*	*75*	*lbs/acre*	*0*	*0*	*acre*	*75*	*lbs/acre*	*0*	*40*	*acre*	*75*	*lbs/acre*	*2,978*
Rural Septic/Manure	*186*	*properties*	*49*	*lbs/prop*	*9,114*	*11*	*properties*	*49*	*lbs/prop*	*539*	*66*	*properties*	*49*	*lbs/prop*	*3,234*	*73*	*properties*	*49*	*lbs/prop*	*3,577*
Winery Large	*3*	*wineries*	*355*	*lbs/winery*	*1,065*	*0*	*wineries*	*355*	*lbs/winery*	*0*	*0*	*wineries*	*355*	*lbs/winery*	*0*	*0*	*wineries*	*355*	*lbs/winery*	*0*
Winery Medium	*2*	*wineries*	*200*	*lbs/winery*	*400*	*0*	*wineries*	*200*	*lbs/winery*	*0*	*0*	*wineries*	*200*	*lbs/winery*	*0*	*0*	*wineries*	*200*	*lbs/winery*	*0*
Winery Small	*9*	*wineries*	*54*	*lbs/winery*	*486*	*0*	*wineries*	*54*	*lbs/winery*	*0*	*11*	*wineries*	*54*	*lbs/winery*	*594*	*15*	*wineries*	*54*	*lbs/winery*	*810*
Subsurface Inflow	1,000	AF	21.02	mg/L	13,034						0	AF	0.44	mg/L	0	0	AF	0.44	mg/L	0
REMOVAL	**-17,395**	**AF**	**10**	**mg/L**	**-112,763**	**-3,300**	**AF**	**15**	**mg/L**	**-30,599**	**-3,105**	**AF**	**12**	**mg/L**	**-23,293**	**-517**	**AF**	**16**	**mg/L**	**-5,181**
Zone 7 Pumping	-5,940	AF	16.93	mg/L	-62,359															
Retailer Pumping	-6,570	AF	9.98	mg/L	-40,642															
Ag Calculated	-400	AF	8.62	mg/L	-2,138	-133	AF	0.78	mg/L	-65	-53	AF	13.05	mg/L	-429	-21	AF	16.18	mg/L	-211
Other Pumping	-1,185	AF	10.34	mg/L	-7,597															
Mining Losses	-3,200	AF	0.00	mg/L	0															
Subsurface Outflow	-100	AF	0.44	mg/L	-27	-3,166	AF	15.55	mg/L	-30,535	-3,052	AF	12.08	mg/L	-22,865	-496	AF	16.18	mg/L	-4,971
Subsurface to Streams						*-2,166*	*AF*	*5.51*	*mg/L*	*-7,396*	*-3,052*	*AF*	*12.08*	*mg/L*	*-22,865*	*-496*	*AF*	*16.18*	*mg/L*	*-4,971*
Subsurface to MB						*-1,000*	*AF*	*37.32*	*mg/L*	*-23,139*										
NET NITROGEN LOADING					**-25,121**					**1,683**					**-9,504**					**3,724**

Figure 3-16: Summary of Total Nitrogen Loading and Removal at Buildout

BASIN	N LOADING (lbs N/yr)	N REMOVAL (lbs N/yr)	NET N LOADING (lbs N/yr)
Main Basin	87,642	-112,763	-25,121
Fringe Basin North	32,283	-30,599	1, 83
Fringe Basin Northeast	13,789	-22,293	9,504
Fringe Basin East	8,905	-5,181	3,724

The percentage of loading from each source in each basin area is shown in *Figure 3-17* below. At "buildout," the largest components of loading and removal of nitrogen are about the same as those estimated for current conditions; only slight percentage changes. The largest source of nitrogen loading for three of the basin areas is irrigation/fertilizer application (i.e., Main Basin, Fringe Basin North, and Fringe Basin Northeast). The 44% to 76% of total loading for this component is a slight increase over the 38% to 73% estimated for the same component under current conditions. For the Fringe Basin East, nitrogen loading is projected to be predominantly from horse boarding facilities (33%) and OWTS use (40%) as compared to 39% and 40%, respectively for the same two components currently. OWTS also are projected to contribute a significant source of nitrogen (23%) at buildout in the Fringe Basin Northeast, as compared to 22% currently.

Figure 3-17: Percentage Loading by Source at Buildout

Nitrogen Source	Main Basin	Fringe Basin North	Fringe Basin Northeast	Fringe Basin East
Recharge	10%	2%	7%	2%
Leakage	15%	20%	5%	1%
Irrigation/Fertilizer	44%	76%	61%	14%
Animal Boarding	4%	0%	0%	33%
OWTS	10%	2%	23%	40%
Winery	2%	0%	4%	9%
Subsurface Inflow	15%	0%	0%	0%

The largest removal of nitrogen in the Main Basin is predicted to be from groundwater pumping (99.9% versus 99.7% currently). In the Fringe Basin areas, where there is little groundwater pumping, the majority of nitrogen removal will be from subsurface outflow (95% to 99.8%, approximately the same as current). However, because there are no monitoring wells down-gradient of the Fringe Basin East, the nitrate concentration of the subsurface outflow had to be estimated. For the calculations presented in *Figure 3-15*, the average nitrate concentration of the basin was used as the nitrate concentration of the outflow.

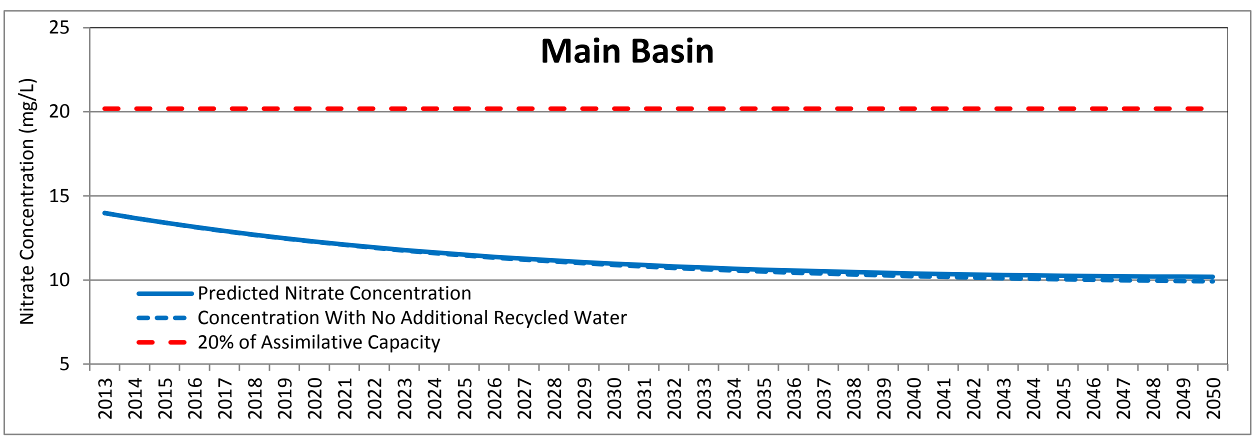
At buildout, the net nitrogen loading in the Main Basin will continue to be negative because of nitrogen removal by groundwater pumping. In the Fringe Basin Northeast the net nitrogen loading will continue to be negative primarily because of high nitrate concentrations in the subsurface outflow. However, the net annual nitrogen loading will continue to be positive in the Fringe Basin North and Fringe Basin East because there is little groundwater pumping or subsurface outflow, and no other major nitrogen removal mechanisms are apparent.

3.4 Projected Nitrate Concentrations

Zone 7 created a spreadsheet model to estimate future nitrogen concentrations for the four basin areas. These are presented and discussed by basin area below. Also shown on the graphs for the Main Basin and Fringe Basin North, where the recycled water irrigation projects are planned, are the predicted concentrations if there were no additional recycled water irrigation projects. According to the Recycled Water Policy, a recycled water irrigation project must use less than 10% of the available assimilative capacity or multiple projects must use less than 20% of available assimilative capacity. Since there are three planned recycled water projects in the Valley (by DSRSD, Livermore, and Pleasanton), the results are assessed relative to 20% of the available assimilative capacity.

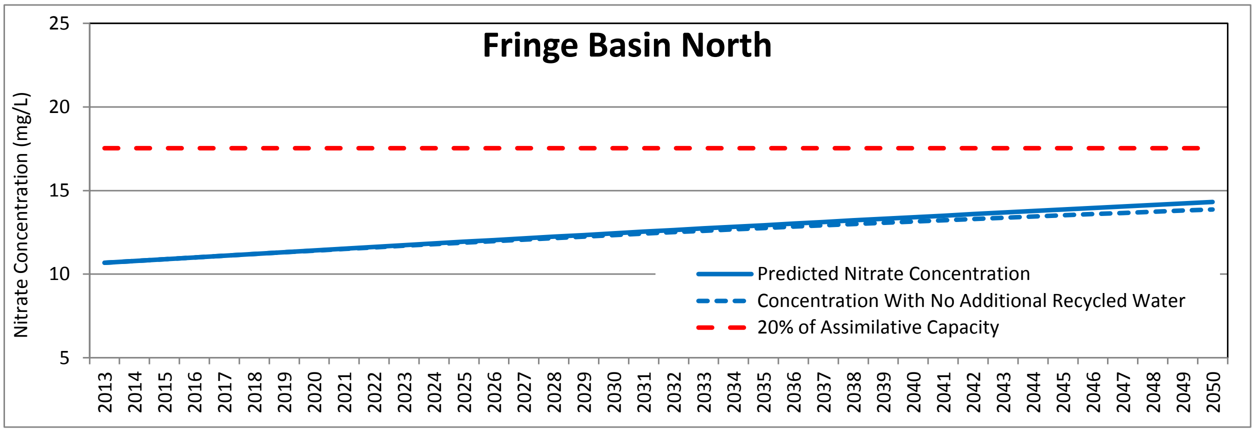
Nitrate concentrations in the Main Basin are expected to drop (see *Figure 3-18* below) primarily because of the removal of nitrates by groundwater pumping. The graph below also shows that there is only a minor expected increase in concentrations (<1 mg/L) from future planned recycled water, primarily because it is assumed that for the majority of land uses, nitrogen loading from the recycled water irrigation projects will be offset by reduced fertilizer application (*Section 3.2.2*).

Figure 3-18: Predicted Nitrate Concentrations in Main Basin



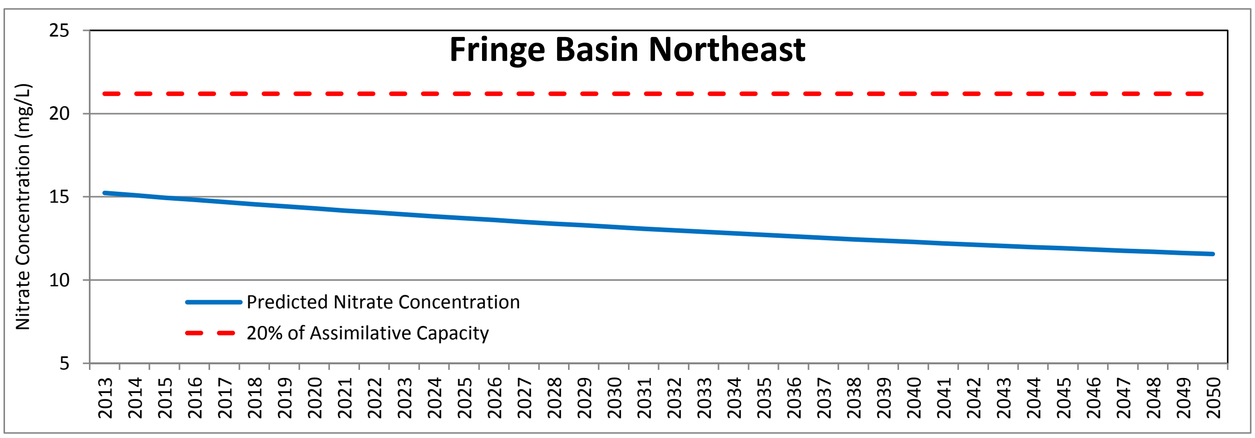
While net nitrate loading is positive in the Fringe Basin North, the total nitrogen loading increase is small relative to the overall volume of water in the basin. Therefore concentrations are only expected to rise slightly (about 2 mg/L) and are not expected to approach the limit of 20% of the assimilative capacity (see *Figure 3-19* below). Also, there is only a minor expected increase in concentrations (<1 mg/L) from future planned recycled water, primarily because the nitrogen loading from the recycled water irrigation projects will be offset by reduced fertilizer application.

Figure 3-19: Predicted Nitrate Concentrations in Fringe Basin North



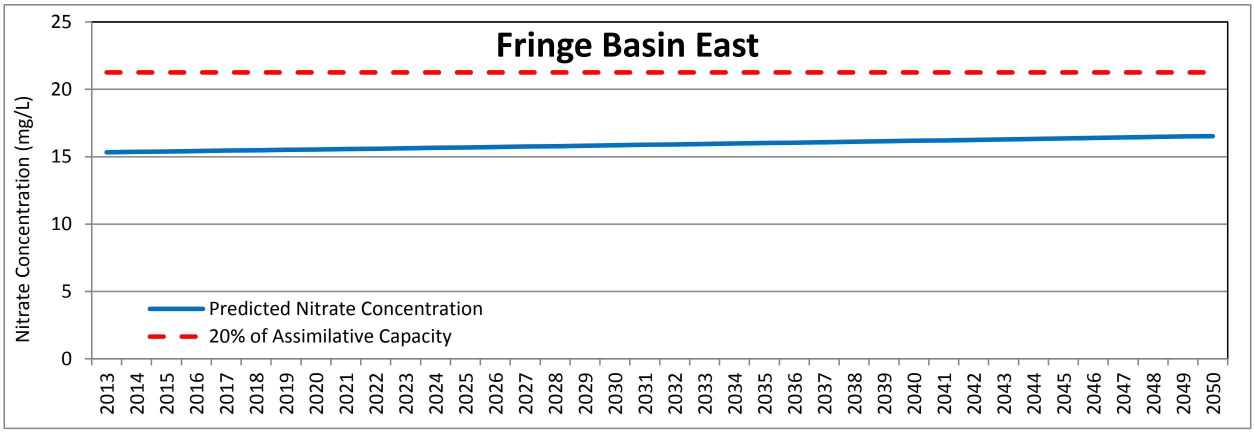
Nitrate concentrations in the Fringe Basin Northeast are expected to drop (see *Figure 3-20* below) because of the net negative nitrogen loading, primarily because of nitrate losses due to subsurface overflow from the basin. No recycled water irrigation projects are planned over this basin.

Figure 3-20: Predicted Nitrate Concentrations in Fringe Basin Northeast



Due to the positive net nitrogen loading primarily from anticipated increases in rural residential and agri-commercial land uses (livestock manure and OWTS leachate), nitrate concentrations are expected to rise only slightly (about 1 mg/L) in the Fringe Basin East (see *Figure 3-21* below), and are anticipated to remain below the 20% of the assimilative capacity limit. No recycled water irrigation projects are planned over this basin.

Figure 3-21: Predicted Nitrate Concentrations in Fringe Basin East



Zone 7 performed an analysis to assess the sensitivity of the nitrogen leaching rates in soil for fertilizer application and irrigation. The results of this parameter sensitivity analysis are presented in Appendix A. For this analysis, Zone 7 used the same method and spreadsheet model that gave the results above, but changed the leachable nitrogen factor for irrigated lands from an average of 13% (*Horsley Witten Group, 2009, see Figure A-8)* to approximately 25% (*RMC, 2012, see Figure A-9)*. The resulting predicted nitrate concentration graphs (*Figure A-10*) were then compared to those above to assess whether the higher nitrogen leaching rates would significantly change the results.

The results indicated that raising the leaching rate (i.e., more nitrogen leaches through the soil) had only a minimal effect on future nitrate concentrations for all basins except for the Fringe Basin North. In the Fringe Basin North, the predicted nitrate concentration increased to approximately 18 mg/L by 2050 and exceeded the 20% assimilative capacity limit sometime in the early 2040s. This is because the net nitrogen loading is positive in this fringe basin and the majority of the nitrogen loading is from fertilizer/irrigation. However, the predicted trend in nitrate concentration from the estimate using the higher leaching factor is not consistent with the historical trend of nitrogen concentrations in monitoring wells in this basin (see *Figure A-11*). Historical nitrate concentrations appear to be generally stable or even decreasing since 1974, which is more consistent with the trend resulting from the lower leaching factor shown in *Figure 3-19*.

Zone 7 will continue to monitor nitrate concentrations as part of its annual GWMP reports, and will reassess the nitrogen leaching rates as more research and concentration data becomes available. Zone 7 will update the predicted nitrate concentration graphs in *Figure 3-18* to *Figure 3-21* if the reassessed leaching rate is determined to be significantly higher, or if there are other significant changes to the parameters used in the calculations (e.g., those presented in *Figure 3-4* and *Figure 3-5*) or to future plans (e.g., future land use, recycled water).

4 Proposed Projects and Antidegradation Analysis

4.1 Recycled Water Projects

The Recycled Water Policy and other state-wide planning documents recognize the tremendous need for and benefits of increased recycled water use in California. As stated in the Recycled Water Policy *"The collapse of the Bay-Delta ecosystem, climate change, and continuing population growth have combined with a severe drought on the Colorado River and failing levees in the Delta to create a new reality that challenges California's ability to provide the clean water needed for a healthy environment, a healthy population and a healthy economy, both now and in the future. …….We strongly encourage local and regional water agencies to move toward clean, abundant, local water for California by emphasizing appropriate water recycling, water conservation, and maintenance of supply infrastructure and the use of stormwater (including dry-weather urban runoff) in these plans; these sources of supply are drought-proof, reliable, and minimize our carbon footprint and can be sustained over the long-term."* Clearly, the benefits in terms of sustainability and reliability of recycled water use cannot be overstated (quoted from *RMC, 2013*).

Recycled water represents a significant potential resource for the Valley. Livermore, Pleasanton, and DSRSD plan to expand the use of recycled water for turf and landscape irrigation projects over the next few years. The cities supplied Zone 7 with the location of existing and future recycled water use as compiled in *Figure 3-14*. The estimated volumes of future planned recycled water use are shown in the figure below:

Figure 4-1: Existing and Future Recycled Water Use

Location	Volume AF	Inside Main Basin %
Existing		
Livermore	1,700	59%
DSRSD	2,800	0%
Future		
East Pleasanton Plan	300	100%
Pleasanton Phase 1	1,700	41%
Staples Ranch	200	50%
DSRSD – planned	300	0%
Livermore - planned	300	100%

Mitigation of the water quality concerns related to salt loading from recycled water use is addressed in Zone 7's SMP (*Zone 7, 2004, Chapter 3, Section 3.3.1.1*) and in Zone 7 Annual Reports for the GWMP (most recent is *Zone 7, 2014* for the 2013 Water Year, October 2012 to September 2013). Zone 7 continues to collaborate with Livermore, DSRSD, and Pleasanton to incorporate future planned recycled water use expansions, and to plan for future groundwater demineralization facilities to mitigate for the potential impact to groundwater and delivered water quality.

4.2 Stormwater Capture Projects

Zone 7 supports low impact development (LID) projects with pervious surfaces that allow for improved management of stormwater and enhanced groundwater recharge, particularly in developed areas (*Zone 7, 2011*). As stated in the Recycled Water Policy, *it is also the intent of the State Water Board that because stormwater is typically lower in nutrients and salts and can augment local water supplies, the inclusion of a significant stormwater use and recharge component within the salt/nutrient management plans is critical to the long-term sustainable use of water in California.* While there are currently no proposed large-scale plans for stormwater capture and recharge in the Valley, the County and Cities have required stormwater capture and recharge for various small-scale projects. Zone 7 encourages the continuation of this concept into future land development as a means to help dilute and attenuate nitrate concentrations in groundwater (*Sections 5.4* and *6.3.1*).

Zone 7 does include stormwater recharge as part of its areal recharge and stream flow recharge calculations, however the effect of individual, small-scale stormwater capture and recharge projects is not included at this time due to the uncertainties in the projected quantity and volume. The current calculations represent a conservative approach since stormwater capture and recharge would likely decrease nitrate concentrations in the groundwater basin. Future updates to this plan may re-evaluate this approach as future projects are proposed.

4.3 State Water Board Recycled Water Policy Criteria

Section 9 Anti-Degradation of the State Water Board Recycled Water Policy states, in part:

> *a. The State Water Board adopted Resolution No. 68-16 as a policy statement to implement the Legislature's intent that waters of the state shall be regulated to achieve the highest water quality consistent with the maximum benefit to the people of the state.*
>
> *b. Activities involving the disposal of waste that could impact high quality waters are required to implement best practicable treatment or control of the discharge necessary to ensure that pollution or nuisance will not occur, and the highest water quality consistent with the maximum benefit to the people of the state will be maintained…..*
>
> *d. Landscape irrigation with recycled water in accordance with this Policy is to the benefit of the people of the State of California. Nonetheless, the State Water Board finds that the use of water for irrigation may, regardless of its source, collectively affect groundwater quality over time. The*

State Water Board intends to address these impacts in part through the development of salt/nutrient management plans described in paragraph 6.

(1) A project that meets the criteria for a streamlined irrigation permit and is within a basin where a salt/nutrient management plan satisfying the provisions of paragraph 6(b) is in place may be approved without further antidegradation analysis, provided that the project is consistent with that plan.

(2) A project that meets the criteria for a streamlined irrigation permit and is within a basin where a salt/nutrient management plan satisfying the provisions of paragraph 6(b) is being prepared may be approved by the Regional Water Board by demonstrating through a salt/nutrient mass balance or similar analysis that the project uses less than 10 percent of the available assimilative capacity as estimated by the project proponent in a basin/sub-basin (or multiple projects using less than 20 percent of the available assimilative capacity as estimated by the project proponent in a basin/sub-basin).

4.4 Antidegradation Assessment

Section 3.4 includes graphs of future average nitrate concentrations for scenarios with and without the proposed recycled water irrigation projects in the Main Basin and Fringe Basin North. The graphs show that irrigation with recycled water contributes very minor nutrient loading in the basins (<1%), and that the recycled water projects do not use more than 20% of the available assimilative capacity. Nitrogen loading from recycled water can be minimized even further by employing recycled water irrigation BMPs (*Section 5.3.3*), and fertilizer BMPs (*Section 5.3.2*) when turf or landscape fertilizers (or fertigation) are applied along with recycled water.

The NMP analysis finds that recycled water use can be increased while still protecting and improving groundwater quality for beneficial uses. *Figure 4-2* addresses how the proposed recycled water irrigation projects comply with each of the components of State Water Board's Anti Degradation Policy (Resolution No. 68-16).

Figure 4-2: Antidegradation Assessment

<table>
<tr><th>State Water Board Resolution No. 68-16 Component</th><th>Antidegradation Assessment</th></tr>
<tr><td>Water quality changes associated with proposed recycled water project(s) are consistent with the maximum benefit of the people of the State.</td><td rowspan="3">The irrigation projects will
contribute only a minimal increase (<1 mg/L) in groundwater nitrate concentrations at urban buildout.
will not use more than 20% of the available Assimilative Capacity
will not cause groundwater quality to exceed Basin Plan Objectives</td></tr>
<tr><td>The water quality changes associated with proposed recycled water project(s) will not unreasonably affect present and anticipated beneficial uses.</td></tr>
<tr><td>The water quality changes will not result in water quality less than prescribed in the Basin Plan.</td></tr>
<tr><td>The projects are consistent with the use of best practicable treatment or control to avoid pollution or nuisance and maintain the highest water quality consistent with maximum benefit to the people of the State.</td><td>Because all planned recycled water projects over the groundwater basin are landscape irrigation projects, most of the nitrogen from these projects will be removed by plant uptake and volatilization (and some by bacterial denitrification under certain conditions). Additional nitrogen loading will be avoided with the use of recycled water and fertilizer use BMPs (see Section 6.1)</td></tr>
<tr><td>The proposed project(s) is necessary to accommodate important economic or social development.</td><td>The recycled water projects are crucial for continued sustainability of the Valley's water supply and are part of the urban growth plans for Cities of Dublin, Livermore, and Pleasanton.</td></tr>
<tr><td>Implementation measures are being or will be implemented to help achieve Basin Plan Objectives in the future.</td><td>Both, the SMP and the NMP contain measures that have been or will be implemented to address current and future salt and nutrient loading of the Groundwater Basin.</td></tr>
</table>

5 Nutrient Management Goals and Strategies

5.1 Introduction

As shown in *Section 3.4* above, basin-wide nitrogen concentrations are expected to drop or stay relatively constant over the long-term; however, there are some existing high nitrate concentrations in local areas of concern (*Section 2.4*). Zone 7's general goal is to further assess and reduce groundwater nitrate concentrations near these "Areas of Concern" using strategies that have a nominal impact on future development and the environment while reducing the nitrogen loading to levels that can be assimilated by natural processes (e.g., denitrification, dilution and diffusion). The strategies presented in this chapter are designed to delineate the extent and boundaries of the Areas of Concern (*Section 5.2*), and to simultaneously minimize nitrogen loading from existing sources (*Section 5.3*).

5.2 Investigate Areas of Concern

In general, the Areas of Concern in the Main Basin are relatively well delineated because of the basin's significance for groundwater production. In contrast, the geology and extent of nitrate concentration in the Fringe Basins Northeast and East have not been well delineated because of their relative role for groundwater production in the Valley and limited development. Zone 7 plans to focus future investigation on Areas of Concern where:

- Concentrations appear to be rising significantly (i.e., May School, Greenville),
- Future development is planned in unsewered areas (i.e., Greenville), and/or
- Significant data gaps exist (i.e., May School, Greenville, and Mines Road).

Goal 1: Obtain additional information in shallow aquifer zones of the Areas of Concern.

Strategy 1a: Identify and sample additional existing domestic wells with pertinent well screen intervals.

Strategy 1b: Encourage additional hydrogeology studies in Areas of Concern as part of new commercial developments. Such studies could include the installation of new monitoring wells or direct-push type borings (e.g., Geoprobe, Hydropunch).

5.3 Minimize Nitrogen Loading

5.3.1 Introduction

The primary sources of nitrogen loading over the groundwater basin are from fertilizer application, recycled water irrigation, leaching of livestock manure, and onsite wastewater treatment systems (OWTS). Best Management Practices (BMPs) are the best tools for minimizing nitrogen loading from irrigation (fertigation), turf and crop fertilization practices, and penned livestock facilities such as horse boarding facilities. And while the additional nitrogen loading from future recycled water project expansions is expected to be small (*Section 3.4*), it would be prudent to employ the fertilizer application BMPs as well as the recycled water irrigation BMPs for all recycled water irrigation projects.

OWTS use in the Valley involves domestic and commercial systems to treat and dispose of winery process wastewater. OWTS management, especially in the Areas of Concern, requires long-term goals and strategies for ensuring impacts from new onsite wastewater disposal systems are not going to create a new nitrate problem or exacerbate an existing one. Eventually, the conventional OWTS in the Areas of Concern should be converted to alternative systems having nitrogen reduction treatment, or the affected homes and businesses should be connected to a municipal or community sewer system. Management of onsite treatment and disposal of wastewater from wine making and bottling processes is under the Water Board's jurisdiction, and is currently provided for through the Water Board's waste discharge requirement (WDR) permit program. Although WDRs are an effective means for managing nutrient loading from this land use, improvements are needed in stakeholder guidance and permit compliance.

5.3.2 Fertilizer Application

Goal 2: Minimize nitrogen loading from fertilizer application

Strategy 2a: Promote the use of fertilizer BMPs (*Section 6.2.2*) to avoid over-application of fertilizers. Using results of soil and irrigation water chemical testing to determine the appropriate amount of additional fertilizer to apply is a good way to lessen excess leachable nitrogen in the soil.

Strategy 2b: Limiting irrigation water application to the crop and landscape plants' agronomic rate will reduce the amount of nutrient-rich leachate that migrates below the vegetation root zone and into the underlying aquifer(s).

5.3.3 Recycled Water Irrigation

Goal 3: Minimize nitrogen loading from recycled water irrigation projects

Strategy 3a: Follow Recycled Water Policy guidance for landscape irrigation projects. Minimize recharge of nitrogen by irrigating landscapes to the prescribed agronomic rates. Account for the nitrogen content of the recycled water when determining how much fertilizer to apply.

Strategy 3b: Maintain low levels of nitrogen in the produced recycled water by keeping the nitrogen concentrations in the source water low and/or optimize low nitrogen levels in recycled water production.

5.3.4 Livestock Manure Management

Goal 4: Minimize nitrogen loading from concentrated livestock facilities such as horse boarding, training, and breeding facilities

Strategy 4: Promote the use of BMPs (*Section 6.2.4*) such as manure management and controlling site drainage to prevent nutrient contamination of rainfall runoff and irrigation return flows that may percolate to groundwater and/or flow into surface water bodies.

5.3.5 Onsite Wastewater Treatment Systems

5.3.5.1 Winery Process Wastewater

Goal 5: Minimize nitrogen loading from onsite disposal practices of winery process wastewater.

Strategy 5a: Require local wine producers and bottlers to apply for and comply with Water Board WDRs for the proper treatment and disposal of winery process waste streams.

Strategy 5b: Develop guidance document(s) to assist both project proponents and Water Board staff with Report of Waste Discharge (ROWD) and WDR development and evaluations.

5.3.5.2 General OWTS Management

Goal 6: Minimize nitrogen loading from new onsite wastewater treatment systems (OWTS), e.g., septic tank systems.

Strategy 6a: Continue applying Zone 7 policies and County Ordinance and Regulation provisions, e.g., 1 Rural Residential Equivalence (RRE)/5 Ac max.

Strategy 6b: Continue to work with ACEH to ensure that: 1) they are aware of groundwater nitrate issues in the Livermore Valley Groundwater Basin; 2) variance requests are given the appropriate scrutiny; and 3) their OWTS approvals are consistent with adopted NMP goals and objectives.

5.3.5.3 OWTS Management in Areas of Concern

Goal 7: Reduce nitrogen loading from OWTS in Areas of Concern.

Strategy 7a: Increase understanding of existing conditions and causes, and set realistic management goals and apply adaptive management as necessary.

Strategy 7b: Require new development projects utilizing OWTS in the Areas of Concern to reduce and/or minimize the overall nitrogen loading to the property.

Strategy 7c: On at least an annual basis, assess performance of wastewater treatment systems, estimate area-wide nitrogen loading and monitor groundwater quality beneath the Areas of Concern.

5.4 Enhanced Attenuation

Goal 8: Increase capture and infiltration of stormwater recharge to dilute and attenuate nitrate concentrations in groundwater.

Strategy 8: Promote the use of Low Impact Development (LID) BMPs to capture and infiltrate rainfall runoff and irrigation return flow (i.e., applied water).

6 Plan Implementation

6.1 Investigate Boundaries of Areas of Concern

Zone 7 intends to obtain additional information regarding the extent of high nitrate concentrations near Areas of Concern that have significant data gaps, proposed development with OWTS, and/or increasing nitrate concentrations. To this end, Zone 7 plans on pursuing the following options to further investigate the extent of nitrate concentrations:

- Zone 7 will work with well owners to sample existing shallow wells for nitrate. This process could include public outreach to homeowners to identify domestic wells with ideal characteristics (e.g., location, screened intervals, well depth) for further delineating the extent of nitrate concentrations in Areas of Concern. These wells could then be sampled and analyzed by Zone 7 at no cost to the well owner.

- Zone 7 will assess the data available, identify data gaps, and prepare maps showing preferred locations for future monitoring wells potentially to be installed by developers for each Area of Concern. It is anticipated that the studies will be conducted in the following priority: Greenville, Buena Vista, Mines Road, May School, Happy Valley, Staples Ranch, Jack London, Constitution, Charlotte Way, and Bernal.

- Zone 7 will work with Alameda County planning and health agencies to encourage or require hydrogeologic studies as part of new commercial developments. These studies could include installing new monitoring wells in locations identified on the preferred well location maps, sampling of existing wells, or drilling direct-push type borings.

- Zone 7 may require that new wells and borings near Areas of Concern include the running of electronic logs (elogs) and/or collecting and analyzing groundwater samples. The results of these elogs and groundwater samples can be used to better understand the geology and assess the extent of contamination in the Areas of Concern.

- The data results and work products generated from the tasks above (e.g., preferred well location maps, well sampling results) will be presented in the GWMP Annual Reports or as a separate report, as appropriate, based on the size and extent of the study and/or timing of its completion.

6.2 Implementation Measures to Minimize Nitrogen Loading

6.2.1 Introduction

Nitrate concentrations are expected to remain well below 20% of the assimilative capacity limit for all four groundwater areas in the Livermore Valley Groundwater Basin; however there are local Areas of

Concern where nitrate concentrations are above the Basin Objective (BO, 45 mg/L as NO_3). The main sources of nitrogen loading throughout the groundwater basin include fertilizer application, recycled water irrigation, livestock facilities, and onsite wastewater treatment systems. The implementation measures presented below are designed to minimize loading from these main sources, particularly in the Areas of Concern shown on *Figure 2-15* and described in *Section 2.4*. Many of these implementation measures include continuing with existing Best Management Practices (BMPs) that are monitored and administered by other agencies.

6.2.2 Fertilizer BMPs

Fertilizer application should be adjusted to the needs of the plants/crops to which it is being applied and take into account the nutrients already present in soil and irrigation water to avoid over-fertilization. The implementation plan promotes the continued use of the following fertilizer BMPs by agriculturists, park districts, school districts and other landscape and turf managers and practitioners.

- Targeted application of fertilizer and soil amendments – limit the application of salts and nutrients to the area at the point of the irrigation drip emitter, rather than broadcast across a large area.
- Adjust fertilizer amounts to account for nutrients already present in irrigation water and soil. Nutrient levels can be assessed by testing soil and water.
- Apply irrigation at agronomic rates to prevent nutrients in fertilizer from leaching into the groundwater.
- Effective vineyard management includes regular soil and petiole testing to help understand what, and volume of, nutrients that need to be added to the soil to produce the desired grape production and flavor. When the soil and petiole testing includes nitrogen as a test parameter, the results can be used to ensure that the amount of additional nitrogen applied is limited to that amount needed by the vines.

6.2.3 Recycled Water Irrigation BMPs

The use of recycled water for irrigation is controlled by water recycling criteria in Title 22 of the California Code of Regulations, and by discharge requirements established by the Regional Water Board. In addition to adhering to these regulations related to recycled water, the implementation plan recommends the continued use of the following BMPs by those who irrigate with recycled water:

- Reduce application of fertilizer to account for nitrogen in the recycled water.
- Irrigate during evening and early morning hours to reduce evaporation and human exposure.

- An effective irrigation system should be used that applies recycled water at agronomic rates. Infiltration of recycled water past the active root zone should be limited to only what is needed to remove salts from the root zone.

6.2.4 Livestock Manure Management

Livestock and Equestrian Facilities are another source of nitrates due to concentrated amounts of manure where animals are kept. Equestrian Facilities include horse boarding, training, and breeding facilities. The NMP endorses the County's requirement for concentrated and confined livestock facilities to implement design measures and BMPs for livestock manure management, such as:

- Manure management – remove manure regularly. If manure can't be removed daily then it should be covered and stockpiled on an impervious surface. Surface water should be prevented from reaching the storage area.

- Building and site design – should keep animal areas, such as paddocks and corrals, as dry as possible during the rainy season.

- Wash rack design – should not allow water to flow into storm drains, creeks, or recharge areas. Wash racks should be connected to the sanitary sewer or lined evaporation ponds, if possible.

- Facility and BMP inspections are performed by Alameda County Public Works as part of their Clean Water Program.

Additional guidance for manure management can be found in existing documents such as *Horse Manure Management – A Guide for Bay Area Horse Keepers (Buchanan et al., 2003)*. The existing City and County proposed development review and referral process is another opportunity to educate facility managers and architects on the design and operation considerations for limiting nutrient impacts to surface waters and groundwater.

6.2.5 Onsite Wastewater Treatment and Disposal

Limitations for the expansion of municipal sewer coverage in the Livermore-Amador Valley associated with the establishment of urban growth boundaries have resulted in the continued reliance of OWTS for development in the unincorporated areas. In particular, the continued growth of winery-related commercial development in or near the south Livermore high nitrate areas is a concern for maintaining or improving groundwater quality. OWTS that may have been allowed in the past may not be appropriate in the future as conditions and circumstances surrounding particular locations change or become known.

As provided for in the Water Board Basin Plan, ACEH has committed to developing a Local Agency Management Program (LAMP) for Water Board approval that will address their management of OWTS in unincorporated Alameda County. A LAMP is a management program that allows local agencies to establish minimum standards that are different from those specified in the State OWTS Policy, but are necessary to protect water quality and public health. Requirements for different minimum lot size for new development using OWTS and the addition of nitrogen-removing treatment equipment on OWTS for certain conditions are examples of special provisions that ACEH will likely include in its LAMP.

6.2.5.1 Winery Process Wastewater

There are currently over 50 wineries located over the Livermore Valley Groundwater Basin, however, many of them do not produce or bottle wine onsite. The ones that do produce or bottle wine, also produce a wastewater stream during the wine production and bottling operations. This winery process water, which contains nutrients, is often disposed of in evaporation ponds, on the surface as irrigation or dust control water, or in the subsurface using OWTS and leachfields. Regardless of which of these disposal methods is used, the Water Board has authority to regulate the discharge; thus a Report of Waste Discharge is required to be submitted to the Water Board for the discharge of wastewater to the surface or subsurface. The Water Board will then approve the discharge by issuing Waste Discharge Requirements, waive the need of a WDR, or deny approval of the discharge.

- To assist applicants with their ROWD preparation and the Water Board with their evaluation of ROWDs and WDR decisions, Zone 7 and ACEH will continue to provide relevant information on groundwater occurrence, use, quality and vulnerability to the Water Board and applicants.

- The preparation of a guidance document on the proper treatment and disposal of wastewater and organic wastes generated from the wine making and wine bottling processes would be beneficial for the development of plans that are effective at minimizing nutrient loading to the groundwater basin.

6.2.5.2 General OWTS Program

One of the purposes of the Alameda County Onsite Wastewater and Individual/Small Water Systems Ordinance and Regulations is to prevent environmental degradation of surface water and groundwater from onsite disposal of private sewage to the greatest extent possible. Included in the regulations are special provisions for the Upper Alameda Creek Watershed, above Niles; namely:

a. a minimum parcel size requirement of 5 acres for new single-family OWTS; and
b. a maximum discharge of 320 gallons per day per 5 acres for commercial OWTS.

Continued application of the general provisions of the County OWTS Ordinance and Regulation and these special provisions are expected to minimize the groundwater nitrate impact from OWTS use in the majority of the unincorporated areas of the Livermore Valley Groundwater Basin except in the Areas of Concern. Additionally, the following measures are planned:

- Zone 7 and ACEH will continue working together to ensure that both agencies are aware of groundwater issues in the Livermore Valley Groundwater Basin and that any OWTS approvals are consistent with the adopted NMP goals and objectives.

- Zone 7 and ACEH will continue to collaborate on the decisions surrounding approval of new OWTS for commercial facilities' domestic wastewater disposal on a case-by-case basis and to evaluate the potential risks and make proper decisions as additional information becomes available.

- Zone 7 and ACEH will continue to collaborate on assessing the potential risks and impact(s) associated with granting OWTS regulation variances and on developing any special requirements necessary to ensure groundwater quality protection.

- Zone 7 and ACEH will collaborate to determine the applicable time periods of any new OWTS permits, and continued compliance monitoring and renewal requirements to ensure long-term successful performance.

6.2.5.3 OWTS Management in Areas of Concern

Zone 7 has identified ten Areas of Concern with elevated nitrate concentrations in groundwater. Current and past onsite wastewater disposal practices are thought to be an important contributor to the high nitrate concentrations found in these areas. As such, ongoing and future wastewater disposal projects in the Areas of Concern should be managed with a bias towards reduction of the current loading. It is also important to increase the understanding of the extent of the nitrate impacts in many of these areas and to monitor the concentration trends as projects add and subtract wastewater loading in these areas. Towards these goals the following measures are expected to be performed:

- Zone 7 will coordinate further characterization and monitoring of the local nitrate plumes by working with ACEH, the Water Board and various property owners and consultants on the development of plans for the construction and operation of additional monitoring wells.

- Zone 7 will continue its effort to inform ACEH and Alameda CDA of the nitrate issues in the Livermore Valley Groundwater Basin and to collaborate on development plans, permit reviews, and CEQA analyses for projects involving onsite wastewater disposal in Areas of Concern to assure approvals are consistent with adopted NMP goals and objectives.

- Local Agency Formation Commission (LAFCO), developers and County and City planning agencies are expected to continue to work together to create opportunities for discontinuing onsite disposal of nutrient-rich wastewater within the Areas of Concern, such as connecting dwellings and businesses to municipal or community sewage treatment works when feasible.

- ACEH, Zone 7, and the Water Board will work together on the development, approval, and implementation of the LAMP to identify the special need areas, contributing local groundwater and geologic expertise, and providing ongoing regional groundwater monitoring.

In five of the ten Areas of Concern, OWTS are the predominant method of wastewater disposal, but unlike the other Areas of Concern, there are no current plans for extending the municipal sewer service to these five areas. The five areas are:

- Happy Valley (*Figure 6-2*)
- Buena Vista (*Figure 6-4*)
- Mines Road (*Figure 6-5*)
- May School (*Figure 6-3*)
- Greenville (*Figure 6-4*)

Accordingly, special OWTS permit requirements have been developed for new OWTS applications received for these five Areas of Concern. These five special OWTS permit requirement areas are shown in
Figure 6-1 to *Figure 6-5*, and the recommended permit requirements are summarized below and presented in a table in *Figure 6-6*. These requirements are intended to minimize the impact to existing homeowners and future development while still being protective of the environment and groundwater quality.

These special permit provisions are designed to limit or reduce the amount of nitrogen loading from OWTS in the five Areas of Concern over time by requiring parcels planned for new or replacement OWTS to meet a lower nitrogen loading standard than what exists for parcels located outside of the Special OWTS Permit Areas. These proposed requirements do not apply to existing, properly-working and properly-sized OWTS.

As is the case for properties outside Special OWTS Permit Areas, the requirements are based on the total size of the property parcel (see graph on *Figure 6-7*), and assume that the nitrogen loading from one Rural Residential Equivalent (RRE), i.e., a typical, single-family home served by a conventional OWTS is 34 lbs N/year. For new or remodel development on parcels of less than seven acres in the special OWTS permit requirement areas, the project must achieve a total nitrogen loading from all OWTS on the property of less than 0.7 RRE (23.8 lbs N/year) per parcel. This is the equivalent to the loading from two advanced single-family OWTS, each capable of 65% nitrogen reduction. For example, in order to add an additional single-family dwelling with a new OWTS to a parcel that already has an existing single-family dwelling with a conventional OWTS, the project must include installation of pre-treatment equipment, capable of removing 65% of the nitrogen content from the wastewater stream, on both OWTS (new and existing systems). As a consequence, the net result would be an onsite loading reduction from a pre-project total of one RRE to a post- project total of 0.7 RRE. (0.35 + 0.35 RRE).

For parcels equal to or greater than 7 acres, the total nitrogen loading from all OWTS must not exceed 0.5 RRE per 5 acres (3.4 lbs N/parcel acre/year). For example, the total nitrogen loading limit for a ten acre parcel is calculated as follows:

$$10\ acres \text{ x} \frac{0.5\ RRE}{5\ acres} = 1\ RRE = 34\ lbsN/yr$$

Alternatively, if the property owner performs a hydrogeologic study demonstrating that the proposed project will not cause nitrate concentrations to rise, then the total nitrogen loading limit is 1 RRE/5 acres (6.8 lbs N/parcel acre). The study must show that total on-site recharge does not exceed 36 mg/L (80% of the MCL) or the maximum concentration at the site, whichever is lower. The 80% MCL limit is based on Zone 7 Water Quality Policy and provides a standard buffer for not exceeding the MCL. This alternative is intended to encourage additional hydrogeologic studies that can further define the boundaries and nitrate concentrations of Areas of Concern.

Because wastewater generated by commercial operations can result in higher loading rates than residential flows, the permitting of OWTS for new commercial projects within the special permit requirement areas require a higher level of scrutiny. At a minimum, projects must include a nitrogen-removing system, but also must demonstrate by analysis that the project will result in an improved nitrate condition beneath the site and not cause the offsite condition to worsen. Many of the commercial use OWTS will fall under the Water Board's jurisdiction and thus be subject to their Report of Waste Discharge (ROWD) requirements.

These same permit criteria are anticipated to be incorporated into the County's LAMP and used by the Water Board while developing Waste Discharge Requirements (WDR) for commercial projects within their purview if they prove to be effective at improving or halting groundwater quality degradation in these Areas of Concern. The following are measures specific to the special permit requirement areas:

- Until ACEH's LAMP has been finalized and approved by the Water Board, ACEH should incorporate and implement an interim permit approval policy such as the one recommended in *Figure 6-6*.

- Zone 7 will continue to refine the special permit area boundaries as more groundwater quality data becomes available in the future.

- Zone 7 and ACEH will continue to support the Water Board in its WDR decisions and specific requirements.

- Zone 7 will work with ACEH to assess the effectiveness of the County's OWTS moratorium in Happy Valley and whether this regulation should be continued in the County's LAMP.

Figure 6-1: Special OWTS Permit Areas

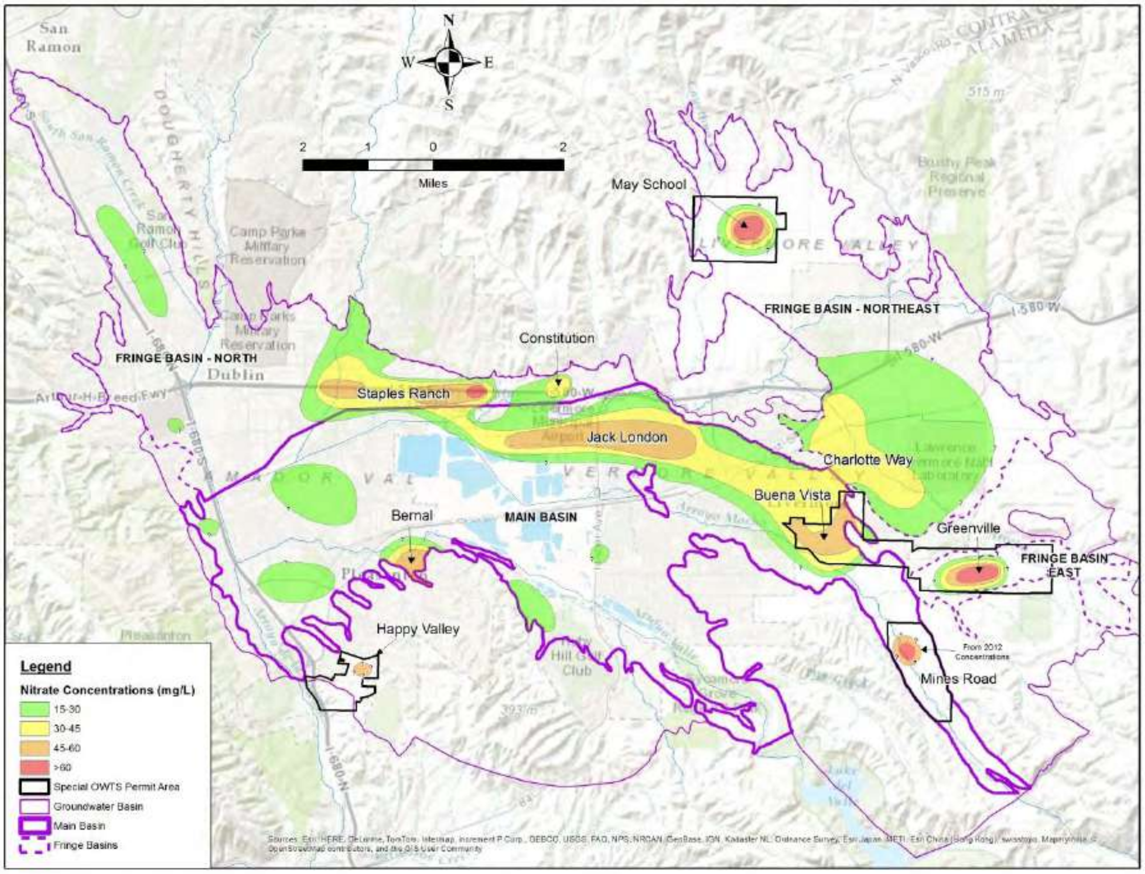


Figure 6-2: Happy Valley Area of Concern

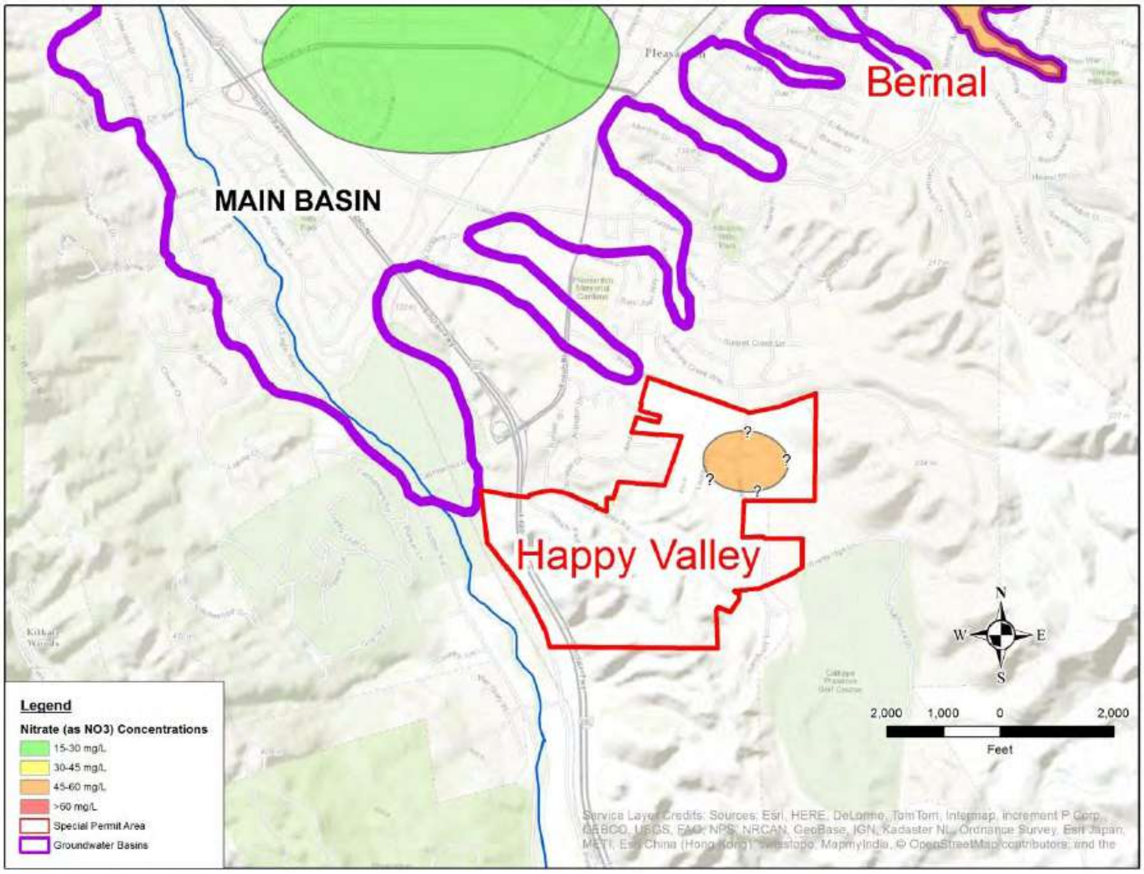


Figure 6-3: May School Area of Concern

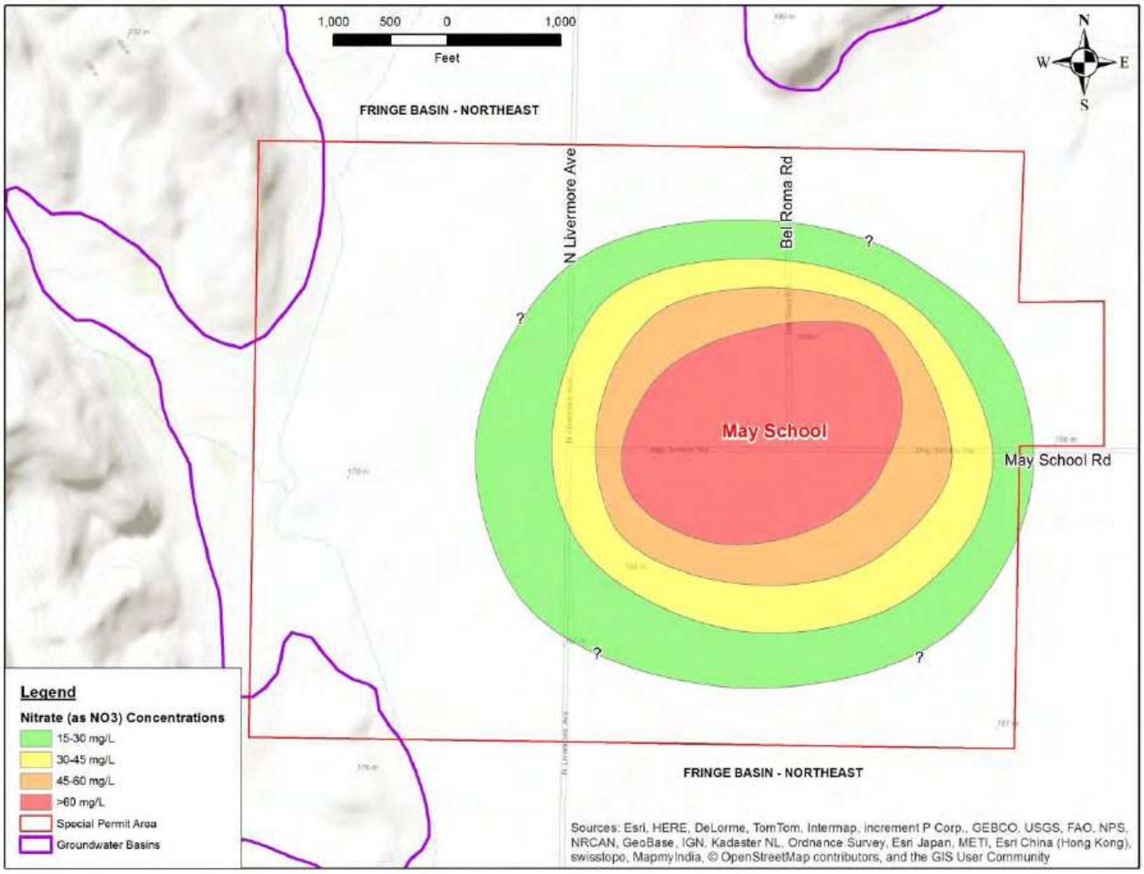


Figure 6-4: Buena Vista/Greenville Areas of Concern

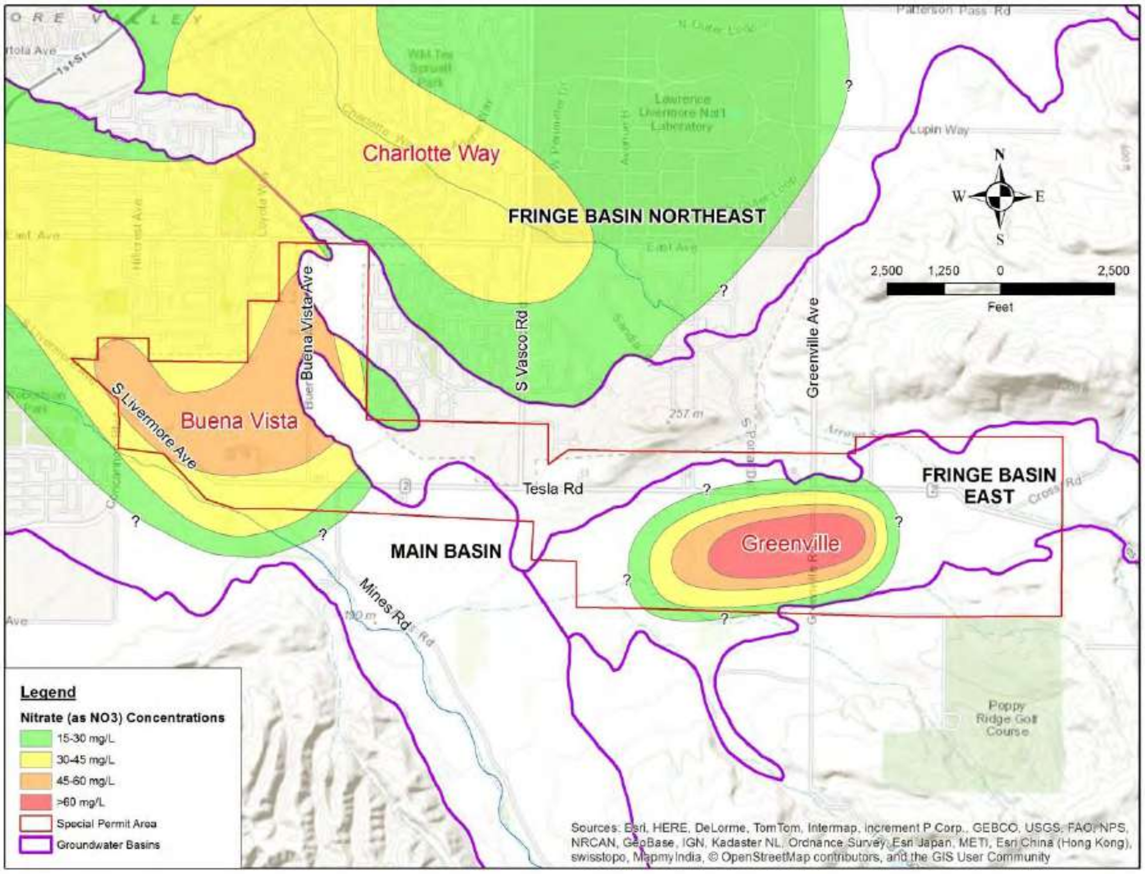


Figure 6-5: Mines Road Area of Concern

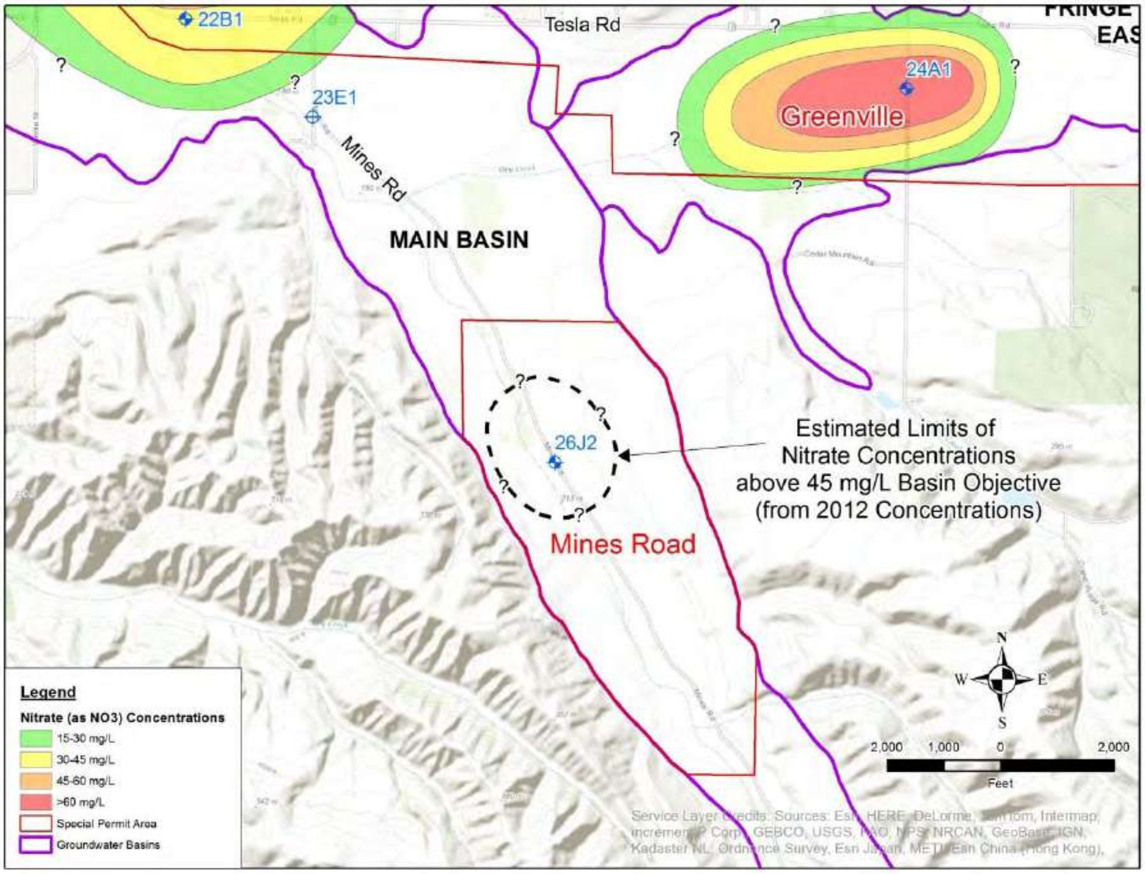


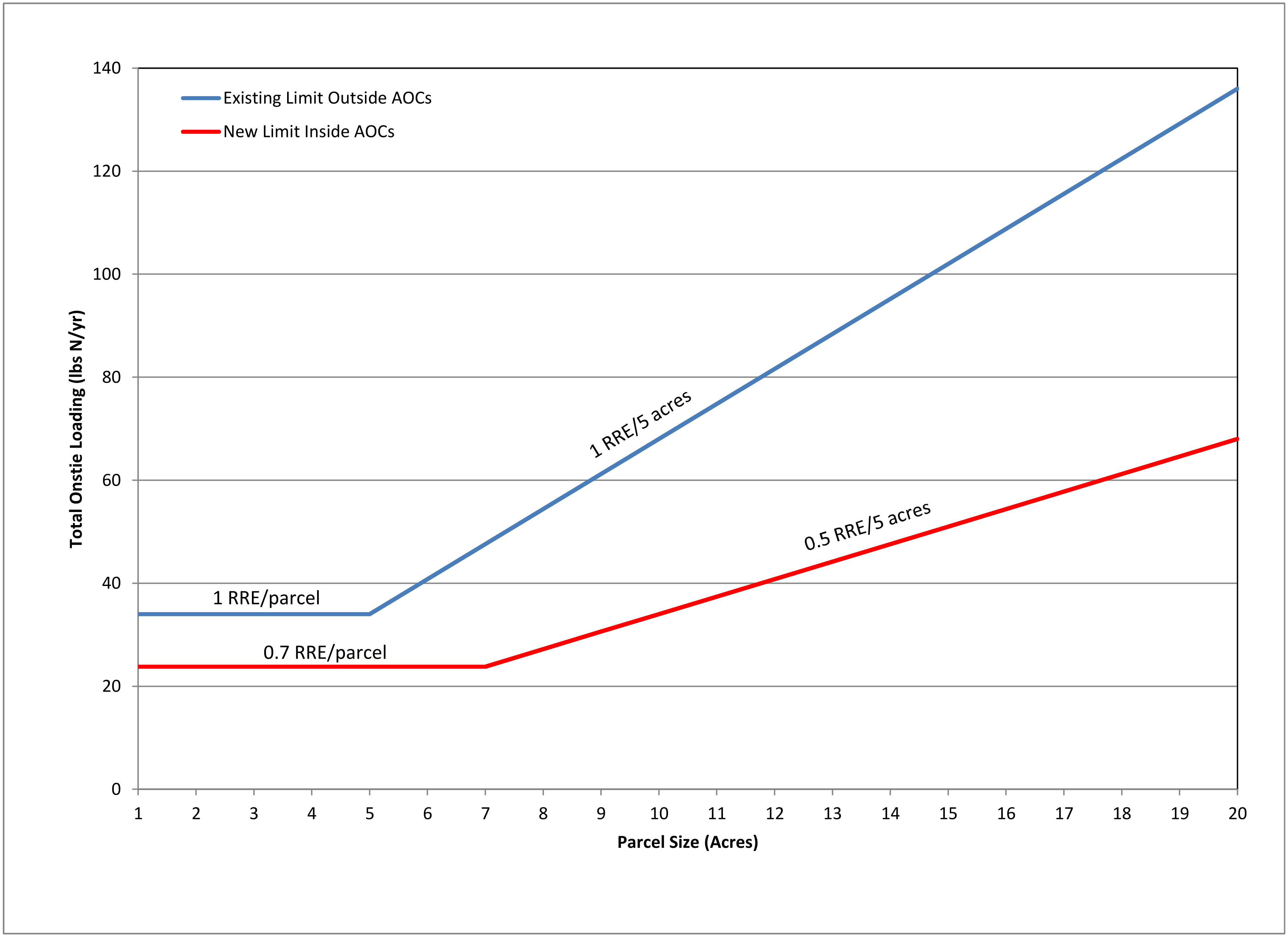
FIGURE 6-6
PROPOSED OWTS PERMIT REQUIREMENTS
FOR SPECIAL OWTS REQUIREMENT AREAS
NUTRIENT MANAGEMENT PLAN

OWTS Scenario	Parcel Size	New Requirement	Max Nitrogen Loading Rate[2]
New, upgraded, or replacement OWTS required by County OWTS Ordinance[1]	*≤ 7 acres*	*Must install/upgrade/replace with code-compliant nitrogen-reducing system(s).*	*23.8 lbs/year Per Parcel*
	> 7 acres	*Total nitrogen loading on the parcel must not exceed the Maximum Nitrogen Loading Rate. Commercial uses must also install/upgrade/replace with code-compliant nitrogen-reducing system(s).*	*3.4 lbs/year Per Parcel Acre*
		OR	
		Prepare hydrogeologic study that assesses current groundwater nitrate conditions beneath the site and demonstrates that nitrate concentration of total onsite recharge[3] does not exceed 36 mg/L (80% of MCL) or the maximum concentration at the site, whichever is lower.	*6.8 lbs/year Per Parcel Acre*

1 Does not apply to existing, properly-working and properly-sized OWTS.
2 Loading rates calculated based on 1 RRE = 34 lbs/yr.
3 Assume that 18% of rainfall naturally recharges to groundwater unless study demonstrates otherwise.

ACEH = Alameda County of Environmental Health
OWTS = Onsite Wastewater Treatment System
RRE = Rural Residential Equivalence
MCL = Maximum Conaminant Level (NO_3 = 45 mg/L)

FIGURE 6-7
Graphs of OWTS Limits



6.3 Implementation Measures to Enhance Nitrate Attenuation

6.3.1 Low Impact Development BMPs

Low Impact Development (LID) BMPs promote the use of small-scale, natural drainage features to slow, clean, capture, and infiltrate rainfall in an effort to replenish local aquifers, reduce pollution, and increase the reuse of water. This NMP encourages development approval agencies to require LID BMPs such as those listed below to help dilute and attenuate nitrate concentrations in groundwater:

- Bioretention cells and swales,
- Permeable pavement blocks, and
- Soil amendments to improve soil permeability

6.4 Basin Monitoring Programs

6.4.1 Introduction

Zone 7 currently monitors the following as part of its GWMP:

- groundwater (levels and quality),
- climatological (precipitation and evaporation),
- surface water (streamflow and quality),
- mining area (mining activities and water export volumes),
- land use (area),
- groundwater production (volume and quality),
- land surface subsidence (inelastic and elastic), and
- wastewater/recycled water (use and quality).

The monitoring programs focus on the Main Basin where groundwater is pumped for municipal uses, but monitoring stations are located throughout the groundwater basin to assess conditions in the fringe and upland basins. The programs are designed to assess the sustainability and quality of the groundwater basin, and the results are used in water resources management planning and decision making. Complete descriptions of the monitoring programs are provided in Zone 7's GWMP and SMP. The components of the programs that address nutrient monitoring are outlined below. These programs are evaluated annually and revised as necessary as part of Zone 7's Annual Reports for the GWMP.

Zone 7's existing monitoring programs already address nutrient monitoring, and no changes are proposed at this time. Zone 7 will identify data gaps and suggested locations and depths for new monitoring wells and/or soil borings for expedited groundwater sampling in the Areas of Concern. Zone 7 will provide this information to property owners, developers, and regulatory agencies to assist in developing efficient strategies for fully characterizing nitrate concentrations and nitrogen loading for projects inside Areas of Concern. Zone 7 will also work with ACEH to develop OWTS monitoring plans that may require the installation and monitoring of additional regional monitoring wells, up-gradient and down-gradient of high nitrate concentration areas, by the owners and developers.

State policy does not require monitoring for Constituents of Emerging Concern (CECs) for basins where recycled water use is limited to irrigation projects. Since the recycled water use in the Valley is currently limited to irrigation projects, Zone 7 does not monitor for CECs at this time; however, Zone 7 will continue to review the regulations and Valley conditions to assess whether future CEC monitoring is appropriate.

6.4.2 Nutrient Specific Monitoring Programs

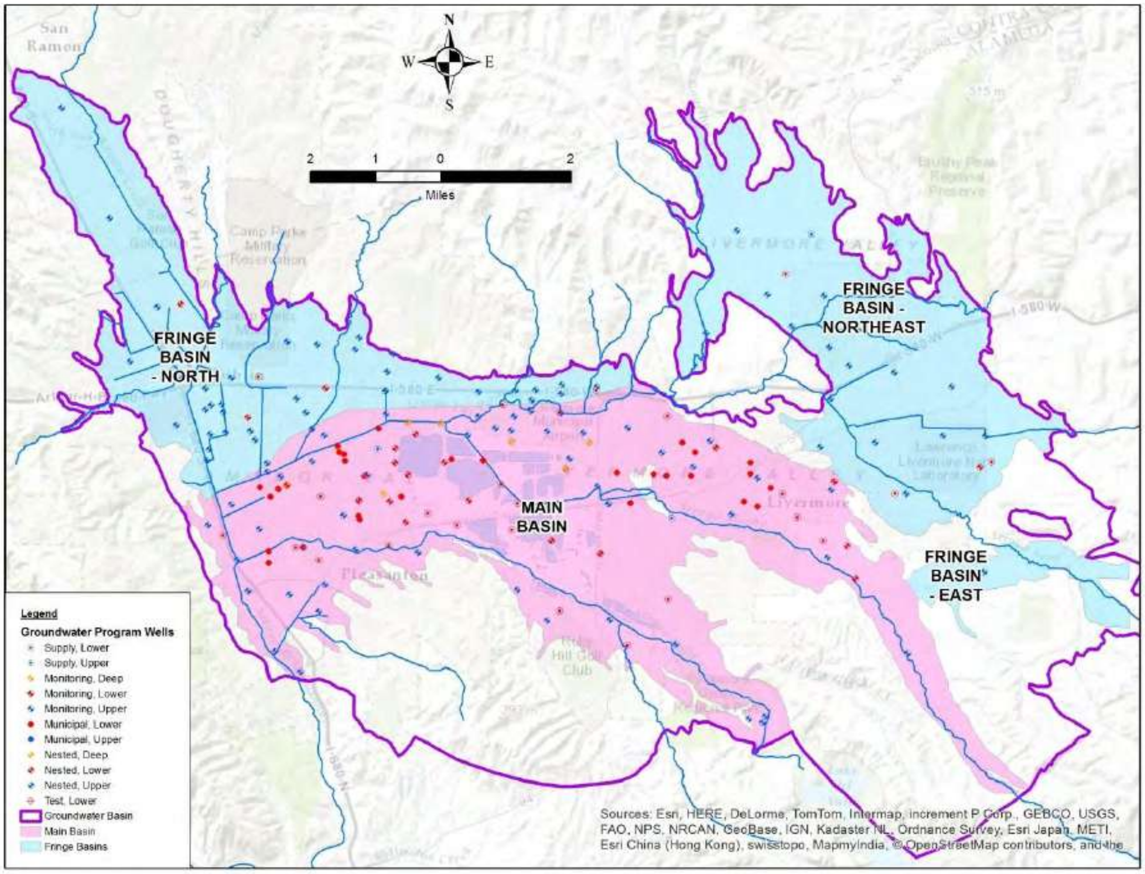
Climatological Monitoring – Zone 7's network of seven rainfall stations, two pan evaporation stations, and one California Irrigation Management Information System (CIMIS) station provide daily rainfall and evaporation data for basin recharge calculations. This information is used to calculate the volume of recharge, evaporation, and nitrogen loading from rainfall.

Surface Water Monitoring – This program focuses on the four main gaining and losing streams that impact the groundwater basin (i.e., Arroyo Valle, Arroyo Mocho, Arroyo Las Positas, and Arroyo De La Laguna), and the diversions and accretions that affect the flows into or from each of them. Zone 7 measures the inflow and outflow from the streams to quantify the volume of water recharging or discharging from the groundwater basin's aquifers. Zone 7 also samples and analyzes water from the streams to provide a record of water quality for the basin's recharge and discharge waters from which the groundwater basin's annual nitrate loading is calculated.

Zone 7's Water Level Monitoring – Zone 7 measures groundwater levels in over 230 monitoring and production wells (see *Figure 6-8* below and *Figure A-7*) twice per year during seasonal extremes (i.e., spring highs and fall lows) for storage tracking. Water level measurements are also measured monthly in some wells to monitor subsidence, adjust recharge operations, and identify when semi-annual water level measurements should be scheduled.

Zone 7's Water Quality Sampling –Zone 7 samples groundwater at least annually from all accessible groundwater wells in the program. Samples are analyzed by Zone 7's laboratory for metals and general minerals (including Nitrate as NO_3 and Phosphate as PO_4).

Figure 6-8: Map of Program Wells



Land Use Monitoring – Zone 7 maps and quantifies Valley land use (see *Figure 3-7* for the 2013 land use map) for areal recharge calculations (e.g., rainfall recharge, applied water recharge, and unmetered groundwater pumping for agriculture) and salt/nutrient loading (e.g., from irrigation, horse boarding facilities, and properties with OWTS). The program identifies changes in land use with an emphasis on changes in impervious areas and the volume and quality of irrigation water that could impact the volume or quality of water recharging the Main Basin. Land use data are derived from aerial photography, permit applications, field observations, and City and County planning documents.

Wastewater and Recycled Water Monitoring - Zone 7 compiles and reviews data on the volume and quality of wastewater collected and recycled water used within the watershed from the Livermore Water Reclamation Plant (LWRP), DSRSD Water Reclamation plant, and the Veterans Hospital sewage treatment plant. Zone 7 also reviews new OWTS applications located within the Valley for compliance with Zone 7's Wastewater Management Plan. Zone 7 must approve all onsite disposal systems for new commercial developments or any residential OWTS that will potentially exceed the loading allowed for the site.

6.5 Implementation Schedule

- The investigation of the Areas of Concern is ongoing. Zone 7 is currently soliciting permission to sample existing wells from homeowners near the Areas of Concern. Zone 7 is also currently working with several commercial developers to perform hydrogeologic studies in the Greenville special permit area.

- The Implementation Measure BMPs for Fertilizers, Irrigation, Livestock Manure Management, and Low Impact Development are already in place throughout the Valley.

- Zone 7 will assess the available data, identify data gaps, and prepare preferred well location maps for each of the Areas of Concern as identified in *Section 6.1*. These monitoring wells will potentially be installed by the developers. These will be prepared with the following schedule:

Figure 6-9: Proposed Schedule for Areas of Concern

Area of Concern	Calendar Year of Completion
Greenville	2016
Buena Vista	2016
Mines Road	2016
May School	2017
Happy Valley	2017
Staples Ranch	2018
Jack London	2018
Constitution	2018
Charlotte Way	2018
Bernal	2018

The results of the data and work products generated from the tasks above (e.g., preferred well location maps, well sampling results) will be presented in the GWMP Annual Reports or as a separate report, as appropriate, based on the size and extent of the study and/or timing of its completion.

- Zone 7's groundwater monitoring programs are also already in place, the results of which are presented in Zone 7's Annual Reports for the GWMP. New monitoring wells constructed as part of new developments (*Section 6.1.5.3*) will be added to the existing programs.

- The NMP recommends that the special OWTS permit requirements discussed in *Section 6.2.5.3* and described in *Figure 6.6* be incorporated into the LAMP, which ACEH anticipates completing a draft in 2016, and finalizing it by 2018.

7 References

Buchanan, Marc et al. 2003, Horse Manure Management: A Guide for Bay Area Horse Keepers.

California Department of Public Health. 2014. Titles 22 and 17 California Code of Regulations, California Department of Public Health's Recycled Water Regulations.

California Department of Water Resources.1974. California's Groundwater, Bulletin 118-2, Evaluation of Ground Water Resources: Livermore and Sunol Valleys.

_____. 2003. California's Groundwater, Bulletin 118—Update 2003.

California Regional Water Quality Control Board, San Francisco Bay Region, 2013, San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan).

Camp Dresser and McKee Inc. 1982. Wastewater Management Plan for the Unsewered, Unincorporated area of Alameda Creek Watershed above Niles. Prepared for Zone 7 of Alameda County Flood Control and Water Conservation District.

Horsley Witten Group, 2009, Evaluation of Turfgrass Nitrogen Fertilizer Leaching Rates in soils on Cape Cod, Massachusetts, June 29, 2009.

Moran, Jean; Esser, Bradley; Hillegonds, Darren; Holtz, Marianne; Roberts, Sarah; Singleton, Michael; and Visser, Ate. 2011, California GAMA Special Study: Nitrate Fate and Transport in the Salinas Valley.

Northwest Hydraulic Consultants (NHC), 2007, Hydrology Model Conversion and Update of Present Impervious, memorandum for Zone 7 Water Agency, August 3, 2007.

RMC, 2002, Groundwater Nitrate Sources in the Buena Vista Area, May 2002.

———. 2012, Santa Rosa Plain Subbasin Salt and Nutrient Management Plan, Draft Report prepared for the City of Santa Rosa, July 13, 2012.

———. 2013, Sonoma Valley Salt and Nutrient Management Plan, Prepared for the Sonoma Valley county Sanitation District, September 2013.

Solley, W. B., R. R. Pierce, H. A. Perlman (USGS). 1998. Estimated use of water in the United States in 1995. US Geological Survey circular; 1200. Denver, CO: US Geological Survey. Report nr 06079007X. ix, 71p.

USGS, 1983, Land Application of Wastewater and Its Effect on Ground-water Quality in the Livermore-Amador Valley, Alameda County, California, USGS Water Resources Investigations Report 82-4100, March 1983.

Zone 7 (Alameda Flood Control and Water Conservation District, Zone 7). 1987. Statement on Zone 7 Groundwater Management. August. Prepared by Zone 7 Board Committee.

———. 1992. Main Groundwater Basin Natural Safe Yield, Internal Memo prepared by Zone 7 Water Agency.

———. 2003. Draft Report, Well Master Plan, Prepared by CH2MHill for Zone 7 Water Agency.

———. 2004. Salt Management Plan. Prepared by Zone 7 Water Agency.

———. 2005a. Groundwater Management Plan. Prepared by Jones & Stokes and Zone 7 Water Agency.

———. 2005b. Well Master Plan Conformed EIR, Prepared by ESA for Zone 7 Water Agency.

———. 2007. Annual Report for the Groundwater Management Program—2006 Water Year. Prepared by Zone 7, June 2007.

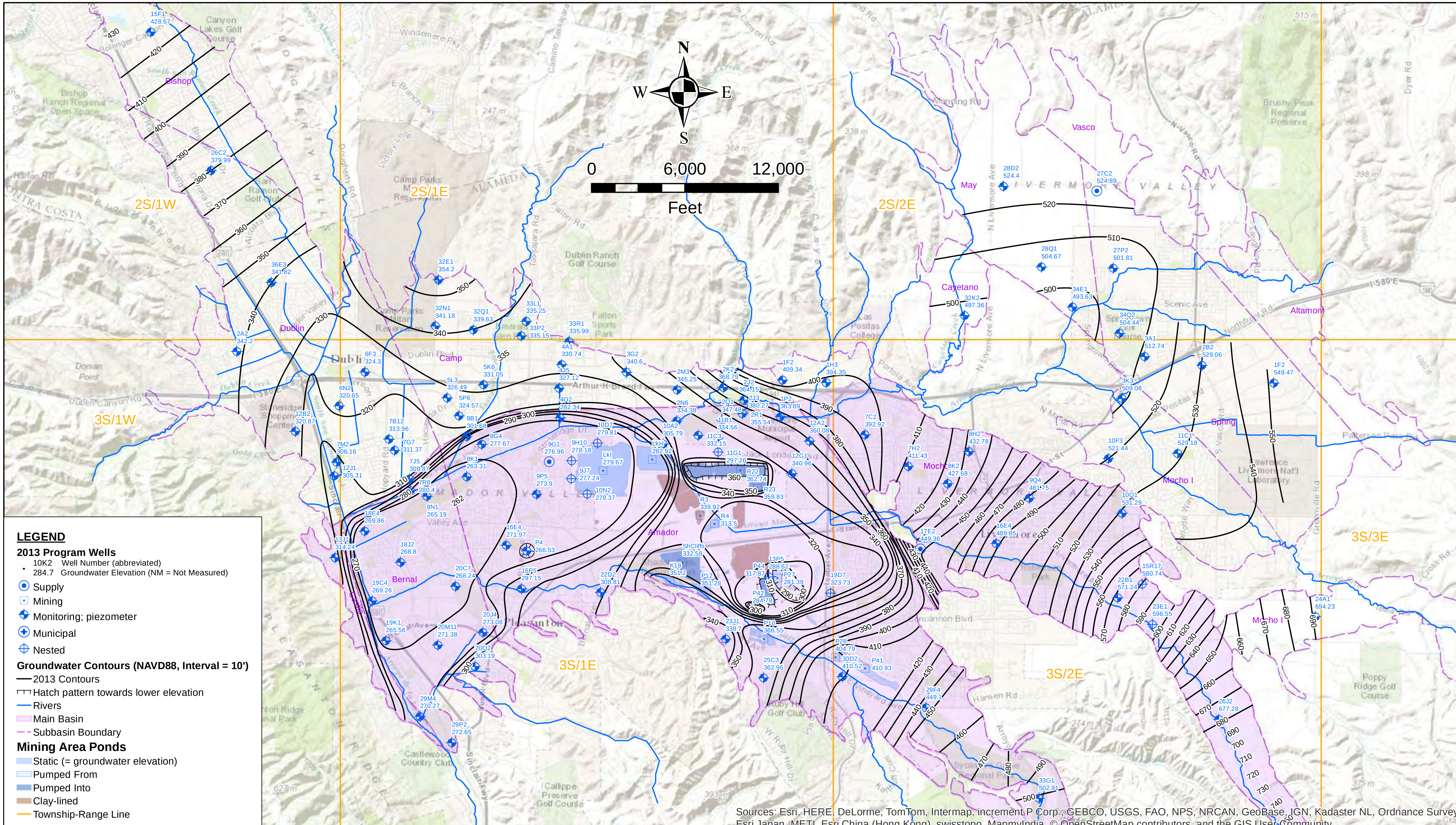
———. 2011. 2011 Water Supply Evaluation. Prepared by Zone 7, July 2011.

———. 2012. Toxic Sites Surveillance Annual Report 2011. Prepared by Zone 7, April 2012.

———. 2014. Annual Report for the Groundwater Management Program—2013 Water Year. Prepared by Zone 7, August 2014.

Appendix A

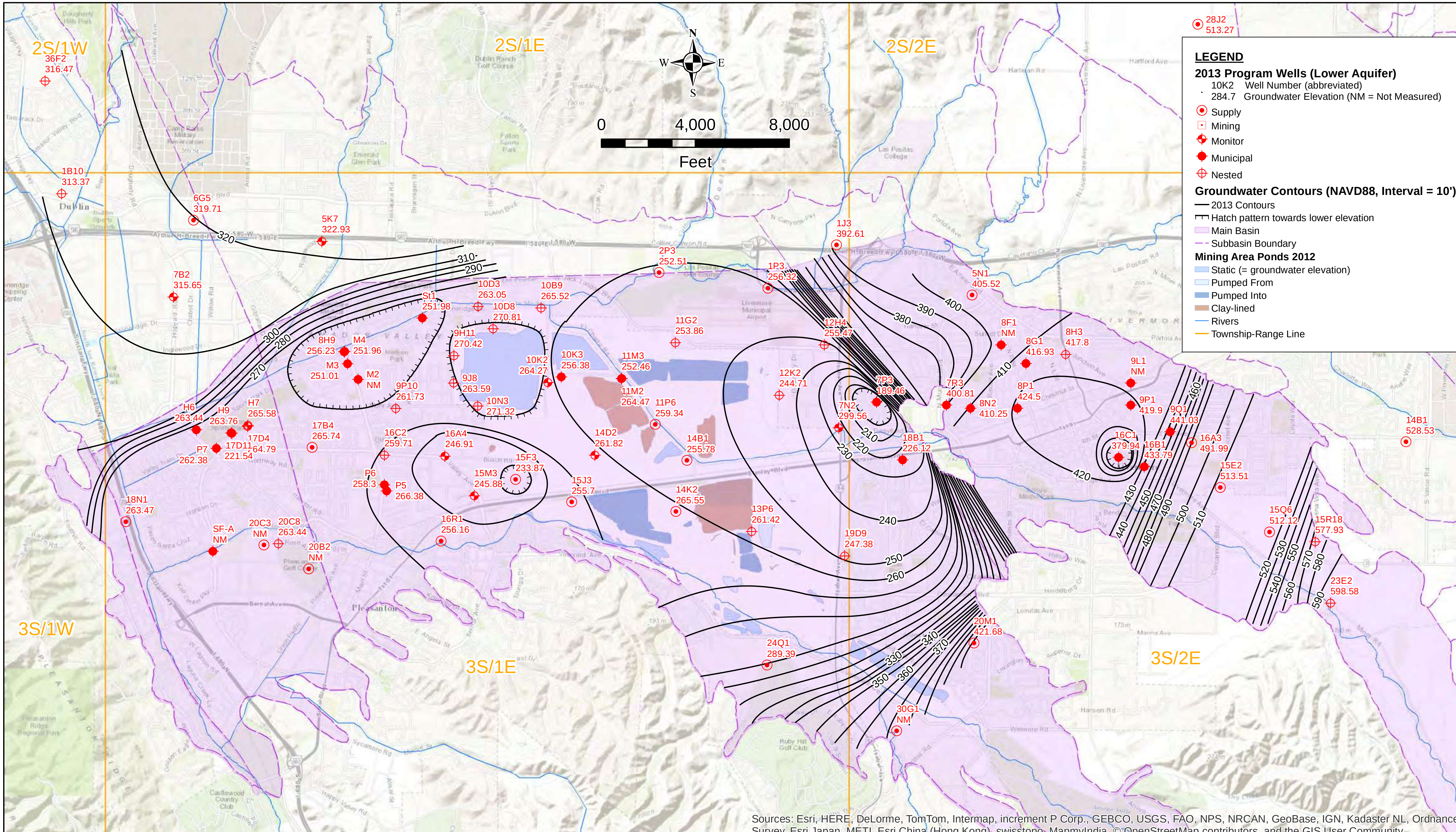
Supporting Figures



ZONE 7 WATER AGENCY
100 North Canyons Parkway
Livermore, CA

DRAWN: TR	SCALE: 1 in = 6,000 ft
REVIEWED: MK	DATE: Apr 24, 2015
FILE: E:\PROJECTS\SNMP Update\Report\Figures\NMPFigA-01-GradientUpper13.mxd	

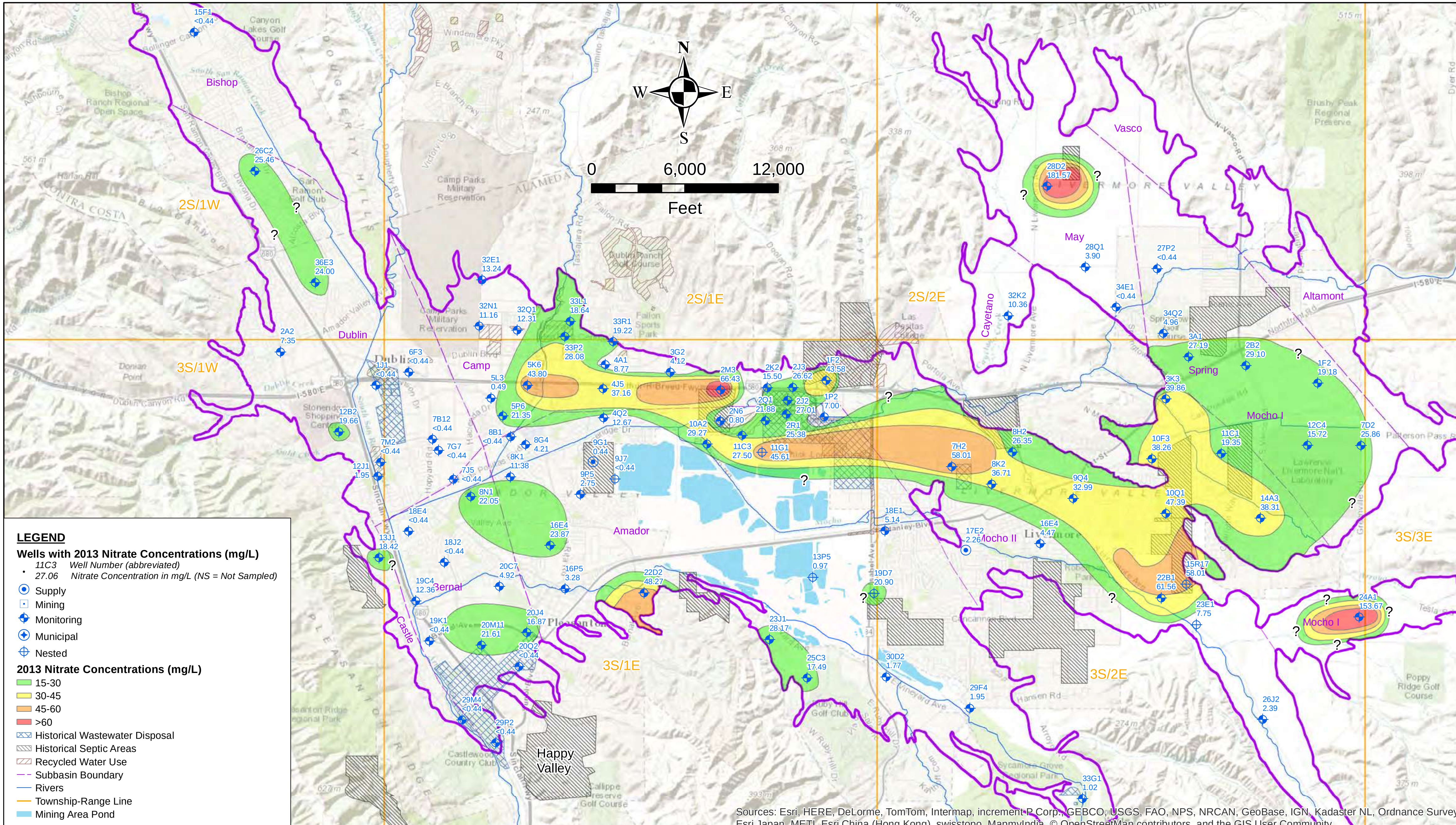
Figure A-1
Groundwater Gradient Map
Upper Aquifer; Fall 2013 (September)
Livermore Valley Groundwater Basin



ZONE 7 WATER AGENCY
100 North Canyons Parkway
Livermore, CA

DRAWN: TR
SCALE: 1 in = 4,000 ft
REVIEWED: MK
DATE: Apr 24, 2015
FILE: E:\PROJECTS\SNMP Update\Report\Figures\NMPFigA-02-GradientLower13.mxd

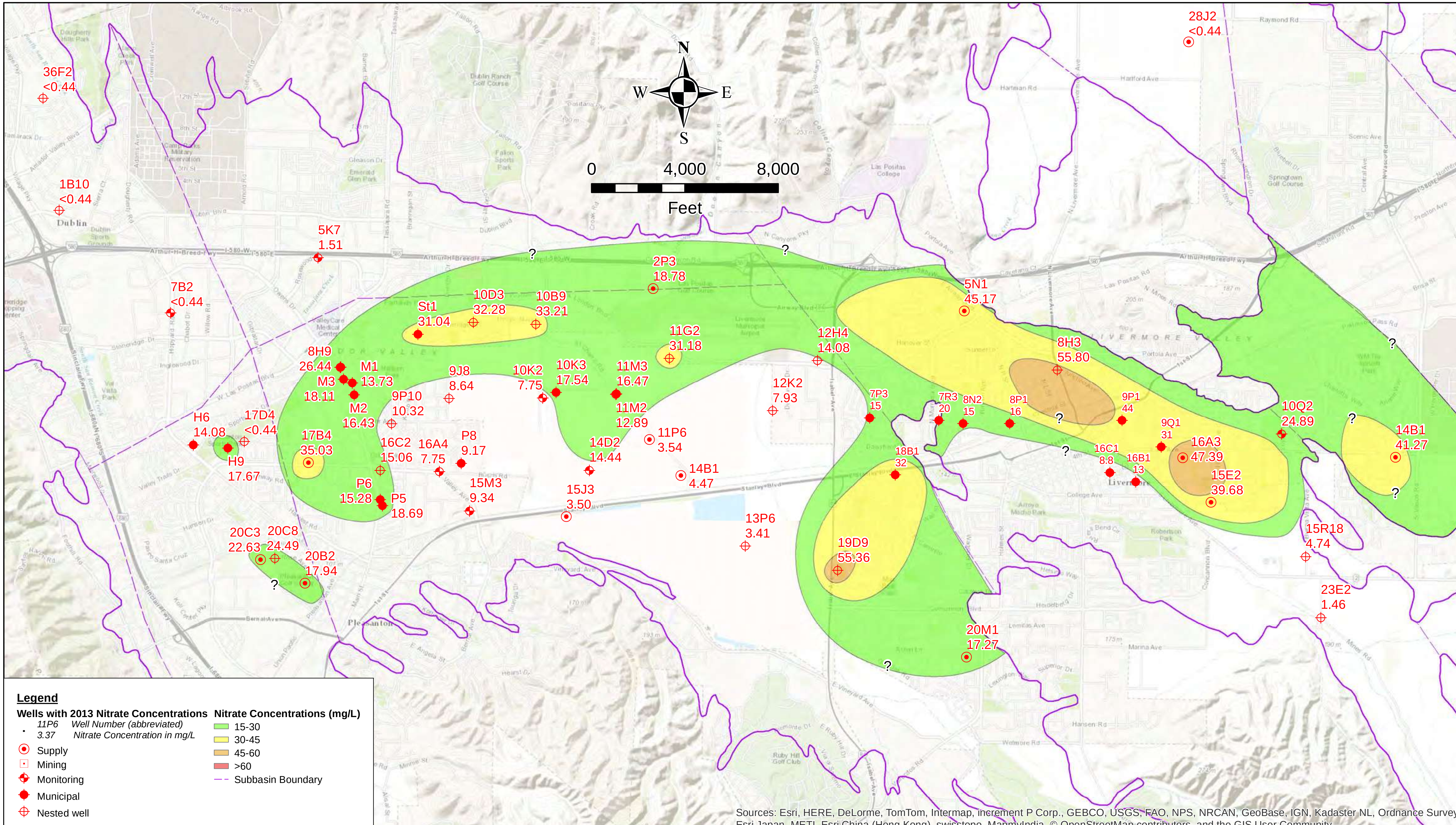
Figure A-2
Groundwater Gradient Map
Lower Aquifer; Fall 2013 (October)
Livermore Valley Groundwater Basin



ZONE 7 WATER AGENCY
100 North Canyons Parkway
Livermore, CA

DRAWN: TR	SCALE: 1 in = 6,000 ft
REVIEWED: CW	DATE: Apr 17, 2015
File: E:\PROJECTS\SNMP Update\Report\Figures\NMPFigA-03-NitrateUpper13.mxd	

Figure A-3
Detailed Map of Nitrate Concentrations (mg/L)
Upper Aquifer, 2013 Water Year
Livermore Valley Groundwater Basin



ZONE 7 WATER AGENCY
100 North Canyons Parkway
Livermore, CA

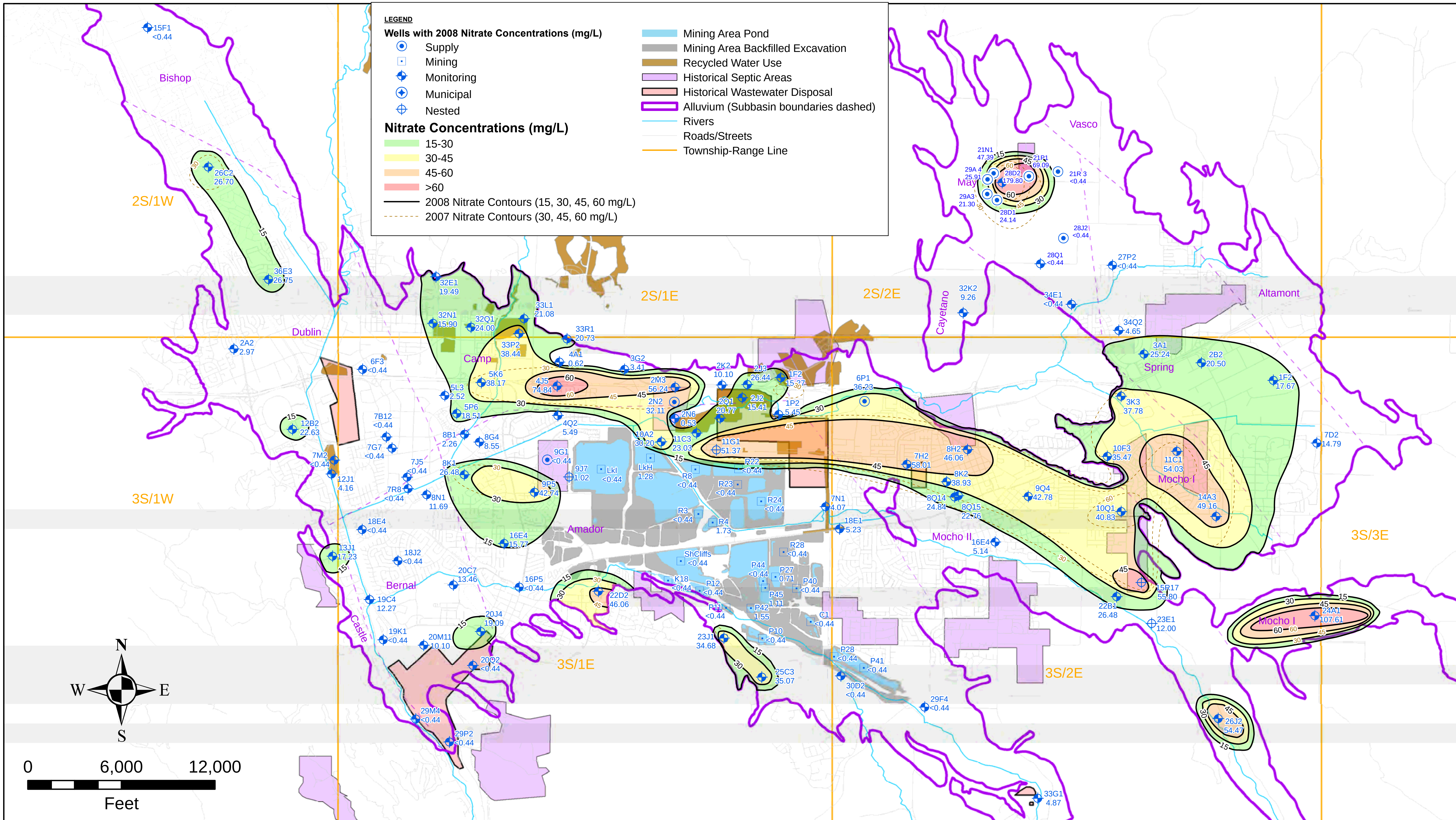
DRAWN: CW/TR
REVIEWED: TR
SCALE: 1 in = 4,000 ft
DATE: May 6, 2015
Path: E:\PROJECTS\SNMP Update\Report\Figures\NMPFigA-04-NitrateLower13.mxd

Figure A-4
Detailed Map of Nitrate Concentrations (mg/L)
Lower Aquifer, 2013 Water Year
Livermore Valley Groundwater Basin

FIGURE A-5
GROUNDWATER STORAGE PROGRAM
NODAL CONSTANTS FOR STORAGE CALCULATIONS

MAIN BASIN NODE	Area (ft^2)	Upper Aquifer Surface (ft MSL)	Upper Aquifer Bot Conf Lyr (ft MSL)	Upper Aquifer Bottom (ft MSL)	Upper Aquifer Thick (ft)	Upper Aquifer SY	Upper Aquifer SS	Lower Aquifer Top (ft MSL)	Lower Aquifer Bottom (ft MSL)	Lower Aquifer Thick (ft)	Lower Aquifer SY	Lower Aquifer SS
NODE 15	200	329	290	243	47	0.07	0.0024	205	33	172	0.20	0.0012
NODE 16	320	325	281	235	46	0.05	0.0024	195	33	162	0.20	0.0002
NODE 17	301	336	283	222	61	0.09	0.0024	179	63	116	0.20	0.00005
NODE 18	679	334	283	228	55	0.11	0.0024	196	33	163	0.20	0.0012
NODE 19	703	328	268	222	46	0.11	0.0024	199	53	146	0.20	0.0002
NODE 20	534	332	265	229	36	0.05	0.0024	215	73	142	0.20	0.00001
NODE 23	414	340	297	243	54	0.13	0.0024	191	63	128	0.20	0.0018
NODE 24	503	343	300	230	70	0.14	0.0024	196	73	123	0.20	0.0003
NODE 25	883	360	330	242	88	0.17	0.0024	222	73	149	0.20	0.0007
NODE 26	953	353	303	226	77	0.17	0.0024	182	3	179	0.20	0.0003
NODE 29	388	363	333	278	55	0.23	0.0024	229	229	0	0.20	0.0001
NODE 30	718	369	none	259	110	0.15	0.0024	230	83	147	0.20	0.0002
NODE 31	1213	372	none	259	113	0.12	0.0024	239	3	236	0.20	0.0003
NODE 33	165	397	374	327	47	0.09	0.0024	307	253	54	0.20	0.0008
NODE 34	683	402	none	299	103	0.08	0.0024	283	123	160	0.20	0.0003
NODE 35	2357	422	none	310	112	0.11	0.0024	297	113	184	0.20	0.0002
NODE 36	1753	493	none	387	106	0.09	0.0024	381	381	0	0.20	0.00001
NODE 38	867	429	none	352	77	0.13	0.0024	339	303	36	0.20	0.0008
NODE 39	1839	484	none	395	89	0.10	0.0024	378	333	45	0.20	0.0003
NODE 40	913	566	none	487	79	0.23	0.0024	473	423	50	0.20	0.00004
NODE 41	1624	732	none	620	112	0.10	0.0024	607	607	0	0.20	0.00003
NODE 42	686	551	none	464	87	0.18	0.0024	450	403	47	0.20	0.0001

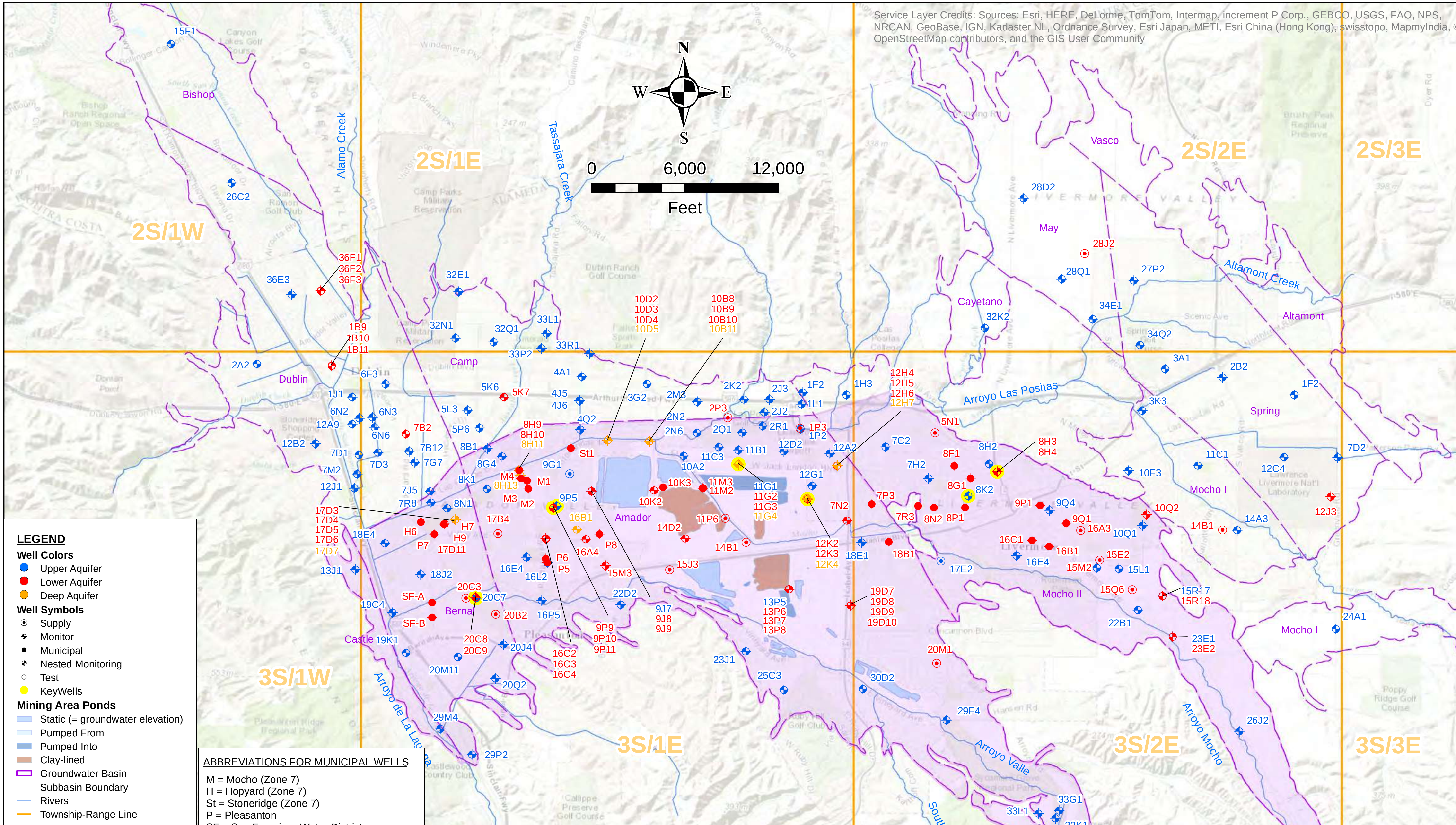
Surface Ground surface
ft MSL Top and bottom elevations are in feet above Mean Sea Level (NAVD88)
Bot Conf Lyr Bottom elevation of upper aquifer confining layer
SY Specific Yield - used for unconfined conditions
SS Specific Storage - used for confined conditions



ZONE 7 WATER AGENCY
100 North Canyons Parkway
Livermore, CA

DRAWN: TR/CW	SCALE: 1 in = 6,000 ft
REVIEWED: TR	DATE: May 7, 2009
FILE: E:\MONITOR\GM\2008wy\Annual\Fig3.2-10-NitrateUpper.mxd	

Figure 3.2-10
Nitrate Concentrations (mg/L)
Upper Aquifer; 2008 Water Year
Livermore Valley Groundwater Basin



ZONE 7 WATER AGENCY
100 North Canyons Parkway
Livermore, CA

DRAWN: TR

REVIEWED: MK

SCALE: 1 in = 6,000 ft

DATE: Apr 27, 2015

FILE: E:\PROJECTS\SNMP Update\Report\Figures\NMPFigA-07-GQWells.mxd

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

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Sandwich, MA • 02563
Phone - 508-833-6600 • Fax - 508-833-3150 • *www.horsleywitten.com*

Evaluation of Turfgrass Nitrogen Fertilizer Leaching Rates in Soils on Cape Cod, Massachusetts

June 29, 2009

Prepared for:
Brian Dudley
Department of Environmental Protection
Cape Cod Office
973 Iyannough Road
Hyannis, MA 02601

Submitted by:
Horsley Witten Group
90 Route 6A
Sandwich, MA 02563

EXECUTIVE SUMMARY

This study was conducted by the Horsley Witten Group, Inc. (HW) on behalf of the Massachusetts Department of Environmental Protection (DEP) to review existing information on nitrogen leaching rates from fertilizer applied to turfgrasss, and make a recommendation on an appropriate rate to be applied to water quality assessments conducted by the Massachusetts Estuaries Project (MEP) on 89 Cape Cod and southeastern Massachusetts embayments (the MEP embayments).

The MEP Model assumes a 20% nitrogen leaching rate within the embayments, based on research conducted by Dr. Brian Howes (MEP Reports). A recent study conducted by Dr. A. Martin Petrovic, on behalf of the Pleasant Bay Alliance (Petrovic, 2008), determined that a 10% nitrogen leaching rate would be appropriate for the embayments. HW reviewed the MEP Reports and Dr. Petrovic's study, and interviewed Dr. Howes to discuss his calculation method used in deriving the MEP Model leaching rate. HW also conducted a literature search and review of publications cited by both researchers, and of relevant articles published in related peer-reviewed journals. Finally, HW obtained and analyzed 20 years of water quality monitoring data and fertilizer use on greens and fairways from a Cape Cod golf course, the Bayberry Hills golf course in Harwich, MA. This analysis showed a leaching rate under greens of approximately 14% in the first ten years of the golf course, and 26% in the subsequent ten years.

Nitrogen leaching rates reported in the literature ranged from 0% (Mancino et al., 1990) to 95% (Mancino et al., 1991), and were affected by a number of factors. Based on the information available, HW identified factors affecting nitrogen leaching, including grass type, establishment method, and maturity; soil type, content, and slope; nitrogen fertilization type, rate, and timing; and climate and water application. HW described the impacts of each of these factors on nitrogen leaching, as quantified by research documented in the reviewed publications.

After summarizing the impacts from grass, soil, fertilization, and climate conditions, HW compared the factors to conditions typical of the MEP embayments. Exact Cape Cod conditions were not replicated in the literature reviewed, and based on the importance of climate to leaching rates, HW narrowed the literature search to studies conducted in the states of Massachusetts, Connecticut, and New York. HW analyzed the leaching rate results for each relevant study to obtain one leaching rate representative of the study. The resulting average leaching rate across all studies is 13%. Studies representative of New England weather conditions span a variety of soil types. When considering leaching rate results from studies conducted only on sand, or loamy sand, as are likely to exist on Cape Cod and southeastern coast, the average leaching rate increases to 19%.

The results from the literature review, MEP Model assumptions, and Bayberry Hills golf course water quality data analysis suggest that the MEP leaching rate estimate of 20% is reasonable.

Table 6-1: Land Use Related Loading Factors

Land Use Group	Applied Water[2] (in/yr)	Percent Irrigated	Applied Nitrogen (lbs/acre-year)	Used Nitrogen (lbs/acre-year)	Leachable Nitrogen (lbs/acre-year)	Applied TDS (lbs/acre-year)
Urban Commercial and Industrial	46.8	5%	91	59	23	717
Farmsteads	46.8	10%	83	54	21	717
Vines	9.4	75%	29	23	3	956
Urban Residential	49.2	25%	91	59	23	478
Pasture	49.2	75%	60	39	15	637
Grasslands/ Herbaceous	0	0%	0	0	0	0
Dairy Production Areas[1]	0	0%	83	0	75	717
Urban Landscape	46.8	5%	91	59	23	637
Water	0	0%	0	0	0	0
Perennial Forages	49.2	0%	21	15	4	398
Non-irrigated vines	0	0%	17	16	0	478
Shrub/Scrub	0	0%	0	0	0	0
Non-irrigated Orchard	0	0%	75	60	7	319
Barren Land	0	0%	0	0	0	0
Urban C&I, Low Impervious Surface	46.8	10%	91	59	23	478
Flowers and Nursery	38	50%	124	81	31	956
Other CAFOs	0	10%	83	0	75	797
Paved Areas	0	0%	0	0	0	0
Other Row Crops	20.4	75%	100	65	25	558
Orchard	29.6	75%	133	100	20	1,195
Warm Season Cereals and Forages	23.2	75%	124	87	25	558

Footnotes:

1 See discussion on dairy parcels below.

2 Base applied water values and other climatic data are taken from DWR land and water use data (http://www.water.ca.gov/landwateruse/anlwuest.cfm). On this website, four years of data are available. Climatic data averages, based on these four years of data, was compared to the 21-year average of available CIMIS climatic data for the Santa Rosa area. As the two data sets correspond well, the average DWR applied water values were used, with some adjustment using crop coefficients for the Santa Rosa area to fit the study land use classes.

FIGURE A-10
PREDICTED NITRATE CONCENTRATIONS
25% NITROGEN LEACHING RATE (RMC, 2012)

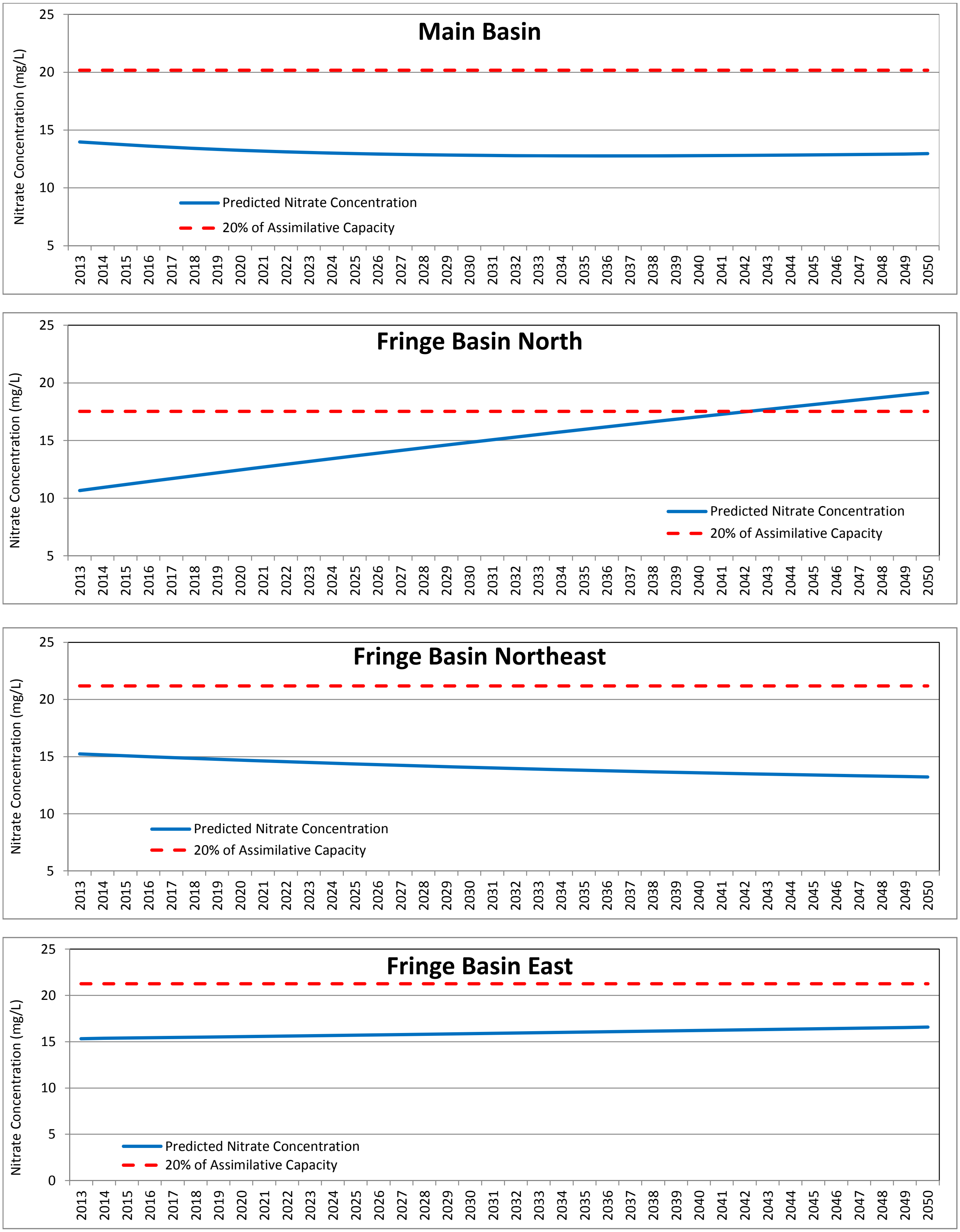
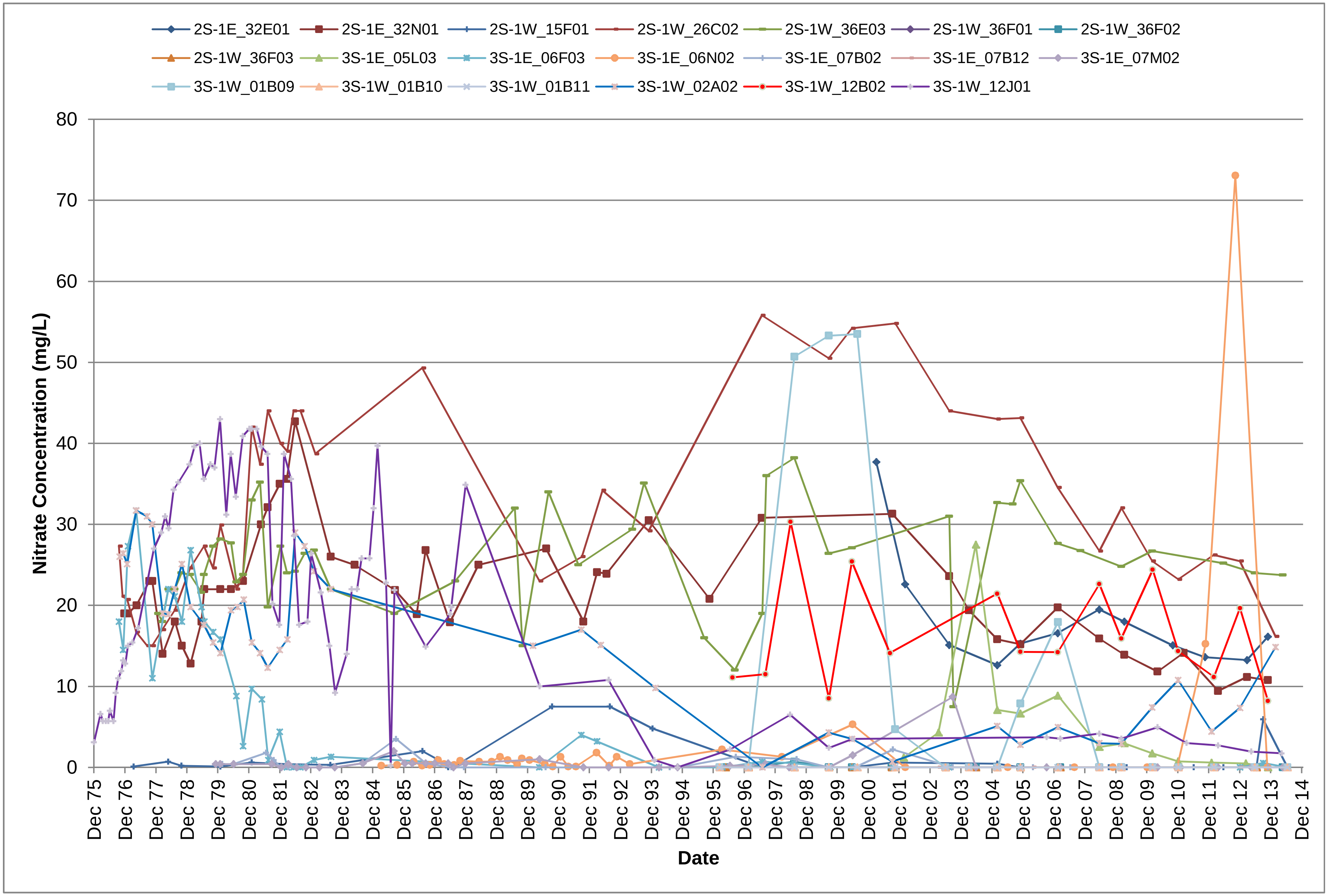


FIGURE A-11
HISTORICAL NITRATE CONCENTRATIONS IN WELLS OUTSIDE AREAS OF CONCERN
FRINGE BASIN NORTH



South East Bay Plain Basin

GROUNDWATER MANAGEMENT PLAN

March 2013

TABLE OF CONTENTS

APPENDICES

REFERENCES

This page intentionally left blank.

ACRONYMS

ACWD	Alameda County Water District
ABAG	Association of Bay Area Governments
AFY	acre-ft per year
AHGW	Arc Hydro Groundwater
ASR	Aquifer Storage and Recovery
CSM	Conceptual Site Model
DEIR	Draft Environmental Impact Report
DWR	Department of Water Resources
EBMUD	East Bay Municipal Utility District
EIR	Environmental Impact Report
FEMA	Federal Emergency Management Agency
ftp	File Transfer Protocol
GIS	Geographic Information System
gpd/ft	gallons per day per foot
GMP	Groundwater Management Plan
IGSM	Integrated Groundwater and Surface Water Model
LSCE	Luhdorff & Scalmanini Consulting Engineers
msl	mean sea level
NWIS	National Water Information System
NCGB	Niles Cone Groundwater Basin
NEBIGSM	Niles Cone and South East Bay Plain Integrated Groundwater and Surface Water Model
OLSD	Oro Loma Sanitary District
SB	Senate Bill
SEBP Basin	South East Bay Plain Basin
SSM	Soil Survey Manual
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
USGS	U.S. Geological Survey
West Yost	West Yost Associates
WRIME	Water Resources & Information Management Engineering Inc.

This page intentionally left blank.

PREFACE

What Is The Intent of Preparing A Groundwater Management Plan (GMP)?

Water is a finite resource with increasing demand for water exploration and reliance on local groundwater supplies has increased. Preserving this valuable natural resource is essential. Various state and local stakeholders recognize that proper management of groundwater resources is necessary.

Recognizing the importance of managing groundwater resources, in 1992, the California Legislature passed Assembly Bill 3030 (AB 3030) which provided local public agencies increased management authority via the development of GMPs. In September 2002, Senate Bill 1938 expanded AB 3030 by requiring GMPs to include specific components in order to be eligible for grant funding for various types of groundwater related projects. A GMP provides the framework for coordinating groundwater management activities among stakeholders. In general, GMP documents are prepared to identify basin management goals and objectives. They also are used to guide future efforts that could be undertaken to effectively monitor and manage a groundwater basin.

With that understanding, the Board of Directors of East Bay Municipal Utility District unanimously adopted a resolution of intent to prepare a GMP for the South East Bay Plain Basin on May 24, 2011. EBMUD, together with other basin stakeholders, has prepared this GMP as a means to assure basin sustainability for generations to come.

The South East Bay Plain Basin's Groundwater Management Plan Satisfies Multiple Stakeholder Needs and Objectives

What Is A GMP?

A Groundwater Management Plan (GMP) is a planning tool that assists overlying water providers in maintaining a safe, sustainable and high quality groundwater resource within a given groundwater basin. GMPs are intended to be "living documents" that can be readily updated and refined over time to reflect progress made in achieving the GMP's objectives. Because many agencies are new to groundwater planning, state law (SB 1938) outlines a series of actions that will promote ongoing GMP development.

In addition, GMPs have become a required "baseline" document for agencies seeking grant funds available from the State of California. Like other planning documents required by the State, an approved GMP is a minimum requirement for agencies seeking competitively awarded grant funds.

What Is Required In A GMP?

SB 1938 describes the preparation of GMPs and contains numerous requirements and provisions which are briefly summarized as follows:

- A GMP contains an inventory of water supplies and describes water uses within a given region.
- A GMP establishes groundwater Basin Management Objectives (BMOs) that are designed to protect and enhance the groundwater basin.

- A GMP identifies monitoring and management programs that ensure the BMOs are being met.
- A GMP outlines a stakeholder involvement and public information plan for the ground water basin.

Why Was The SEBP GMP Prepared?

The South East Bay Plain (SEBP) Basin GMP has been prepared primarily to document ongoing groundwater management activities, coordinate among basin stakeholders, and prepare for future activities:

- A GMP is a prerequisite for state grant funding opportunities.
- The GMP develops a framework or baseline on which to build future planning efforts.
- Preparing a GMP is good planning procedure.
- The SEBP Basin GMP satisfies multiple stakeholder needs and objectives.

Stakeholder Involvement

To address the needs of all affected stakeholders, several meetings and workshops were held that included a discussion of the means of achieving broader involvement in the management of the Basin. Activities have included:

- Stakeholder planning meetings
- Coordinating with other local agencies and interests adjacent to the SEBP basin area
- Soliciting input from stakeholders during the development and public comment process for approving the GMP
- Developing and fostering relationships with state and federal regulatory agencies
- Incorporating comments received from stakeholders into the GMP

Future Action Items and Recommendations

The intended approval date of the SEBP Basin GMP is March 26, 2013. Following approval, Stakeholders will meet periodically to share basin information and to consider potential refinements to the GMP, adding the next increment of details as and when appropriate.

In addition, the following recommendations will move forward:

- Encourage local stakeholder agencies to adopt the GMP
- Encourage Alameda County Board of Supervisors to adopt more stringent policies regarding well standards
- Future grant funding should be used when available to:
  - Better understand the connectivity between the SEBP Basin and the Niles Cone Groundwater Basin
  - Establish survey control within the Basin
  - Expand the groundwater model (to include water quality data evaluation, additional geologic data as collected, etc.)
  - Improve basin understanding

- Coordinate among stakeholders; and
- Support beneficial uses of the SEBP basin

> DWR Bulletin 118 delineates the boundaries of the East Bay Plain Basin ranging from the Carquinez strait in the north to the City of Hayward area in the south. It is bound by the Hayward fault zone in the east and San Francisco Bay in the west. Only the southern portion of East Bay Plain Basin has significant storage capacity and has seen significant municipal, industrial, and irrigation well production.
>
> As such, for all practical purposes, the management of groundwater resources focuses the southern portion of the Basin.

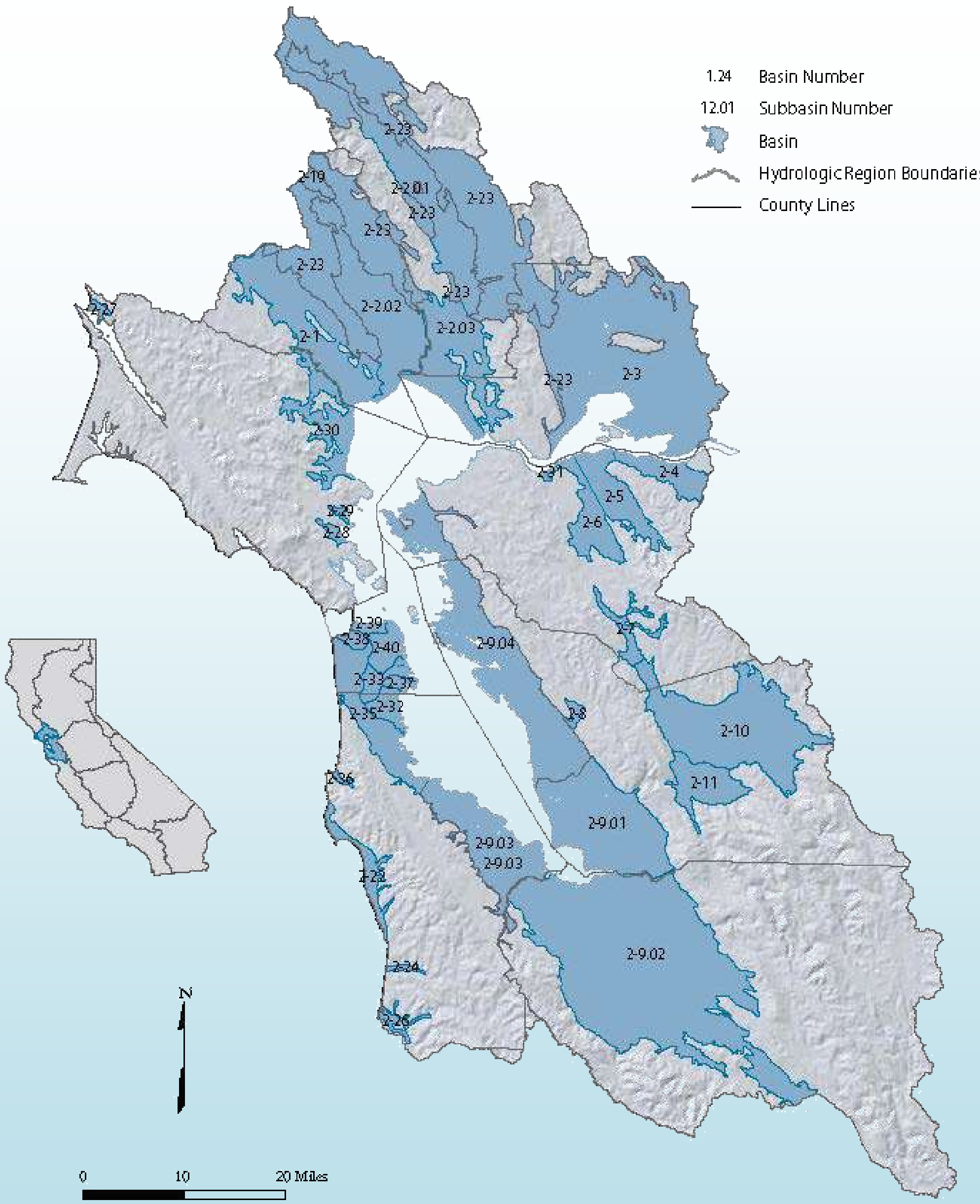


Figure P-1: San Francisco Bay Hydrologic Region

FIGURE P-2
South East Bay Plain Basin Area

This page intentionally left blank.

SECTION 1.0 INTRODUCTION

1.1 BACKGROUND

In 1992, the California Legislature passed Assembly Bill (AB) 3030 which provided local public agencies increased management authority over their groundwater resources by enabling them to develop Groundwater Management Plans (GMPs). In September 2002, Senate Bill 1938 expanded AB 3030 by requiring GMPs to include specific components in order for Basin agencies to be eligible for grant funding for various types of groundwater related projects. A GMP provides the framework for coordinating groundwater management activities among stakeholders. In general, the documents are fashioned to identify basin management goals and objectives, along with guiding further efforts that will be undertaken to effectively monitor and manage a groundwater basin.

In recent years, due primarily to local interest in the southern portion of the East Bay Plain Groundwater Basin (the South East Bay Plain Basin or SEBP Basin), the interest in crafting a GMP for the SEBP Basin has grown. East Bay Municipal Utility District (EBMUD), as the largest water provider overlying the East Bay Plain Basin, has taken the lead to guide the GMP development process.

1.2 STAKEHOLDER INTEREST AND PLAN FORMAT

With the completion of Bayside Groundwater Project Bayside Phase 1 in March of 2010 and the potential future development of Bayside Phase 2, East Bay Municipal Utility District (EBMUD) recognized that local groundwater resources were now a key component of the District's future supplemental supply. Other stakeholder agencies, such as the City of Hayward, have reached similar conclusions. A list of stakeholders is provided in the Table below.

Table 1-1: List of Key Stakeholders

PARTICIPATING KEY STAKEHOLDERS	AGENCY REPRESENTATIVE
Alameda County Environmental Health	Donna Drogos
Alameda County Public Works	James Yoo
Alameda County Water District (ACWD)	Steven Inn
City of Alameda	Laurie Kozisek
City of Hayward	Marilyn Mosher
City of Oakland	Craig Pon
City of San Leandro	Keith Cooke
Hayward Area Recreation District	Edwin Little
Port of Oakland	Liem Nguyen
San Francisco Bay Regional Water Quality Control Board	Barbara Baginska
San Lorenzo Unified School District	Prachi Amin

All of the above stakeholders have an interest in protecting or managing the SEBP basin (see Figure P-2 for a graphical depiction of the Basin boundary). Preparation of a GMP is an effective step to assure basin sustainability. For EBMUD, preparation of a GMP is consistent with commitments made in the Phase 1 EIR for the Bayside Groundwater Project. A GMP provides a mechanism for EBMUD to monitor, manage, and protect water quality and quantity in the SEBP Basin for potable uses. For the Alameda County Public Works Department, the GMP discusses their interest in modifying existing well installation and decommissioning standards. The City of Hayward, like EBMUD, has an interest in exploring the potential for the Basin to address a portion of their water supply. All stakeholders understand that working together through the GMP process safeguards their interests and provides a mechanism for a collaborative basin management approach.

Emergency Water Supply Wells (City of Hayward):

The City of Hayward (City) provides water services for residential, commercial, industrial, governmental, and fire suppression uses. Originally, groundwater wells were used as the primary source of water supply. During the 1940s and 1950s, the well water was supplemented by water purchased from San Francisco's Hetch Hetchy system, owned and operated by the San Francisco Public Utilities Commission (SFPUC). In 1962, Hayward entered into an agreement with SFPUC to purchase water from SFPUC and ceased providing well water in 1963. However, to secure a reliable source of potable water for use in the event of an interruption in delivery from the regional Hetch Hetchy Water System, the City designed and constructed five emergency wells, beginning in the mid-1990s and completed in 2001. Although the City does not currently operate these groundwater wells to meet any portion of its day-to-day normal water demand, these emergency wells, which are located within the City and use the local groundwater basins, can theoretically provide up to a total of 13.6 million gallons per day of potable water. These wells are currently certified by the California Department of Health Services for short duration emergency use only.

Emergency Well Capacities

Well Identification	Capacity
Well A	1.7 mgd
Well B	2.9 mgd
Well C	4.6 mgd
Well D	1.4 mgd
Well E	3.0 mgd

1.3 OBJECTIVES OF GMP

The overarching goal of the South East Bay Plain Basin GMP is to preserve the local groundwater basin as a reliable and sustainable water supply for current and future beneficial uses. To accomplish this goal, the objectives of the GMP together with accompanying plan elements are listed below.

The SEBP Basin GMP Objectives are to:

- Preserve basin storage by maintaining groundwater elevations in the GMP area to ensure sustainable use of the basin;
- Maintain or improve groundwater quality in the GMP area to ensure sustainable use of the basin; and
- Manage potential inelastic land surface subsidence from groundwater pumping

The following plan components are structured to achieve these objectives:

- Stakeholder and Public Involvement
- Monitoring Program
- Data Management and Analysis
- Groundwater Resource Protection
- Groundwater Sustainability

Each component includes specific management actions. Figure 1-1 graphically depicts the means by which objectives are folded into plan components that in turn address goals for basin management.

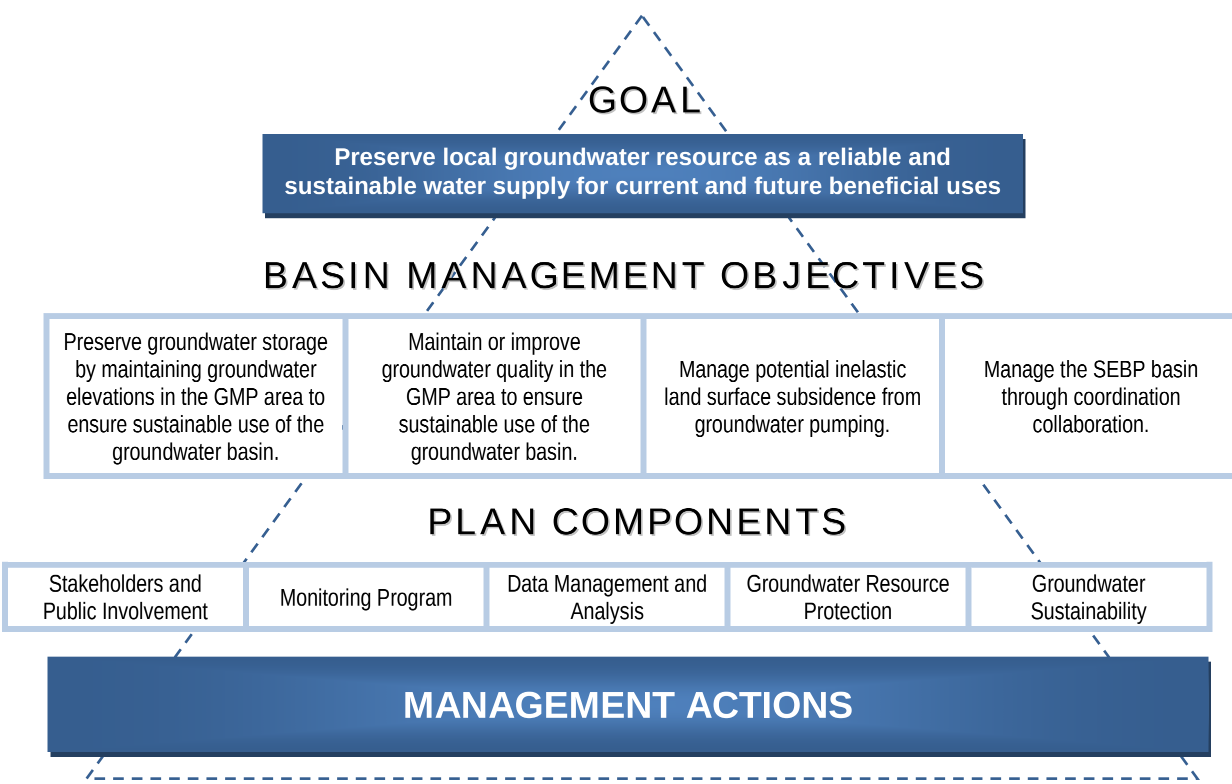


Figure 1-1: Basin Management Objectives

The SEBP Basin GMP accomplishes the following objectives:

- Provides statutory authority for stakeholders to manage the groundwater basin;
- Supports basin sustainability;
- Maintains local control of groundwater;
- Supports the rights and beneficial uses of groundwater for basin users;
- Fosters collaboration and prevents legal disputes among stakeholders; and
- Increases opportunities for future grant funding.

1.4 GMP TIMELINE AND DEVELOPMENT PROCESS

Preparation of the SEBP Basin GMP has taken approximately two years. The effort began with EBMUD's Board adoption of a resolution of intent on May 9, 2010. Significant milestones in the GMP development process since that date are summarized in Table 1-3 below.

Table 1-3: Significant Milestones/Development Process

Milestones	Date
Public Notice to adopt the Resolution of Intent	5/7/2011
EBMUD Board Adoption of the Resolution of Intent	5/24/2011
Stakeholder Liaison Group Meeting	8/9/2011
Technical Consultant Contract Award	11/8/2011
Stakeholder Liaison Group Meeting	3/29/2012
Stakeholder Well Standard Development Subgroup Meeting	10/16/2012
Stakeholder Salts and Nutrients Management Subgroup Meeting	10/16/2012
Stakeholder Land Subsidence Management Subgroup Meeting	10/23/2012
Completion of Draft Technical Study Report	1/23/2013
Completion of Draft GMP document	1/31/2013
Completion of Final Technical Study Report	2/28/2013
Completion of Final GMP document	3/21/2013
Planned Public Notice to Adopt the GMP	3/12/2013
Planned EBMUD Board Adoption of the GMP	3/26/2013

1.5 ELEMENTS OF THE SEBP BASIN GMP

Elements of the SEBP Basin GMP include basin delineation and characterization, the establishment of basin objectives, a description of monitoring activities, and identification of management activities. Stakeholder participation is also detailed.

1.6 DOCUMENT DEVELOPMENT

The GMP was prepared by EBMUD staff with significant assistance provided by stakeholder organizations. The engineering firm of West Yost, Inc. was contracted to prepare a hydrologic study as well as develop a new groundwater model of the basin. EBMUD staff supervised their efforts. Table 1-4 denotes participation in document development by stakeholder/consultant support.

Table 1-4 : GMP Document Development Contributors

GMP Development Lead Agency	EBMUD Board
Technical Consultant for the SEBP Basin Characterization Study	West Yost Associates
Public Outreach	EBMUD staff
Well Standard Development Subgroup	Lead: James Yoo (ACPWA) Members: • Marilyn Mosher (COH) • Prachi Amin (SLUSD) • Ken Minn (EBMUD)
Salts and Nutrients Management Subgroup	Lead: Alec Naugle (SFRWQCB) Members: • Donna Drogos (ACEH) • James Yoo (ACPWA) • Laurie Kozisek (COA) • Marilyn Mosher (COH) • Prachi Amin (SLUSD) • Ken Minn (EBMUD)
Land Subsidence Management Subgroup	Lead: Tom Francis (EBMUD) Members: • James Yoo (ACPWA) • Laurie Kozisek (COA) • Marilyn Mosher (COH) • Ken Minn (EBM UD) • Steve Martin (EBMUD)
Technical Data and Research Contributors	Mike Halliwell (ACWD) John Izbicki (USGS) Ken Minn (EBMUD)
Technical Reviewers	Mike Halliwell (ACWD) Marilyn Mosher (COH) Ken Minn (EBMUD)
DWR Liaison	Mark Nordberg

1.7 AUTHORITY TO PREPARE AND IMPLEMENT A GMP

The authority to manage the groundwater basin is provided through the Act and Water Code Division 6, part 2.75 (§ 10750 et seq.). The state groundwater management law (Water Code Division 6, part 2.75, commencing with section 10750) prohibits the District from managing groundwater within the service area of another local water district, public utility or mutual water company, without the agreement of that other entity. (Section 10750.9 (b)). State law also encourages local water agencies to coordinate on groundwater management plans. (See Water Code §§ 10755.2-10755.4.)

This GMP is prepared to cover the southern portion of East Bay Plain basin as per DWR Bulletin 118. In accordance with Water Code section 10750, EBMUD will be authorized to manage the basin within its service area. Similarly, City of Hayward will be authorized to manage the portion the basin under its groundwater service area. This GMP does not cover areas currently under the management of ACWD.

This plan and implementation of the plan shall comply with these and other applicable limitations of state law. On May 24, 2011, EBMUD Board of Directors formally adopted the Resolution of Intent to prepare the GMP for the South East Bay Plain Basin. The Resolution is included in Appendix A.

1.8 GROUNDWATER MANAGEMENT PLAN COMPONENTS

The South East Bay Plain Basin GMP includes the required and recommended components and applicable voluntary components per CWC § 10750 et seq. as described in DWR's Bulletin 118, California Groundwater – Update 2003 (DWR, 2003).

Seven mandatory components of CWC § 10750 et seq. CWC § 10750 *et seq.* requires GWMPs to include seven mandatory components and twelve voluntary components to be eligible for award of funding administered by DWR for the construction of groundwater projects or groundwater quality projects. These amendments to the CWC were included in Senate Bill 1938, effective January 1, 2003. The amendments apply to funding authorized or appropriated after September 1, 2003.

CWC § 10750 *et seq.*, Mandatory Components:

- Documentation of public involvement statement 1.2, 1.4, 1.6, and 3.3.1
- Establish basin management objectives 1.3
- Monitor and manage groundwater elevations, groundwater quality, inelastic land surface subsidence, and changes in surface water flows and quality that directly affect groundwater levels or quality or are caused by pumping 3.3
- Plan to involve other agencies located within groundwater basin 1.7
- Adoption of monitoring protocols by basin stakeholders 3.3.2
- Map of groundwater basin showing area of agency subject to GMP, other local agency boundaries, and groundwater basin boundary as defined in DWR Bulletin 118 (Figure 2-1)
- For agencies not overlying groundwater basins, prepare GMP using appropriate geologic and hydrogeologic principles.

Twelve voluntary components of CWC § 10750 et seq. includes twelve specific technical issues that could be addressed in GMPs to manage the basin optimally and protect against adverse conditions. In addition, DWR Bulletin 118-223 recommends seven components to include in a GMP. The mandatory, voluntary and recommended components are listed below:

- Control of saline water intrusion. 3.3.5.1
- Identification and management of wellhead protection areas and recharge areas. 3.3.5.1 and 3.3.4.3
- Regulation of the migration of contaminated groundwater. 3.3.5.1
- Administration of well abandonment and well destruction program. 3.3.5.1
- Mitigation of conditions of overdraft. 3.3.5.1
- Replenishment of groundwater extracted by water producers. 3.3.5.1
- Monitoring of groundwater levels and storage. 3.3.2
- Facilitating conjunctive use operations.
- Identification of well construction policies. 3.3.4.1
- Construction and operation by local agency of groundwater contamination clean up, recharge, storage, conservation, water recycling, and extraction projects. 3.3.4.4 and 3.3.5.2
- Development of relationships with state and federal regulatory agencies. 3.3.1.3
- Review of land use plans and coordination with land use planning agencies to assess activities that create reasonable risk of groundwater contamination.

DWR Bulletin 118 Suggested Components:

- Manage with guidance of advisory committee.
- Describe area to be managed under GWMP
- Create link between BMOs and goals and actions of GWMP 1.3
- Describe GWMP monitoring program 3.3.2
- Describe integrated water management planning efforts 3.3.5.1 and 4.4
- Report on implementation of GWMP 4.1
- Evaluate GWMP periodically 4.2

1.9 SEBP GROUNDWATER MANAGEMENT PLAN STRUCTURE

This GMP is structured as follows:

- **Section 1.0 - Introduction:** Provides the executive summary and introductory information.
- **Section 2.0 - Water Resources Setting:** Provides an overview of existing physical conditions that should be understood and considered when developing and implementing groundwater management activities. This section includes information on topics such as precipitation, hydrology, geology, groundwater levels, groundwater quality, existing well infrastructure, and water demand and supply. The understanding of existing physical conditions helps define groundwater management needs, objectives, and actions.
- **Section 3.0 - Plan Implementation:** Discusses the major plan components. The five groundwater management components included in the plan are stakeholders and public involvement, monitoring program, data management and analysis, groundwater protection and groundwater sustainability.

- **Section 4.0 - Plan Implementation and Integration:** Successful management of the basin directly correlates with successful implementation of plan components and associated actions. As the basin is the local resource for multiple stakeholders with various stakes, successful implementation is, in turn, contingent upon effective collaboration and available resources. Also, the basin management is a perpetual task concerning all stakeholders. Leading a group of stakeholders with common interest, EBMUD will foster collaborative efforts in seeking state and federal funding as well as developing mutually beneficial projects in the basin.

Bayside Groundwater Project (EBMUD):

The Bayside Groundwater Project is one of several future water supply projects that will help protect EBMUD's 1.3 million customers against severe water rationing in the event of a prolonged drought. In wet years, water would be stored in a deep aquifer; then extracted, treated and distributed to customers during drought.

The aquifers far beneath San Leandro and San Lorenzo were chosen as project sites after much exploration. The Bayside Groundwater Project's planning began in 2001, the Environmental Impact Report was approved by the EBMUD Board of Directors in November 2005 and the project's construction was completed in 2009.

After successfully operating the project for some time, EBMUD will consider a larger project in the area that would have a storage capacity of 2 to 10 mgd, providing even greater drought protection. The larger project would first be subjected to the same environmental and public review as the first project, and EBMUD will review results of the groundwater monitoring system and extensometer, which measures minute changes in ground surface elevation.

SECTION 2.0 WATER RESOURCES SETTING

2.1 OVERVIEW OF SEBP GROUNDWATER BASIN

The study area covers a large area of the East Bay Plain underlying a portion of the City of Oakland, Alameda, San Lorenzo, and the City of Hayward (see Figure 2-1). The study area is approximately four miles wide and twelve miles long. It extends from the San Francisco Bay on the west to the edge of the alluvial basin at the base of the Oakland hills on the east, and runs from 35th Avenue in Oakland on the north near the City of Hayward's southern boundary. The area is densely populated and highly urbanized and is characterized by industrial, commercial, and residential land uses. Although agriculture was important in the past, there is little agricultural land use in the study area at the present time. More information on the hydrology and hydrogeology of the study area is provided in later sections of this report.

2.2 HISTORICAL GROUNDWATER USE IN THE EAST BAY AREA

Groundwater was a major part of water supply to the East Bay area from the 1860s to 1930. During that time there was a continuous struggle to locate and develop both ground and surface waters to serve the growing population. By the early 1920s, it was recognized that local groundwater and surface water supplies had reached their limits, and water would have to be brought in from outside the Bay Area. After years of planning and construction, Sierran water entered the area in the spring of 1930. However, instead of continuing to be part of the water supply, municipal well fields were shut down and forgotten.

In their 1998 study of groundwater and water supply history of the East Bay Plain, Norfleet Consultants estimated that in the range of 15,000 wells were drilled in the Basin between 1860 and 1950. The majority of these were shallow (less than 100 feet deep), but some were up to 1,000 feet deep. Few of these wells were properly destroyed. EBMUD's historical review indicates that there were only three sites in the East Bay Plain that historically supported municipal well fields: the Alvarado, San Pablo, and southern Oakland areas. The Alvarado Well Field was located south of the SEBP Basin in the Niles Cone. This site had the most prolific wells and supplied about one half of the groundwater to the East Bay Area. There were 8 to 10 individual well fields in the southern Oakland trend. The first well field in the SEBP area was drilled on Alameda Island (the High Street Field) in the 1880s. Within 10 years, the field was shut down because of water quality problems and casing failures. Additional well fields were drilled to the west (Fitchburg, 98th Street, etc.), following the trend of the aquifer. In 1916, the East Bay Water Company, predecessor of EBMUD, drew about 10 million gallons a day from 117 wells including Robert's Landing well filed located in San Lorenzo area. These fields were an integral part of the water supply system until they were shut down in 1930. There were three well fields in San Pablo. They were drilled in the late 1900s to supply water to the rapidly growing Richmond area. Overpumping and intrusion of brackish water caused those fields to be shut down by 1920.

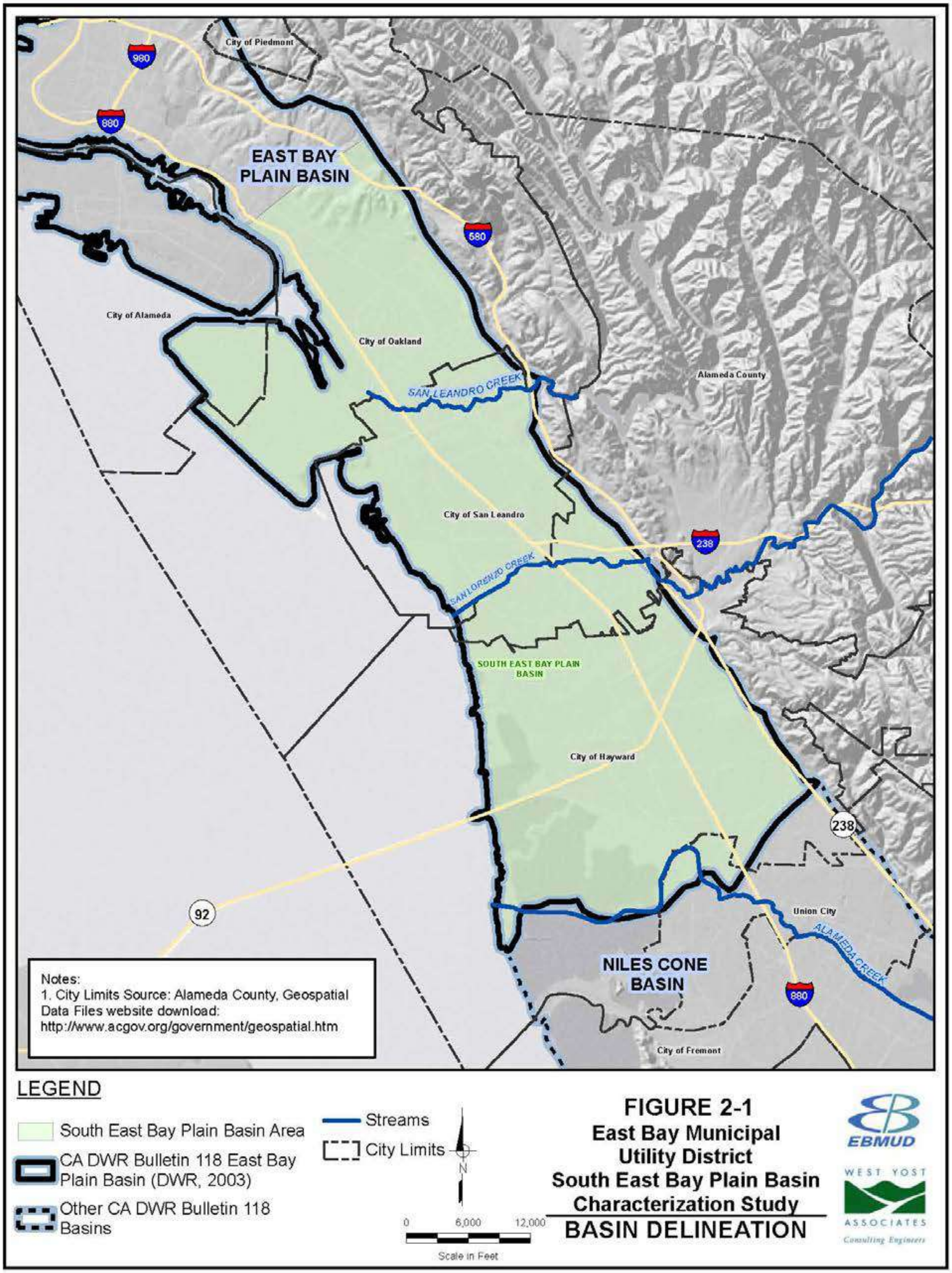
There is little specific information about historic groundwater quality, but the existing information indicates that groundwater had a relatively similar quality throughout the East Bay Plain. Total dissolved solids (TDS) varied between 500 and 1,000 ppm. Salt/brackish water intrusion occurred along the eastern end of Alameda Island (early 1890s), in the Fitchburg Well Field (late 1920s), and in San Pablo (late 1910s). Existing information indicates that the intrusion was restricted to the upper aquifer (above the Yerba Buena Mud) and was caused by overpumping. All of these fields were shut down by 1930. Overpumping continued to occur in the Niles Cone for the next 30 years. This resulted in intrusion of the deeper aquifers by the 1950s.

2.3 GROUNDWATER BASIN DELINEATION

California Water Code Section 10750 et seq., commonly referred to as AB 3030, stipulates certain procedures that must be followed in adopting a GMP under this section. Amendments to Section 10750 et seq. added the requirement that new GMPs being prepared under Section 10750 et seq. must include additional components in order to be eligible for state grants administered through DWR (SB1938 (Stats 2002, Ch 603)). One of the required components is a map showing the area of the groundwater basin, as defined by DWR Bulletin 118, with the area of the local agency subject to the plan as well as the boundaries of other local agencies that overlie the basin.

The SEBP Basin GMP study area is located within the East Bay Plain Subbasin[1] (Figure P-2). DWR describes the East Bay Plain Subbasin as a northwest trending alluvial plain bounded on the north by San Pablo Bay, on the east by the contact with Franciscan Basement rock, and on the south by the Niles Cone Groundwater Basin (NCGB). The East Bay Plain Basin extends beneath San Francisco Bay to the west (DWR, 2003). The study area (shown in light green in Figure 2-1) is bounded on the east, west and south by the groundwater basin boundary as delineated by the DWR in Bulletin 118 (2003) and shown in Figure P-1. The SEBP basin deep aquifer thins to the north and becomes an insignificant source of groundwater near Berkeley (CH2MHill, 2000). For the purpose of this study, the northern boundary of the SEBP Basin GMP area was drawn in Oakland at a location where the depth to basement is relatively shallow and the deep aquifer is relatively thin (CH2MHill, 2004). The southern boundary extends near the southern boundary of the City of Hayward in the transition zone with the Niles Cone Subbasin to the south.

[1] The southern boundary of the basin in DWR Bulletin 118 may be subject to modification in a future edition of the Bulletin 118 as per ongoing discussions between DWR and ACWD.


City of Piedmont
980
880
EAST BAY
PLAIN BASIN
580
City of Alameda
City of Oakland
SAN LEANDRO CREEK
Alameda County
City of San Leandro
238
SAN LORENZO CREEK
SOUTH EAST BAY PLAIN
BASIN
City of Hayward
238
92
Union City
ALAMEDA CREEK
NILES CONE
BASIN
880
City of Fremont
Notes:
1. City Limits Source: Alameda County, Geospatial Data Files website download:
http://www.acgov.org/government/geospatial.htm
LEGEND
South East Bay Plain Basin Area
CA DWR Bulletin 118 East Bay Plain Basin (DWR, 2003)
Other CA DWR Bulletin 118 Basins
Streams
City Limits
N
0
6,000
12,000
Scale in Feet
FIGURE 2-1
East Bay Municipal
Utility District
South East Bay Plain Basin
Characterization Study
BASIN DELINEATION
EBMUD
WEST YOST
ASSOCIATES
Consulting Engineers

2.4 TOPOGRAPHY AND GEOMORPHIC FEATURES

The GMP study area includes Oakland, Alameda, San Leandro, San Lorenzo and Hayward, covering an area of about 115 square miles. The study area consists primarily of flat alleviated lowlands and bay tidal marshes. The topography generally slopes downward toward the San Francisco Bay to the west, ranging in elevation from about 400 feet above mean sea level (msl) in the east to 0 feet msl to the west where the plain meets the San Francisco Bay. This information is relevant to this groundwater study, because groundwater direction and gradient typically correlate well with surface topography on a regional level. Local variations result from groundwater pumping patterns, and geomorphic and structural features such as fault zones.

2.5 SOILS

Soils information was compiled and evaluated from field data collected by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service as well as data collected by the U.S. Geological Survey (USGS). This information is key to developing an understanding of groundwater recharge within the GMP study area. These studies utilized soil information for the East Bay Plain obtained by ACWD during the development of the Niles Cone and South East Bay Plain Integrated Groundwater and Surface Water Model (NEBIGSM) (WRIME, 2005), which included the entire East Bay Plain. The model subregions used for depicting soil information extend beyond the boundaries of the GMP study area.

Soils types for the entire East Bay Plain are shown on Figure 2-2. The Soil Survey Manual (SSM) (U.S. Department of Agriculture, 1993), prepared by the USDA Soil Survey Division was used as a guideline for soil classification. The soil data for the study area were categorized into four classifications established from the Natural Drainage Classes and Hydrologic Soil Groups published in the SSM. The categories are briefly described below.

2.5.1 Type A Soils

Type A soils, defined as excessively drained to somewhat excessively drained soils, are so termed because water moves rapidly through them. Soils are typically coarse-textured and have high hydraulic conductivity in the upper half of the horizon. Examples of type A soils include coarse sands, tailings, and alluvial deposits, which typically occur along major stream channels.

2.5.2 Type B Soils

Type B soils are well drained soils, meaning that water is removed from the soil readily, not rapidly. Soils in the upper one meter of this horizon typically have higher conductivity in the lower half and moderately high hydraulic conductivity in the upper half of the one-meter interval. A representative type B soil is sandy loam.

2.5.3 Type C Soils

Type C soils are moderately well drained soils, meaning that water is removed from the soil slowly during portions of the year. Soils typically have moderately high hydraulic conductivity in the upper half of the horizon and moderately low hydraulic conductivity in the lower half. Examples of type C soils include silty sands, silty loam, and clayey sands.

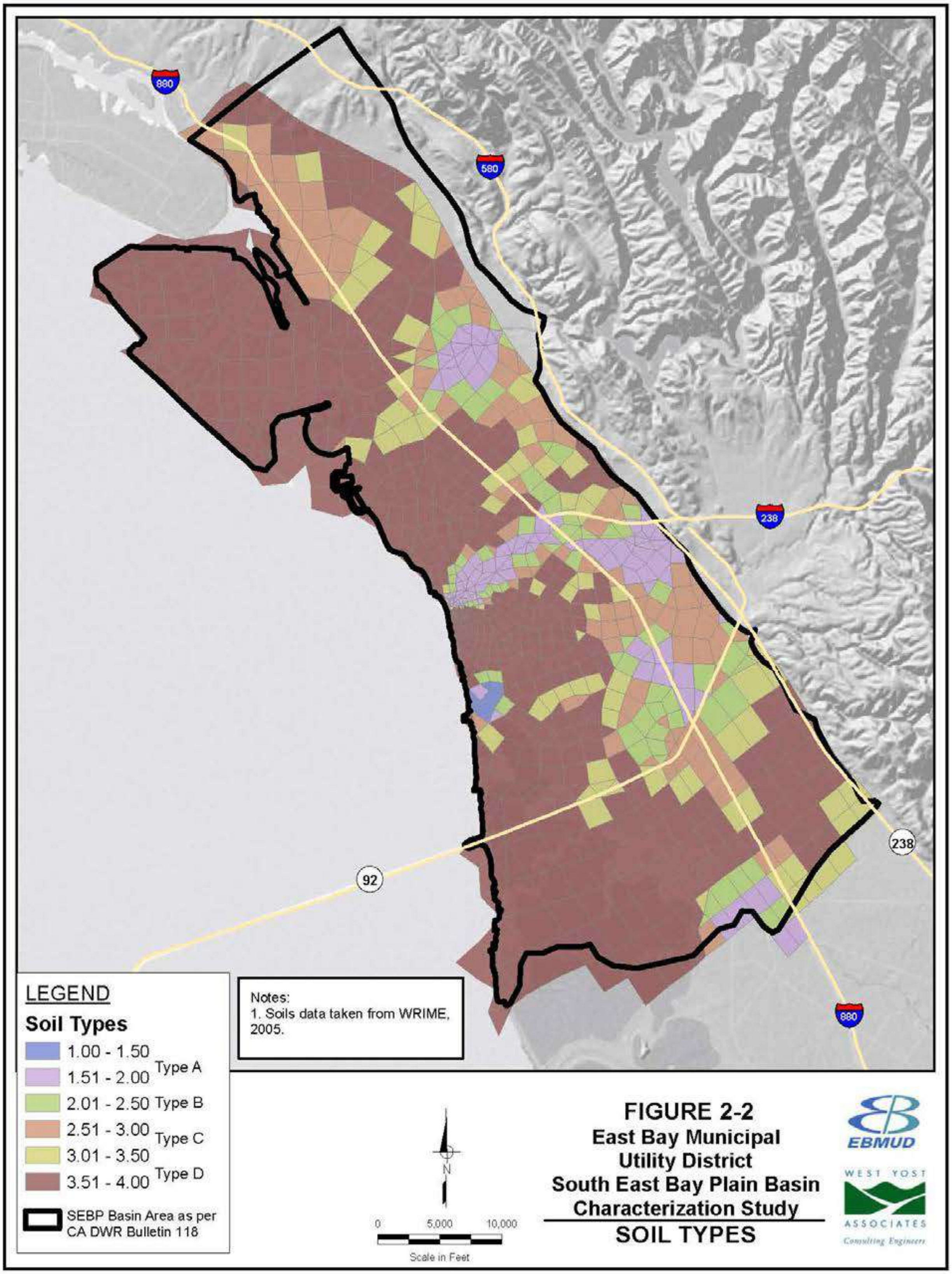


FIGURE 2-2
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
SOIL TYPES

2.5.4 Type D Soils

Type D soils are poorly drained to very poorly drained soils, meaning that water is removed very slowly and free water typically is present at shallow depths or at the surface. These soils typically have low hydraulic conductivity. Examples of type D soils include clays, hardpan, and floodplain deposits.

2.6 SURFACE WATER FEATURES

San Leandro and San Lorenzo Creeks are the principal streams in the study area. These streams originate in the Diablo Range and flow westward into San Francisco Bay. The upland area drained by these streams (43 and 44 square miles, respectively) contains two large reservoirs. With the exception of the Castro Valley area, the drainage basins are not extensively developed. These streams may have been important sources of pre-development groundwater recharge. Muir (1996) estimated that annual recharge from infiltration of stream-flow and direct infiltration of precipitation in the San Leandro and San Lorenzo areas was about 3,500 and 800 acre-ft, respectively.

Channeling of these streams due to urbanization has reduced the amount of surface water available for groundwater recharge along the mountain front (Izbicki, 2003). The results of a USGS study completed in 2003 show that recharge of San Leandro and San Lorenzo Creeks occurs as infiltration of stream flow during winter months. Most recent recharge is restricted to the upper aquifer system in areas near the mountain front. Recently recharged water was not present in the lower aquifer system, probably because of the presence of clay layers that separate the upper and lower aquifer systems. The time to recharge based on Carbon-14 dating of deep groundwater ranged from 500 to greater than 20,000 years. Older groundwater ages suggest that the lower aquifer system is isolated from surface sources or recharge (Izbicki, 2003).

2.6.1 San Leandro Creek

San Leandro Creek stream flow data were not available. Because it is a lined channel having little or no interaction with groundwater, no effort was made to estimate the missing data for San Leandro Creek during construction and calibration of the NEBIGSM (WRIME, 2005).

2.6.2 San Lorenzo Creek

San Lorenzo Creek stream flow data, compiled by WRIME in preparation of the NEBIGSM, covers the period 1964 to 2000 and more recent (2008 to 2012) data retrieved from the USGS for the Hayward Gage (see Appendix B). The steam flows year round with highest flows in the winter months. Flows rarely exceed 2,000 cubic feet per second.

2.7 PRECIPITATION

Although the area is heavily urbanized, precipitation does contribute to recharge in the study area. Rainfall data were compiled and analyzed from two rainfall gages in the study area during development of the NEBIGSM for the period 1922 to 1998. During this period, average rainfall was 19.36 inches per year at the Oakland Museum Station (northern study area) and 17.87 inches per year at the Niles Station (southern study area). Recent precipitation data at the Oakland Museum Station is plotted on Figure 2-3 and shows that average annual precipitation for the period 1971 to 2011 was 22 inches.

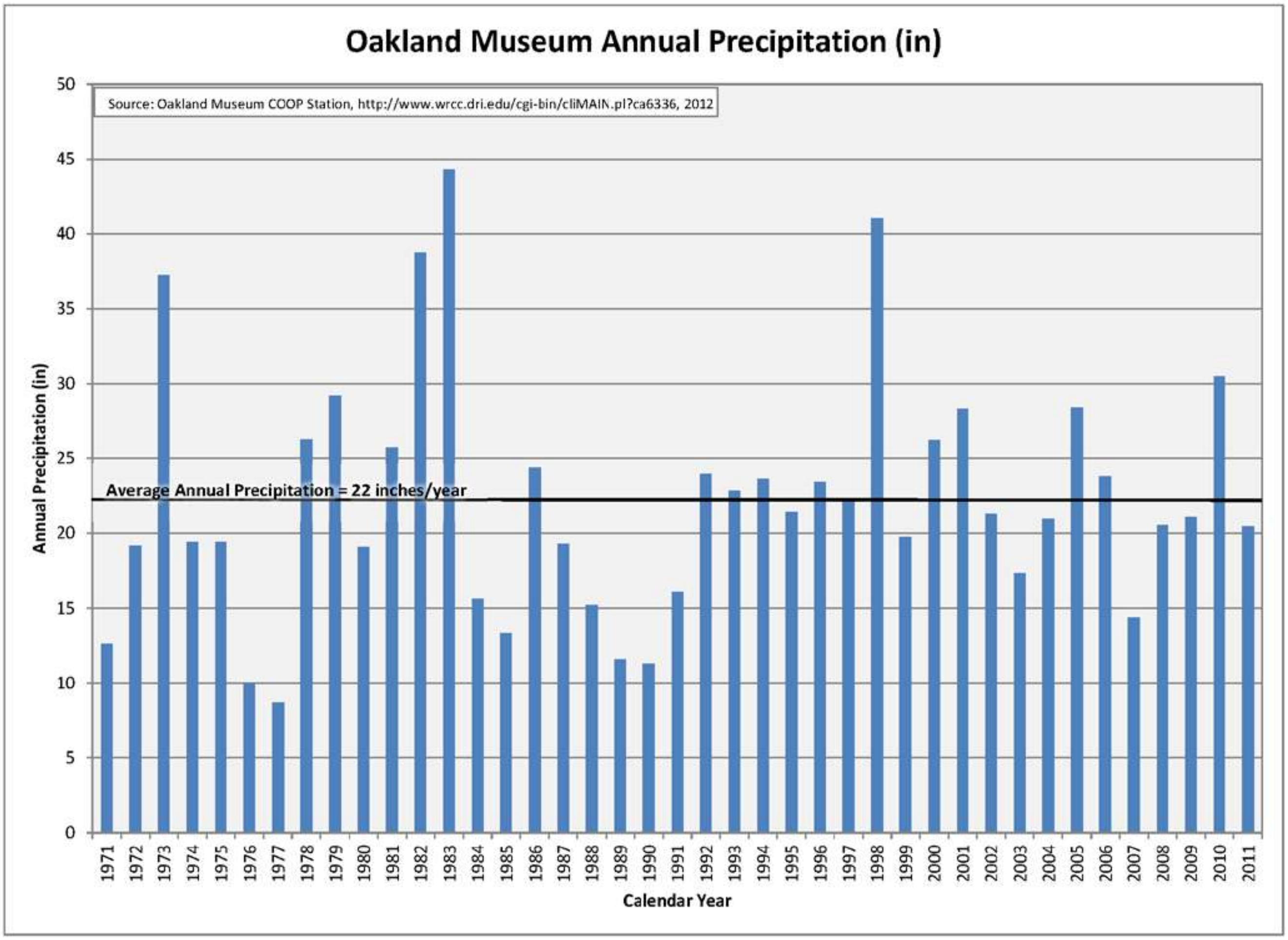


Figure 2-3

2.8 LAND USE

Land use information is another factor considered in developing a recharge area/net percolation map for the study area. Figure 2-4 shows the mix of land uses across the SEBP Basin, including the study area. Principal land uses within the study area include residential, industrial, parks and open space. The land use classification information was developed from the 2006 Planned Land Use GIS data file available from the Association of Bay Area Governments (ABAG) GIS Data Catalog. The 2006 Planned Land Use data file contains geospatial information relating to land uses found in the general plans of the cities and counties of the nine-county San Francisco Bay Area.

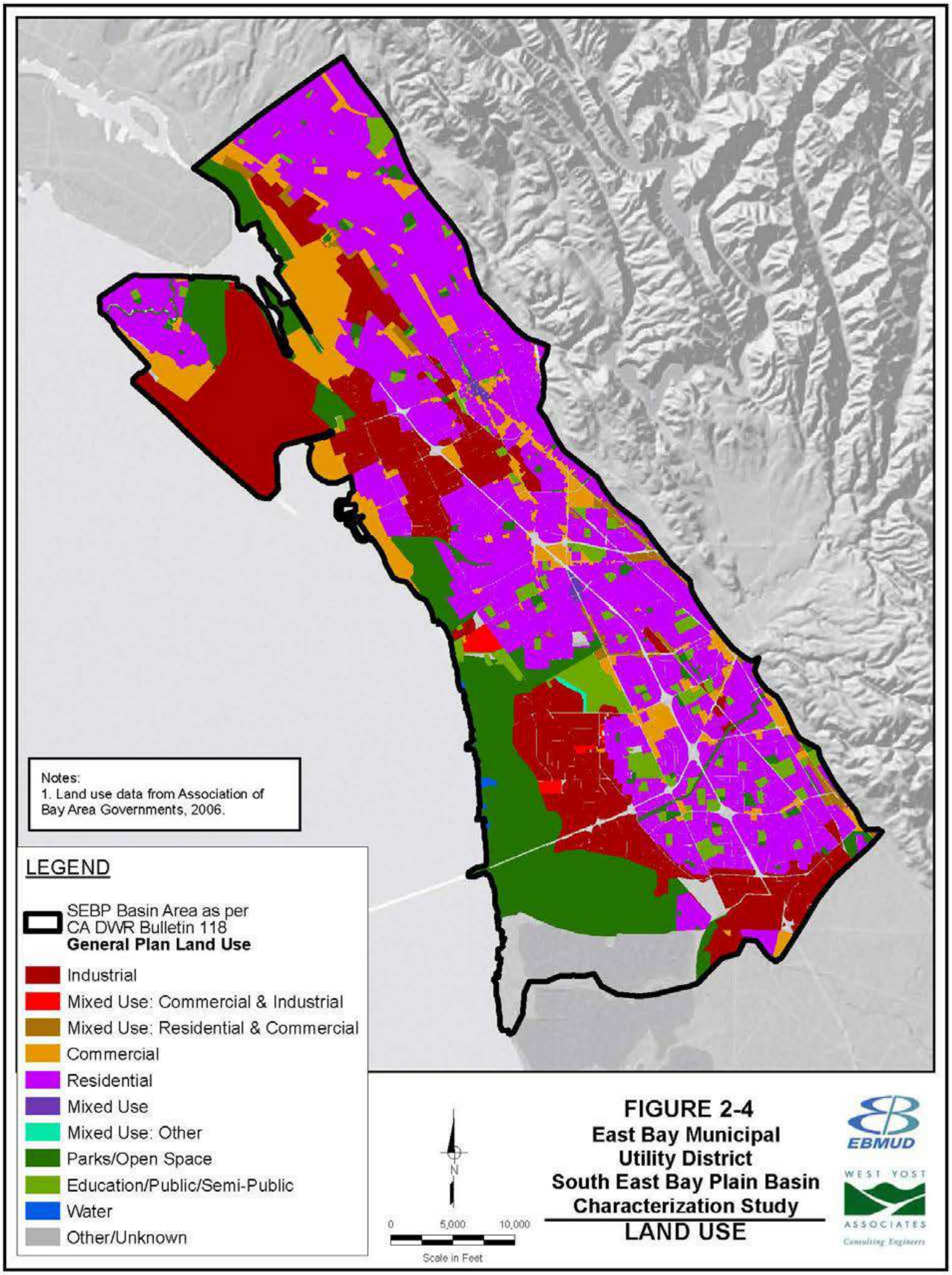


FIGURE 2-4
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
LAND USE

2.9 FLOOD PLAIN DELINEATION

Figure 2-5 shows the Federal Emergency Management Agency (FEMA) flood plain delineation mapping for the study area dated April 2012. The flood plain delineation was derived from 100-year flood maps available directly from FEMA and digitized into GIS Data. The total area included in FEMA's 100-year flood plains is approximately 8,400 acres, or 21 percent of the 39,900-acre GMP area. Because Figure 2-5 is scaled to show the entire GMP area, inset maps were created at ten times the size to show better detail. Inset maps are included in Appendix C showing more detail along creeks and streams within the study area.

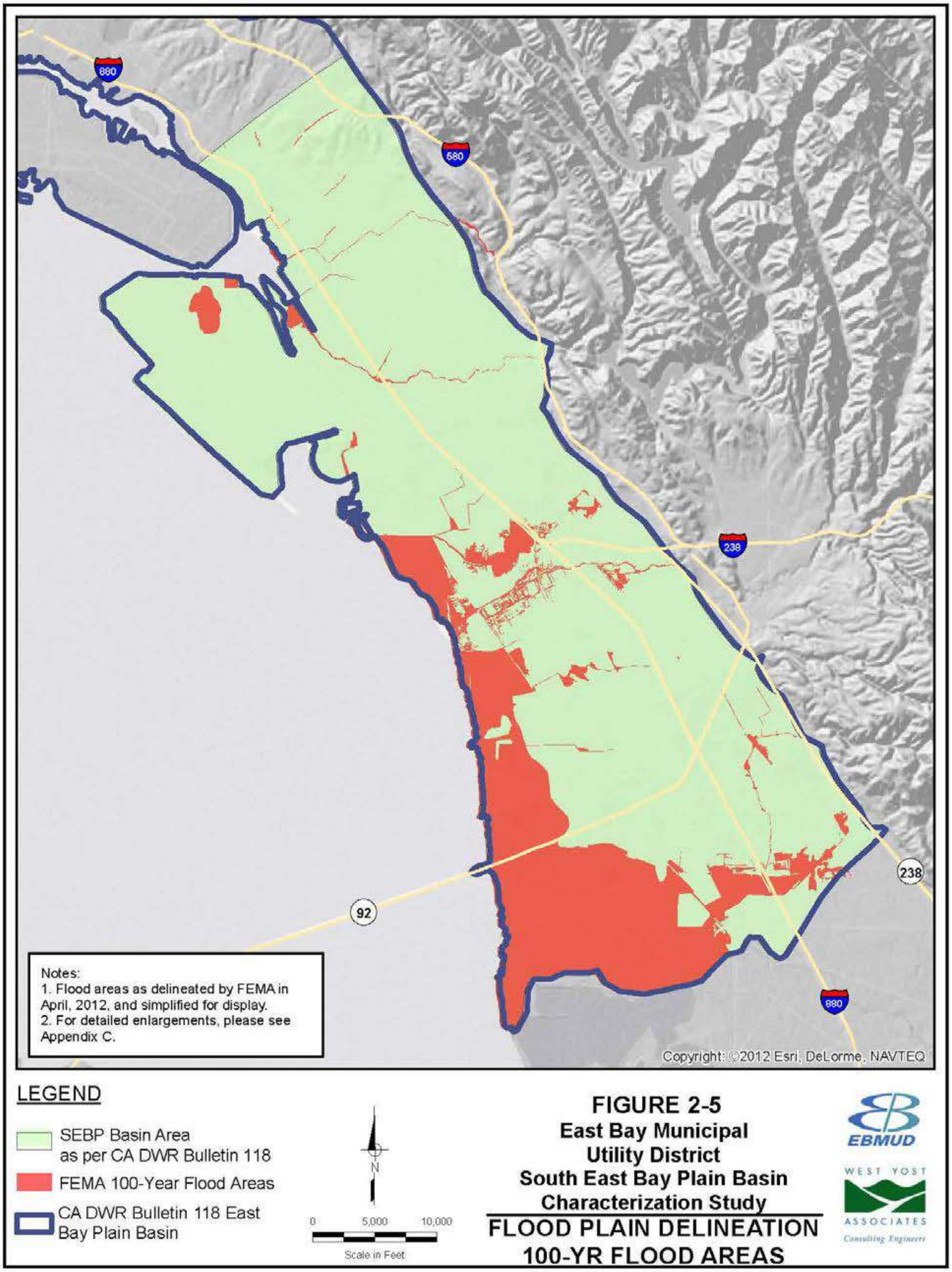


FIGURE 2-5
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
FLOOD PLAIN DELINEATION 100-YR FLOOD AREAS

2.10 HYDROGEOLOGIC SETTING

The purpose of this chapter is to provide sufficient detail on the geologic history and setting to improve understanding of the geologic framework that defines the groundwater basin, including freshwater aquifers. This also includes understanding of the bedrock geometry which defines the boundaries of the basin, aspects of the bedrock geology that could influence groundwater quantity and quality, and the sequence of sedimentation within the bedrock basin that resulted in the SEBP Basin aquifers. The description of the sedimentary sequence is intended to provide a framework for interpreting site-specific geologic information obtained from drilling and logging and to plan future investigative efforts within the SEBP Basin.

The sediments comprising the aquifers of the SEBP Basin, as delineated in this report, are primarily composed of relatively young alluvial deposits formed in approximately the last few hundred thousand years by streams, such as San Leandro, San Lorenzo and Alameda Creeks, emanating from the East Bay Hills. Productive groundwater zones, likely former stream channels, are found in discontinuous sand and gravel deposits. These sand and gravel zones are enclosed in fine grained deposits formed in alluvial systems during flood events that overtopped stream channels. Near San Francisco Bay, the alluvial deposits interfinger with estuarine deposits and localized wind-blown sand deposits of approximately the same age. The fine grained alluvial and estuarine deposits have low permeability and create confined (pressurized) conditions for most of the SEBP Basin groundwater production zones.

The characteristics of the SEBP Basin aquifers are significantly affected by fault motion. Earth movements not only created the groundwater basin and the depositional environments resulting in the aquifer sediments, but also displaced the aquifer sediments once deposited. Even the youngest deposits forming the SEBP Basin aquifer system are affected, because fault motion is ongoing. However, the somewhat older alluvial deposits, possibly including the productive zones in the SEBP Basin Deep Aquifer, have undergone greater northwesterly translation from their original sites of deposition. Also, Alameda Creek is the only antecedent stream in the region, suggesting that it predates the geologically recent deformation and uplift of the East Bay Hills. The geomorphic characteristics of San Leandro and San Lorenzo Creeks suggest that they are young relative to geologically recent deformation and uplift, introducing the possibility that some deeper alluvial deposits may have been formed by Alameda Creek or other local streams that no longer exist.

The alluvial sediments comprising the main freshwater-bearing zones and underlying the SEBP Basin, probably rest upon and are juxtaposed across faults with older fluvial deposits formed in the early stages of the San Francisco Bay lowland's development. Although the permeability of the coarse-grained fluvial sediments is probably less than the permeability of the coarse-grained alluvial sediments due to greater compaction and cementation, the fluvial sediments are significant to the freshwater aquifer system because they are relatively widespread in the southern San Francisco Bay region.

The alluvial, fluvial and estuarine sediments comprising the freshwater aquifer system in the vicinity of the SEBP Basin are underlain by bedrock consisting of very old Franciscan Complex rocks and deformed marine sedimentary rocks, predating the most geologically recent Coast Range uplift. These older rocks are significant because their structural configuration defines the geometry of the groundwater basin and aspects of their mineralogy may influence groundwater quality in the SEBP Basin.

The following sections of this chapter provide summaries of the geologic history and structural features that make up the geologic framework of the SEBP Basin.

2.10.1 Geologic History

A conceptual geologic column shown in Figure 2-6, illustrates the geologic history of the SEBP Basin within the oldest geologic formation at the base and youngest formation at the top. The geologic column is a graphical representation of the geometrical and temporal relationships between the geologic units that define the SEBP Basin's geometry and hydraulic properties and influence its water quality. Figure 2-7 is a surficial geologic map of the area.

The thickness and extent of the SEBP Basin freshwater aquifer system is delimited by the extent and depth to the top of basement rocks comprised of the Franciscan Complex and the overlying marine sedimentary rocks shown near the bottom of Figure 2-6.

Fluvial sediments located at, or near the base of, the freshwater aquifer system may extend the depth and extent of the system beyond the limits indicated by mapped alluvial deposits in the SEBP Basin.

The primary aquifers of the SEBP Basin are comprised of the Late Pleistocene through Holocene alluvial and estuarine deposits (shown on the upper part of the geologic column).

2.10.2 Mesozoic Through Early Cenozoic Basement Rocks Formed During Subduction of the Farallon Plate

The oldest rocks in the vicinity of the SEBP Basin are late Jurassic through early Tertiary age rocks of the Franciscan Complex and Great Valley Sequence. These rocks provide a record of approximately 140 million years of compressive tectonics, oceanic plate subduction and continental accretion, which ended approximately 28 million years ago when the Farallon Plate was subducted beneath the North American Plate, and right-lateral strike-slip motion was initiated along the San Andreas Fault system (Wakabayashi, 1992).

Rocks of the Franciscan Complex are dominated by detrital sediments (greywacke and shale), with lesser amounts of pillow basalts, chert and minor limestone. As originally formed, these rock units present a record of the formation of new oceanic crust (pillow basalts) at oceanic ridges. Chert deposits formed in deep water over the pillow basalts as the oceanic crust moved away from spreading centers and toward the subduction zone on the western margin of North America. Limestone formed in shallow water over oceanic crust at equatorial latitudes. Greywacke and shale were formed by deposition of continentally-derived sediments by turbidity currents at the subduction zone. The entire assemblage was extensively disrupted by folding and faulting in the oceanic trench near the western margin of North America during subduction of the oceanic Farallon Plate. Tectonic disruptions in the subduction zone resulted in metamorphosis of some Franciscan rocks, which are often identified based on metamorphic petrology resulting from high pressure-low temperature conditions brought about by rapid burial and exhumation in the subduction zone. Serpentinite is a characteristic metamorphic rock type of the Franciscan Complex resulting from the metamorphosis of mantle rocks underlying oceanic crust. Intense shearing resulted in mélange, another characteristic part of the Franciscan Complex. Mélange consists of crushed soft rocks, such

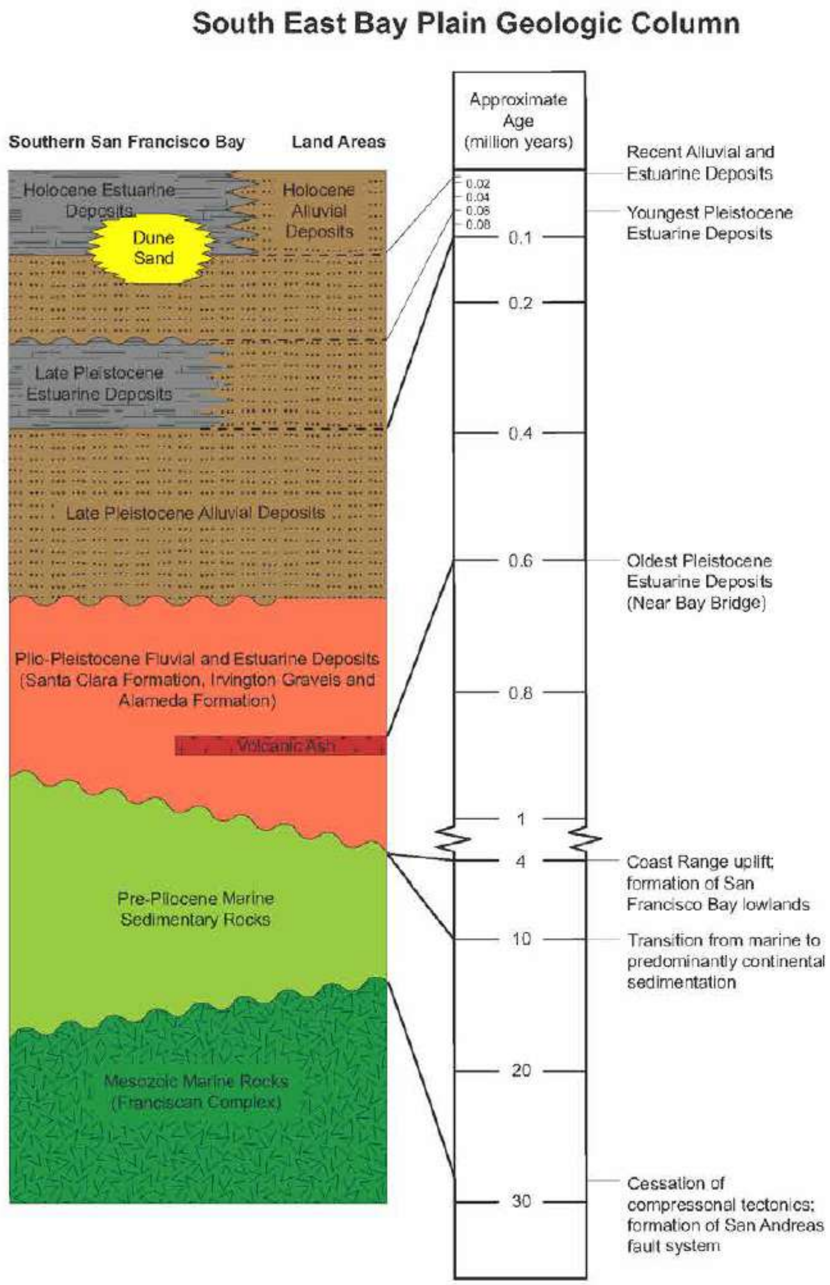


FIGURE 2-6

East Bay Municipal Utility District
South East Bay Plain
Characterization Report

SOUTH EAST BAY PLAIN GEOLOGIC COLUMN

WEST YOST ASSOCIATES Consulting Engineers as shale or serpentinite, containing floating blocks of other more resistant rock types ranging in size from a few square feet to a few square miles (Sloan, 2006). Up to nine different Franciscan Complex terrains have been identified in the San Francisco Bay area (Wahrhaftig and Sloan, 1989; Wakabayashi, 1992).

The Great Valley Sequence formed contemporaneously with the Franciscan Complex in a marine sedimentary basin, known as a forearc basin, located between the Franciscan Complex subduction zone and the Sierran volcanic arc forming the western edge of the continent. The Sierra volcanic arc was the result of melting of the subducted oceanic plate. Buoyant forces drove the melts upwards into the continental crust and to the land surface creating the predominant rock types of the Sierra Nevada. The Great Valley Sequence consists mostly of shale, sandstone and conglomerate.

The Coast Range ophiolite is located at the base of the Great Valley Sequence. The ophiolite is a sequence of dense, igneous rocks of the upper mantle and overlying oceanic crust, which was accreted to the North American continent at the subduction zone. The Mesozoic Coast Range fault system separates the Coast Range ophiolite and overlying Coast Range Sequence on the east from the Franciscan Complex on the west. The Coast Range fault may have been the original demarcation between the Mesozoic rocks undergoing subduction (Franciscan Complex) and those accumulating on the North American continent (Great Valley Sequence).

Figure 2-7 shows the extent of the Franciscan Complex and Great Valley Sequence outcrops mapped in the vicinity of the SEBP Basin. The Hayward fault separates the two units, with virtually all mapped occurrences of the Franciscan Complex occurring west of the Hayward fault. These outcrops consist of marine sedimentary rocks of the central terrain east of Oakland, and mélange and chert of the Marin Headlands terrain at Coyote Hills (Wahrhaftig and Sloan, 1989). Likewise, all mapped occurrences of the Great Valley Sequence are east of the Hayward fault. In the areas nearest the SEBP Basin, the Panoche Formation, a sequence of marine sandstones and shales, is the predominant rock type representing the Great Valley Sequence. The watersheds of San Leandro Creek and San Lorenzo Creek, the two main streams entering the SEBP Basin, are underlain by the Panoche Formation. Runoff characteristics of the streams may be influenced to some degree by the geochemical and hydraulic characteristics of the Panoche Formation.

The Hayward fault is closely associated with the Coast Range ophiolite near the SEBP Basin, which in this area includes the San Leandro Gabbro and other serpentinized rocks (Figure 2-7). Geophysical data show that the Hayward fault in the vicinity of the SEBP Basin is located on the west edge of a 75 to 80 degree easterly dipping mass of San Leandro Gabbro extending to a depth of approximately four to five miles. This indicates that the location of the Hayward fault in this area is controlled by the Mesozoic Coast Range fault because the Coast Range fault separates the Franciscan Complex from the Coast Range ophiolite and the overlying Great Valley Sequence (Ponce, et. al., 2003). This association may be significant to the SEBP Basin groundwater basin, because the mineral chromite is concentrated in ophiolite sequences, including serpentinized derivatives. Sediments eroded from these rocks, including chromite and other chromium compounds, could be present in the SEBP Basin aquifer sediments, because streams such as San Leandro and San Lorenzo Creeks cross the ophiolite belt. These streams contribute alluvial deposits that comprise the SEBP Basin groundwater basin.

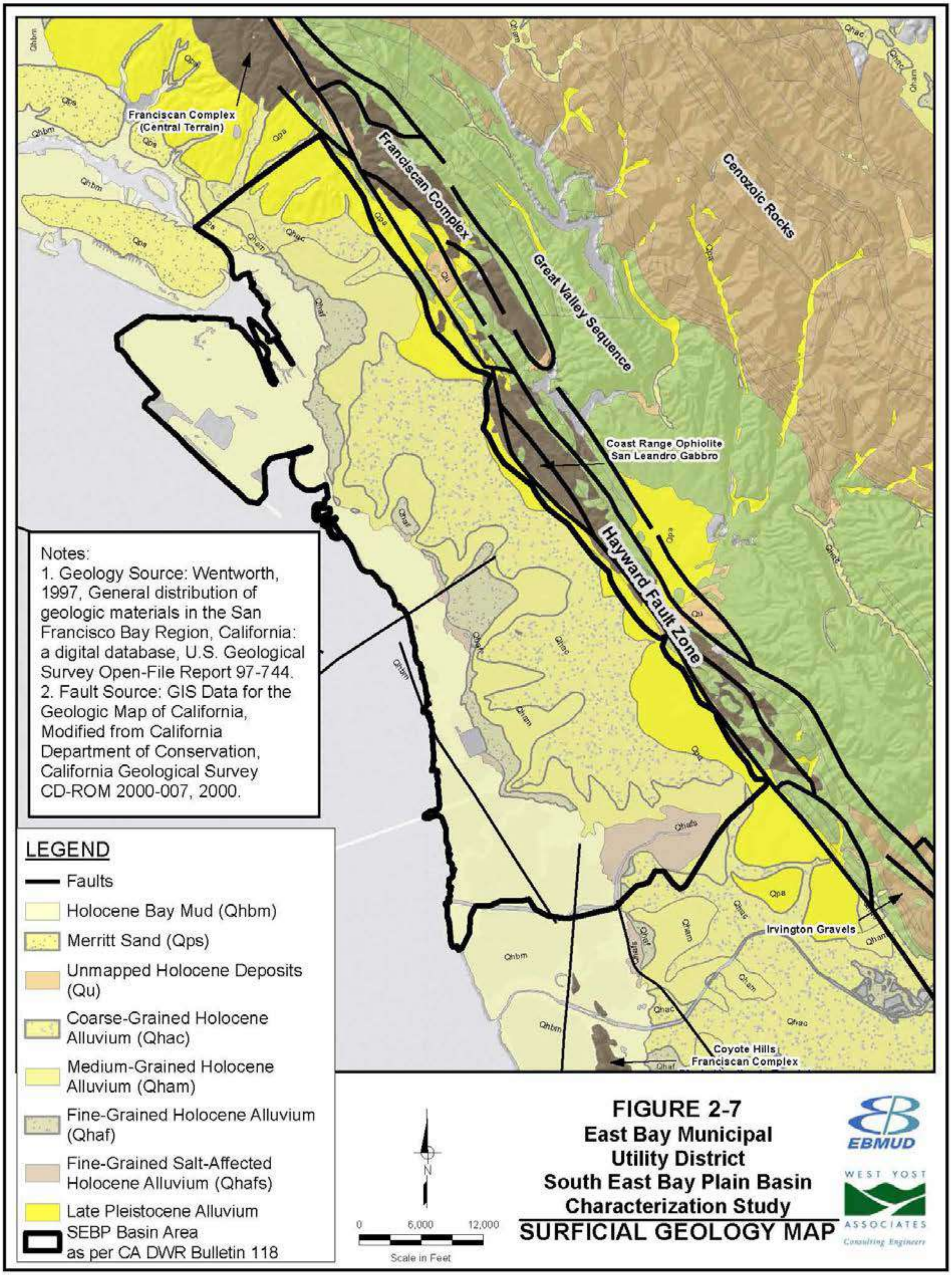


FIGURE 2-7
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
SURFICIAL GEOLOGY MAP

2.10.3 Mid-Cenozoic Rocks Formed Prior to the Existence of the San Francisco Bay Lowlands

Transverse movement on the San Andreas fault system began in Southern California approximately 28 million years ago (Wakabayashi, 1992). Transverse movement progressed northwestward over time, and the Hayward fault began to develop approximately 5 to 12 million years ago. Prior to development of the Hayward fault and extending to about 11 to 12 million years ago, marine conditions prevailed in the vicinity of the SEBP, resulting in the marine sedimentary rocks deposited on Mesozoic basement rocks. These mid-Cenozoic rocks are mapped in the East Bay hills (Figure 2-7). The oldest rocks of this period, typified by the Claremont Formation, were formed in deep water environments while younger rocks, typified by the Briones Formation, were formed in shallow marine environments, demonstrating a general progression from deep to shallow marine conditions. No rocks of this age are mapped near the SEBP Basin, but they are present in the subsurface beneath South San Francisco Bay adjacent to the SEBP Basin (Marlow et al, 1999).

Approximately 10 million years ago, continued uplift resulted in deposition of non-marine sedimentary rocks. Rocks of this age in the vicinity of the SEBP Basin are represented by the Orinda Formation, which outcrops to the northeast near the Caldecott Tunnel. Sediments in the Orinda Formation indicate deposition on an alluvial plain sloping to the east away from the present day San Francisco Bay Peninsula.

2.10.4 Plio-Pleistocene Fluvial Deposits Formed After Creation of the San Francisco Bay Lowlands

Formation of the San Francisco Bay lowlands began approximately four million years ago with uplift of the Coast Range. Fluvial deposits accumulated in localized depositional basins during this time are represented by the Livermore Gravels, the Santa Clara Formation, and in the vicinity of the SEBP Basin, the Irvington gravels (Figures 2-6 and 2-7). The Irvington gravels outcrop intermittently in a narrow band near the Hayward fault extending from the Irvington District of Fremont south towards Coyote Valley. These formations consist predominately of poorly consolidated conglomerate, sandstone, siltstone and clay. They range from approximately 0.5 to 4 million years in age (Page, 1992). They are folded and faulted, consistent with their genetic association with uplift of the Coast Ranges during the same period.

2.10.5 Late Pleistocene Through Holocene Alluvial, Estuarine and Eolian Deposits

Approximately 0.6 million years ago, the Sacramento-San Joaquin River flowed through the San Francisco Bay lowlands to the Pacific Ocean, and the first known estuarine deposits were formed (Trask and Rolston, 1951; Hall, 1966; Sarna-Wojcicki, 1976; Atwater, 1977; Sarna-Wojcicki et al., 1985; Lanphere, et al., 1999)[2].

[2] Data supporting these statements were first reported in an engineering geology study conducted to assess alternative crossings near the San Francisco Bay - Oakland Bay Bridge (Trask and Rolston, 1951). Trask and Rolston, page 1083 (1951) reported encountering a volcanic ash deposit at a depth of 280 feet in the deepest of the five members of the Alameda formation defined in their report. The boring was located on the west side of the Bay Bridge near San Francisco (Figure 4-3). Hall (1966) concluded, based on mineralogical analysis, that Great Valley drainage had been established by the time a similar tuff had been deposited in marine sandstone of the Merced Formation outcropping slightly south of San Francisco (Figure 4-2). Sarna-Wojcicki (1976) correlated the ash documented in Trask and Rolston (1951), and equivalent ashes in the Merced and Santa Clara Formations, with the Rockland Ash of the southern Cascade Range and documented an age of approximately one million years, based on the available radiometric age dating of the time. Atwater (1977) apparently interpreted the deepest member of Trask and Rolston's (1951) Alameda Formation, a stiff greenish gray clay, as an estuarine deposit, and concluded that it was the oldest identified estuarine deposit. Sarna-Wojcicki et al. (1985) documented a revised age of approximately 0.4 million years for the Rockland Ash based on fission track methods. Lanphere, et al. (1999) revised the age upwards to approximately 0.6 million years using radiometric methods.

Sediments deposited during this period consist of estuarine deposits within the footprint of the current San Francisco Bay, alluvial deposits on the flanks of the East Bay Hills extending into the area currently occupied by San Francisco Bay, and eolian (wind-born) sands (Figure 2-6).

The detailed stratigraphy of the deposits underlying the San Francisco Bay was developed by Trask and Rolston (1951). Figure 2-8 shows the five stratigraphic units identified by Trask and Rolston (1951) based on drilling near the Bay Bridge. These stratigraphic units from shallowest to deepest are:

- Bay Mud
- Merritt Sand
- Posey Formation
- San Antonio Formation
- Alameda Formation

As described in footnote 1, the lower part of the Alameda Formation contains the oldest known estuarine deposits identified in the bay. The Alameda Formation rests directly on Franciscan bedrock on the west edge of the bay, but the full thickness of the Alameda Formation was not penetrated by borings elsewhere (Figure 2-7). Researchers concluded that the Alameda Formation may overlay the Santa Clara Formation or the marine Merced Formation in other areas (see footnote 1). This conclusion is reasonable based on the geologic setting described above, noting especially that the ages of the Santa Clara Formation and other similar fluvial deposits, including the Irvington Gravels, predate and overlap the age of the lowest Alameda Formation estuarine deposits (Figure 2-6).

This page intentionally left blank.

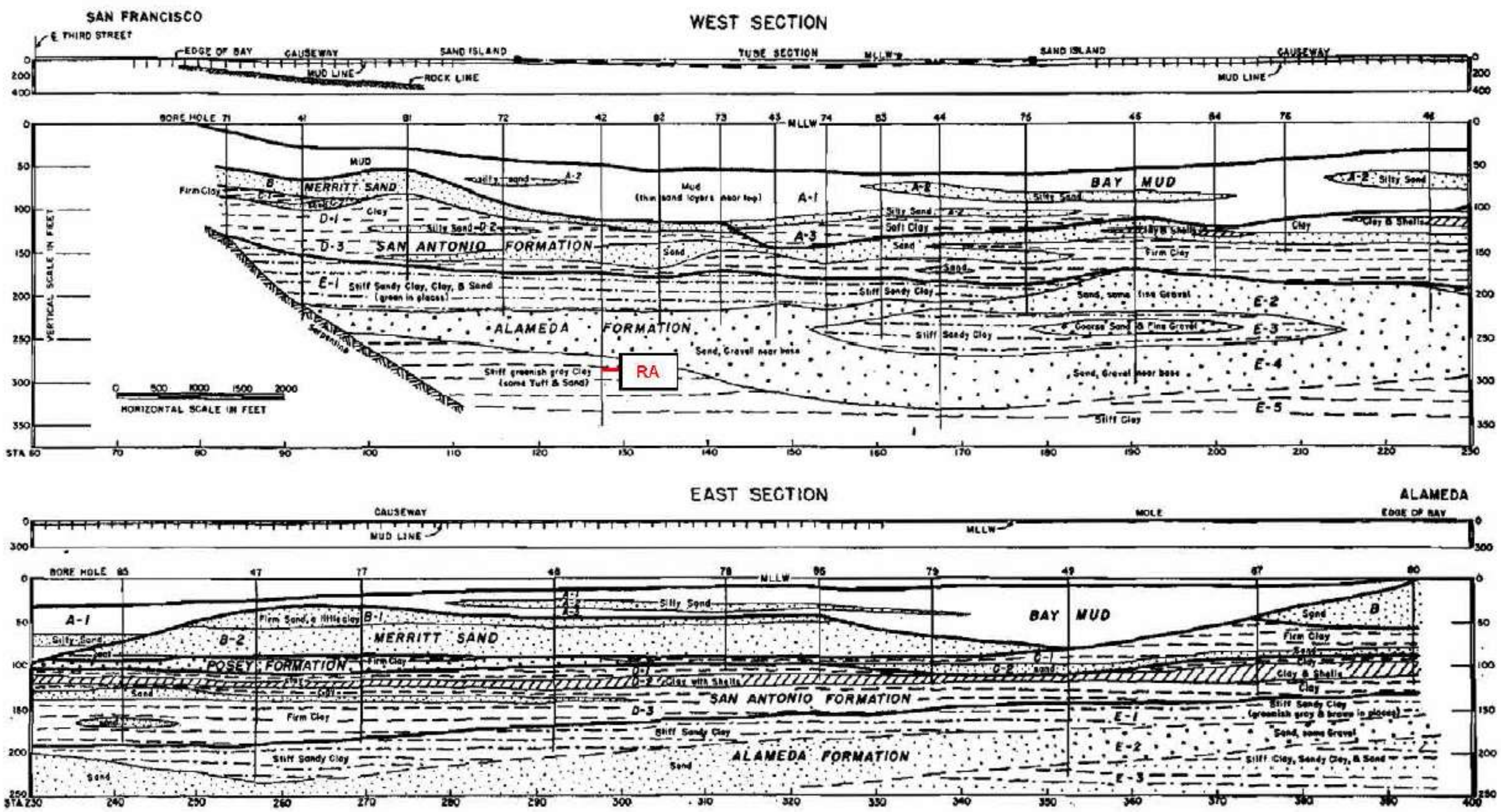


FIGURE 3.—PROFILE OF SEDIMENTS, SOUTHERN CROSSING, SAN FRANCISCO BAY

Note: RA designates location of volcanic ash encountered at a depth of approximately 280 feet. The volcanic ash is correlated with the Rockland Ash (Sarna - Wojcicki, 1976) and has a radiometric age of approximately 600,000 years (Lanphere, et al, 1999). Atwater (1976) interpreted the surrounding clay deposits as representing the oldest known estuarine sediments in San Francisco Bay.

FIGURE 2-8

East Bay Municipal Utility District
South East Bay Plain Basin Characterization Report

CROSS SECTION SHOWING OLDEST IDENTIFIED ESTUARINE DEPOSITS

This page intentionally left blank.

The stratigraphic relationship between the age equivalents of the lower Alameda Formation and adjacent strata is unclear farther south, including adjacent to the SEBP Basin. It is possible that estuarine deposits of lower Alameda Formation age extend as far south as the SEBP Basin, or interfinger with fluvial sediments, because the Santa Clara Formation contains a volcanic ash of the same age as the volcanic ash found in the lower Alameda Formation (Atwater, 1977). Mid-Cenozoic marine rocks formed prior to the existence of the San Francisco Bay lowlands underlie lower Alameda age sediments west of San Leandro (Marlow, 1999).

Atwater (1977) reinterpreted the stratigraphic sequence used by Trask and Rolston (1951) based on microfossil and other evidence collected in the south bay. Atwater (1977) concluded, based on the lack of marine microfossils and estuarine mollusks and other evidence, that the Posey Formation in the south bay is alluvial rather than estuarine. Atwater (1977) also identified the San Antonio Formation as the youngest Pleistocene age estuarine deposit in the south bay, with an age of 60,000 to 100,000 years. The late-Pleistocene estuarine sequence has approximately the same lateral extent as the recent estuarine deposits (Atwater 1977).

Based on this information, the depositional sequence in the south bay is from youngest to oldest (Figure 2-6):

- Estuarine deposits (Bay Mud, Holocene)
- Isolated eolian sand deposits (late-Pleistocene-Holocene)
- Alluvium (late-Pleistocene, <60,000 years)
- Estuarine deposits equivalent to the San Antonio Formation (late Pleistocene, approximately 60,000-100,000 years)
- Alluvium (late-Pleistocene, >100,000 years)
- Fluvial and estuarine deposits with undefined stratigraphic relationships. Plio-Pleistocene, 4 million to 500,000 years; oldest identified estuarine deposit (600,000 years) identified near Bay Bridge

In summary, the significance of this stratigraphic sequence is that thick alluvial and fluvial sequences capped by two major estuarine sequences underlie the bay to the west of the SEBP Basin. If sufficiently permeable, these alluvial and fluvial sequences should have hydraulic continuity with the alluvial and fluvial sediments underlying the SEBP Basin and form a continuous confined aquifer system extending to the west beneath the bay.

Holocene to late-Pleistocene alluvial deposits formed by streams emanating from the East Bay hills are the youngest deposits in the SEBP Basin (Figure 2-6 and 2-7). The SEBP Basin is underlain by the coalesced alluvial fans of San Leandro Creek, San Lorenzo Creek and Alameda Creek. Although Alameda Creek is located south of the SEBP Basin, it has significance to the SEBP Basin geology, because of its size and age. San Leandro Creek and San Lorenzo Creek have small drainages in comparison to Alameda Creek, and, of the three streams, only Alameda Creek is an antecedent stream, predating the most recent Coast Range uplift. Assuming a long-term slip rate of approximately one centimeter per year on the Hayward Fault over 500,000 years, sediments deposited by Alameda Creek west of the Hayward fault could have been displaced approximately three miles to the northwest. Coincidently, this is approximately the distance to the dissected older alluvial deposits mapped on the west side of the Hayward fault in the SEBP Basin (Figure 2-7). Extensive older alluvial deposit are also mapped in the SEBP Basin farther north in the Oakland area. Older alluvial deposits may have been formed by ancestral streams not associated with existing drainages, because the most recent episode of Coast Range uplift has been underway for approximately the past four million years. This uplift has significantly modified the topography of the area.

Regardless of the origin of the oldest late-Pleistocene alluvial deposits in the SEBP Basin, they are likely to be widespread in the subsurface based on the depositional environment. However, estimation of the spatial distribution of coarse versus fine textures in these deposits based on geologic principles is hindered by the unknown nature of ancestral streams forming the deposits and the unknown displacement history of the Hayward fault and possibly other faults hidden in the subsurface.

2.11 GEOLOGIC STRUCTURE

The San Francisco Bay lowlands occupy a down-dropped fault block between the Santa Cruz Mountains and the East Bay hills of the Diablo Range. The block is bounded by major, active strands of the San Andreas fault on the west and the Hayward fault on the east (Figure 2-7). The block is disrupted by other active and inactive faults as evidenced by the seismicity away from the active strands of the San Andreas and Hayward faults, and the bedrock relief, which locally brings Franciscan Complex rocks above the elevation of basin filling sediments.

A map of isostatic residual gravity contours of the SEBP Basin and vicinity is represented in Figure 2-9. Gravity data was evaluated to understand the shape of the bedrock surface underlying the more recent sedimentary deposits, including the freshwater aquifer. Isostatic residual gravity measurements have been corrected to compensate for lateral variation in the density or thickness of large crustal blocks. The SEBP Basin is situated on the eastern edge of one of two major areas of anomalously low gravity measurements (Roberts and Jachens, 1993). The other anomaly is located in eastern San Pablo Bay and is caused by a young pull-apart basin where the Hayward fault steps over to the east to the Rodgers Creek fault (Ponce et. al, 2003). The geologic structure causing the gravity anomaly at the SEBP Basin is an older structure known as the San Leandro synform (Marlow, et. al., 1995). This downward fold predates the most recent Coast Range uplift beginning about four million years ago and affects the Franciscan Complex and the overlying mid-Cenozoic marine rocks (Marlow, et. al., 1999).

A seismic cross section through the San Leandro synform from Marlow, et. al. (1999), is shown in Figure 2-10. The figure shows a basement of Franciscan Complex bounded by an upper erosional surface, which is overlain by dipping layers of mid-Cenozoic marine sediments on the eastern side of the section. The synform was probably formed when the originally flat-lying marine sediments were folded by the same forces that reinitiated Coast Range uplift beginning approximately four million years ago (Figure 2-6). The upper surface of the marine sediments is truncated by an erosional surface that extends across the Franciscan Complex on the western side of the section. The deposits above this surface are relatively undisturbed and consist of late Pliocene through recent fluvial, alluvial, estuarine and eolian deposits. Based on drill hole data presented in Figuers (1998), these sediments extend to depths below sea level of at least 665 feet. The two-way travel time to the base of the sediments is approximately 0.3 seconds. Assuming a seismic velocity of 5,000 feet per second, the depth to the base of the flat-lying sediments is approximately 750 feet.

The gravity anomaly associated with the San Leandro synform extends to the north beneath the SEBP Basin in the San Leandro/Oakland area, suggesting a lower density in, or greater depth to, the Franciscan Complex basement in this area.

A map of the earth's magnetic-field intensity contours based on aerial surveys (USGS, 1996) is represented in Figure 2-12. The map helps to delineate basement features with contrasting magnetic susceptibility, which may not be reflected in density contrasts. The map clearly shows the location of the Hayward fault and another northwest trending feature extending across the bay in the same area as the San Leandro synform. Based on additional processing and analysis of the magnetic data, Ponce et. al. (2003) concluded that the northwesterly trending feature is a serpentinite with a high magnetic susceptibility.

The work of Ponce, et. al. (2003) also shows small magnetic anomalies in the northern SEBP Basin, but the significance of these anomalies has not been assessed.

Figure 2-12 shows the location of a seismic reflection transect across the SEBP prepared by the USGS (Catchings, et. al., 2006). Seismic reflection methods detect sonic velocity differences in the subsurface, which are indicative of contrasting rock types. Seismic reflection data can also be used to differentiate aquifer and aquitard material in some depositional environments. Figure 2-13 is a southwest-northeast cross section based on the seismic reflection results, borehole data, and gravity measurements. Based on the results, depth to the Franciscan Complex ranges from approximately 1,000 feet near the northeastern end of the transect to approximately 3,000 feet on the southwestern end, where the transect crosses into the San Leandro synform (Figures 2-9 and 2-10). The USGS identified three aquifer zones along the transect based on the seismic reflection data and available borehole data. The approximate depths of the bottoms of these zones are as follows:

- Shallow Zone: 70 to 230 feet
- Intermediate Zone: 330 to 460 feet
- Deep Zone: 530 to 660 feet

The depth of each zone increases from northeast to southwest.

The USGS identified five zones in which the reflection data indicated faulting extending through the near surface sediments (Figure 2-13). The most significant of these zones is located approximately 7,000 feet east of the bay shore in the vicinity of Arroyo High School. These faults may be related to the Silver Creek fault, which is mapped at the surface in the Morgan Hill area and inferred to exist in the subsurface as far north as Fremont (Wagner, et. al., 1990). Groundwater flow may be impeded across the fault zones. Also, aquifer thickness and permeability (hydraulic conductivity) may be different on either side of a fault zone, because faulting could juxtapose geologic materials formed in different depositional settings.

This page intentionally left blank.

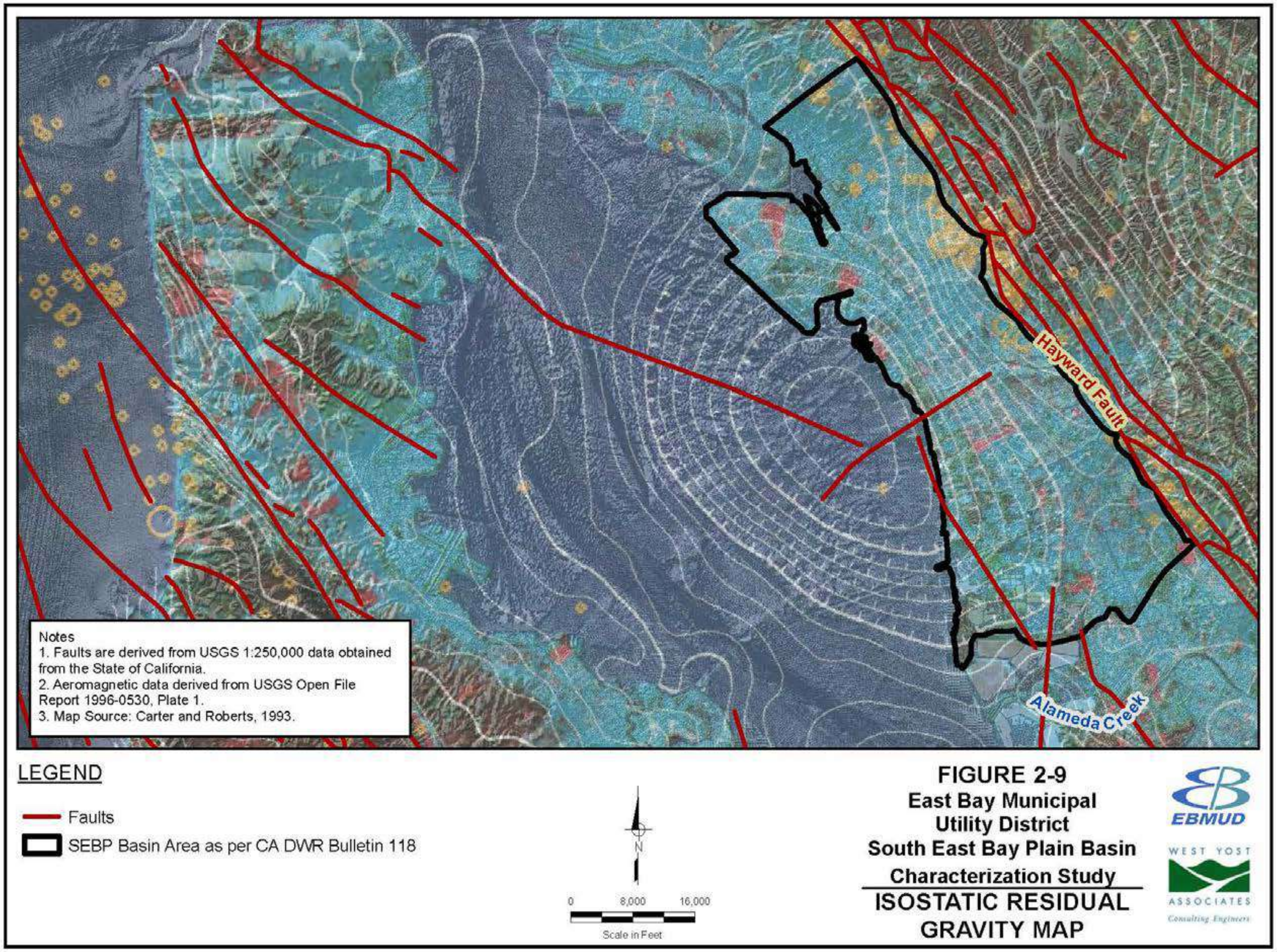
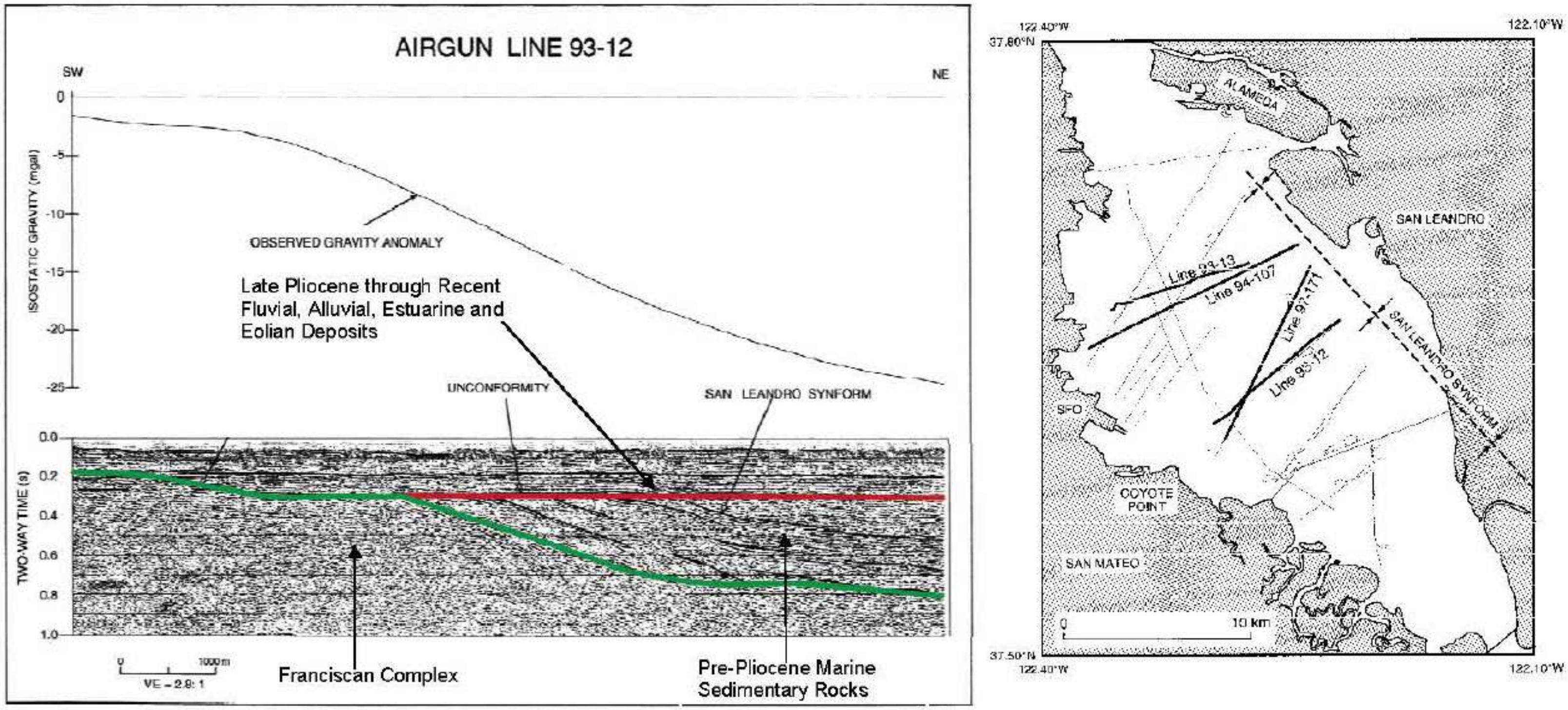


FIGURE 2-9
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
ISOSTATIC RESIDUAL GRAVITY MAP



Reference: Marlow, M.S., R.C. Jachens, P.E. Hart, P.R. Carlson, R.J. Anima, J.R. Child, 1999 Development of San Leandro Synform and Neotectonics of San Francisco Bay Block, California, Marine and Petroleum Geology, V. 16, PP 431-442.

FIGURE 2-10

East Bay Municipal Utility District

South East Bay Plain Basin Characterization Report

SAN LEANDRO SYNFORM

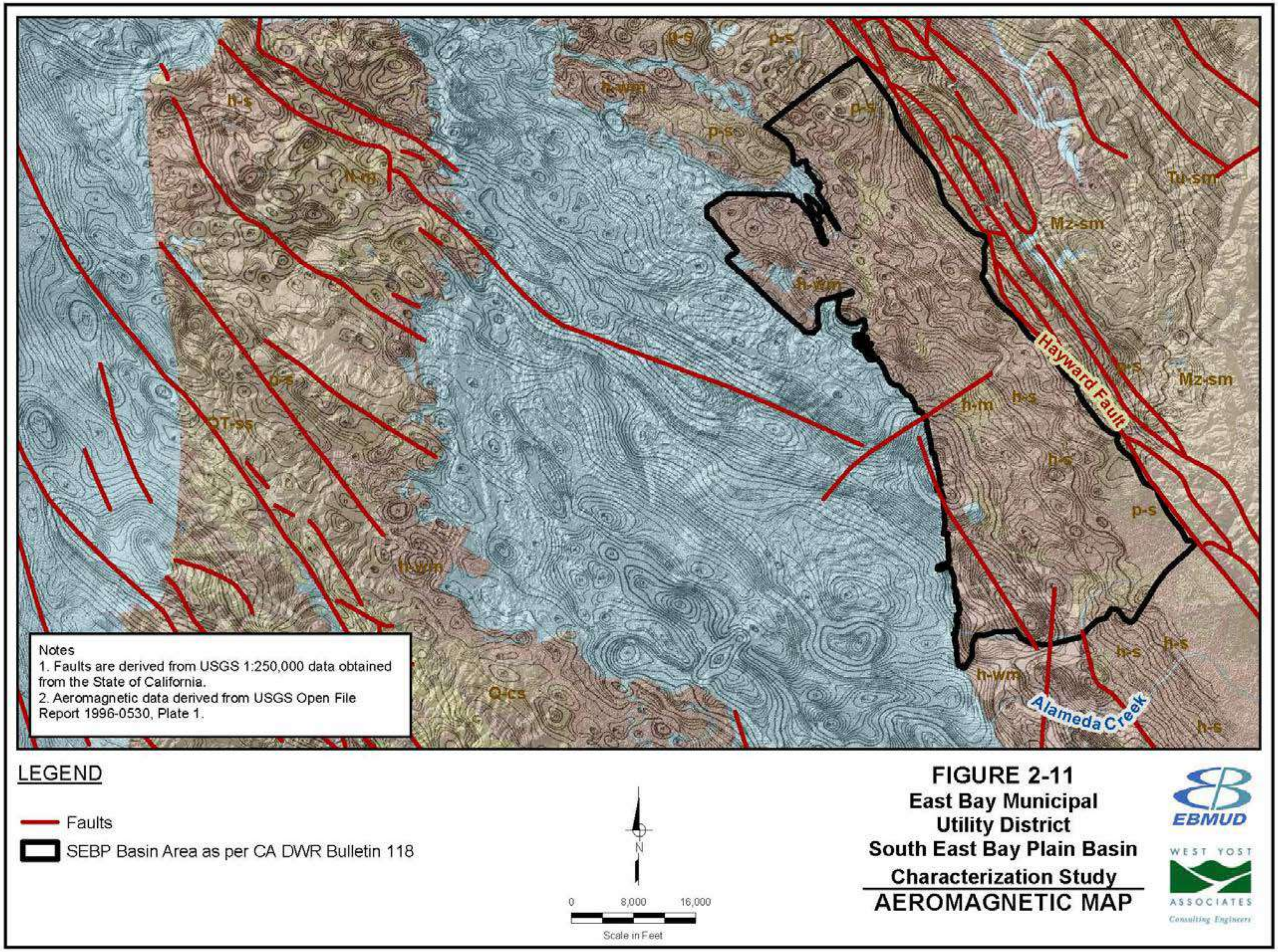


FIGURE 2-11
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
AEROMAGNETIC MAP

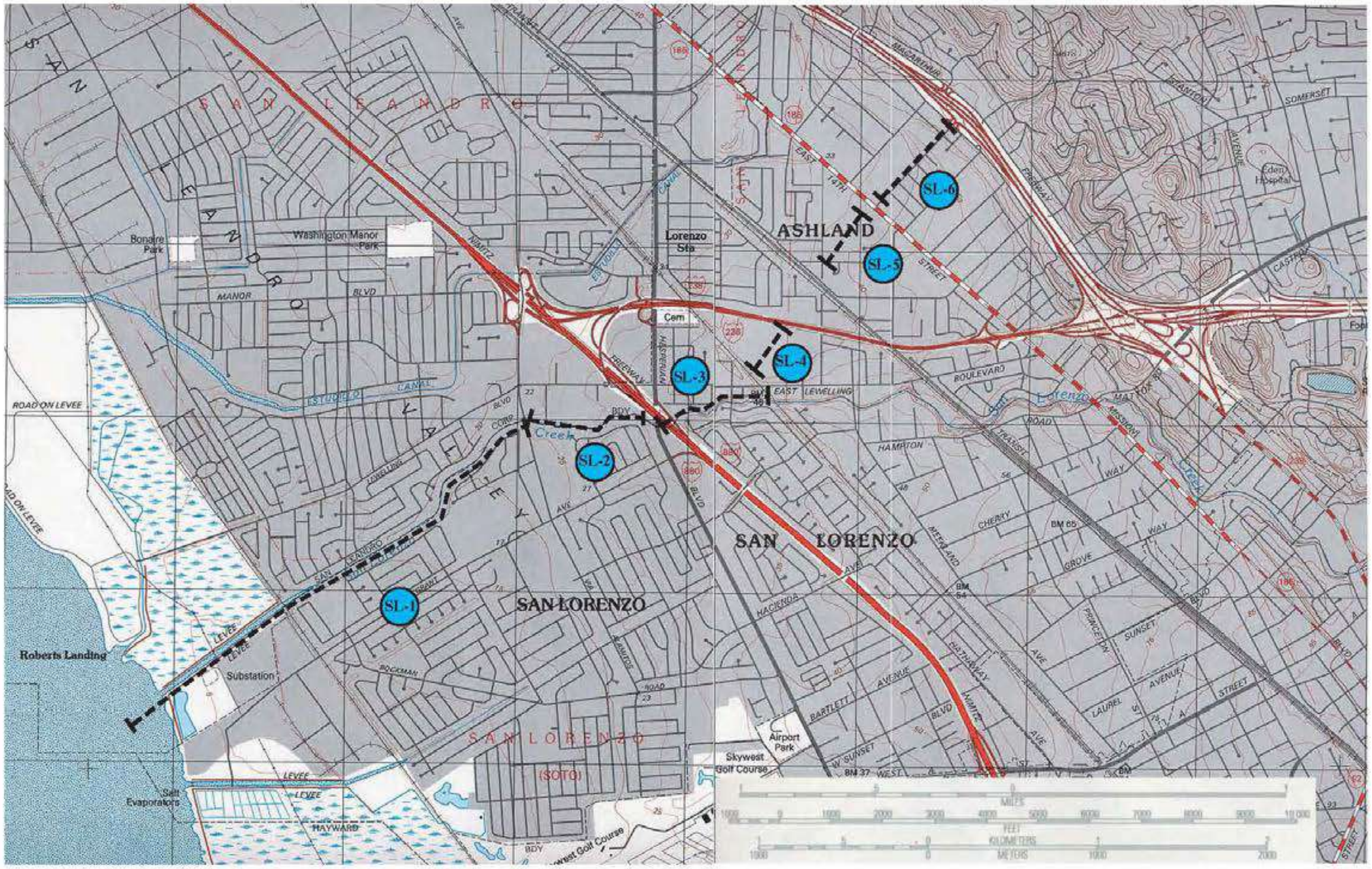
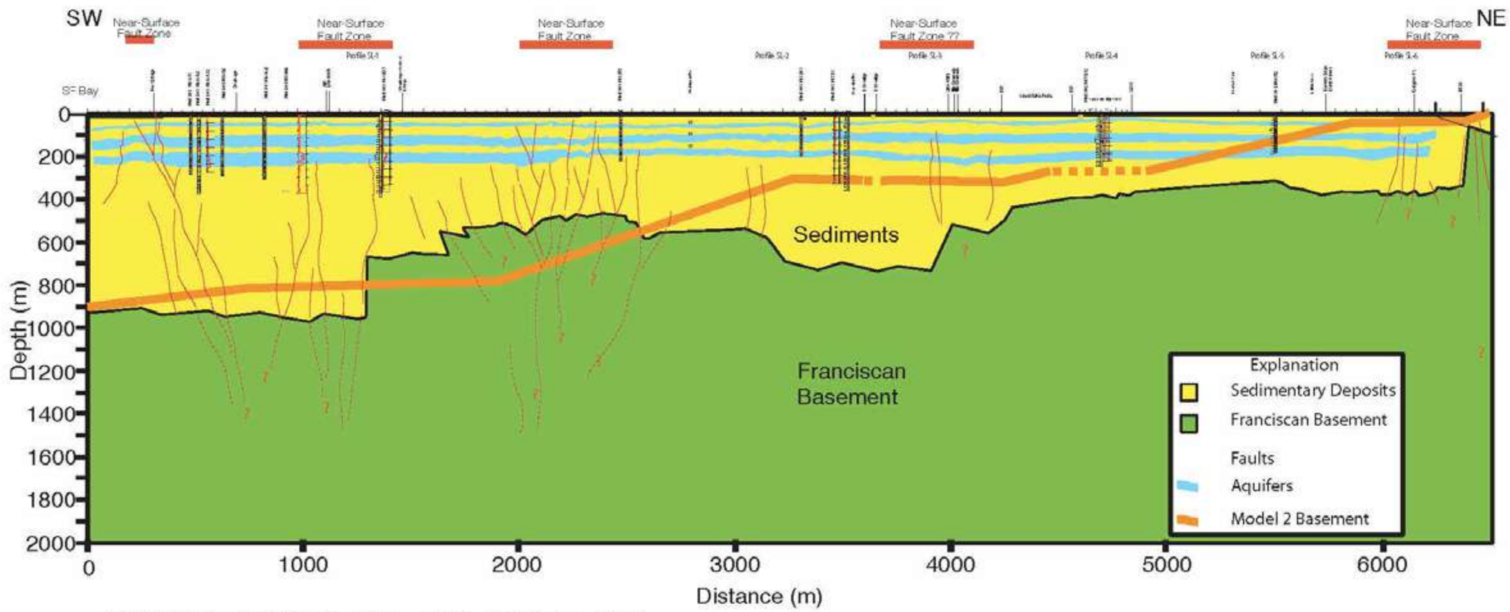


FIGURE 2-12

East Bay Municipal Utility District

South East Bay Plain Basin Characterization Report

EAST BAY PLAIN SEISMIC TRANSECT



Reference: Catchings, R.D., J.W. Borchers, M.R. Goldman, G. Gaudhok, D.A. Ponce, and C.E. Steedman, 2006, Subsurface Structure of the East Bay Plain Groundwater Basin: San Francisco Bay to Hayward Fault, Alameda County, California, USGC Open-File Report 2006-1084.

Figure 2-13

East Bay Municipal Utility District
South East Bay Plain Basin Characterization Report

INTERPRETIVE CROSS SECTION BASED ON SEISMIC, GRAVITY, AND WELL LOG DATA

This page intentionally left blank.

2.12 HYDROGEOLOGIC UNITS

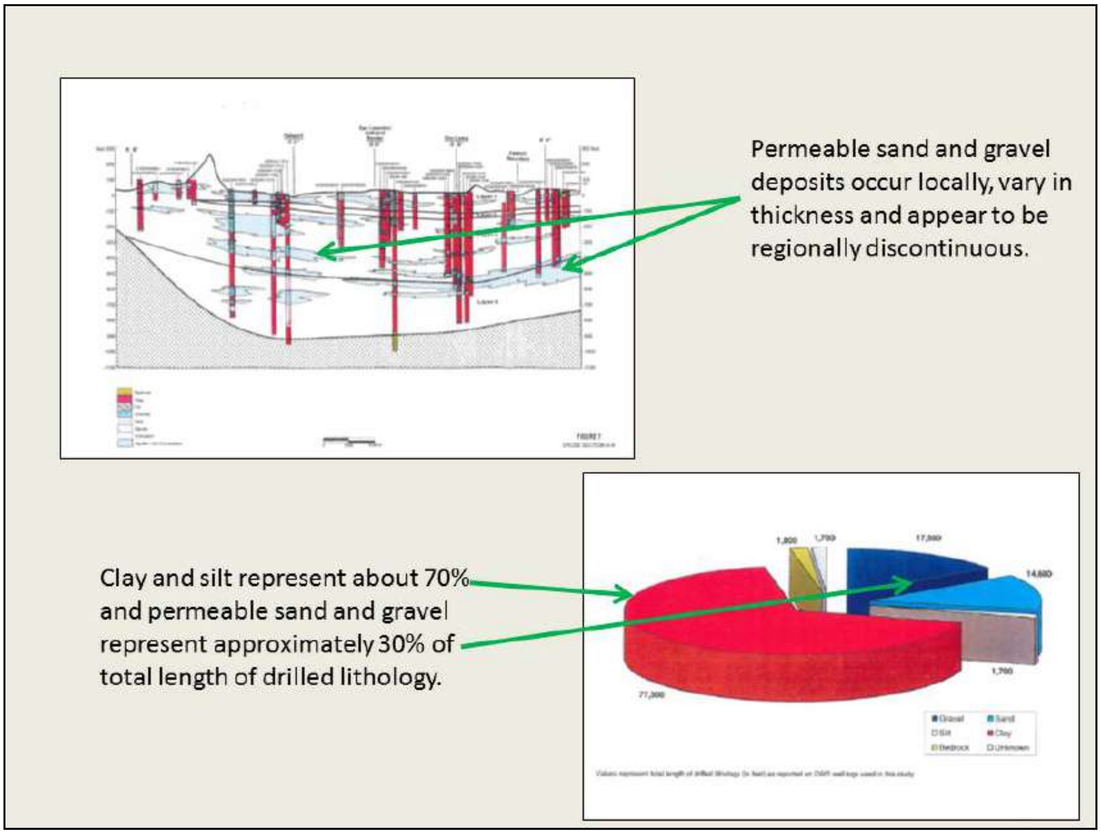
This section describes the hydrogeologic units that comprise the freshwater aquifer system within the SEBP Basin. The discussion provides:

- Rationale for defining the SEBP Basin hydrogeologic units and their relationship to hydrogeologic units in the NCGB
- Summary of the hydraulic properties of the Deep Aquifer Zone, as estimated during previous aquifer testing
- Documentation of groundwater levels, quality and groundwater recharge and discharge areas

Numerous groundwater studies have described the hydrogeology of the SEBP Basin. The objective of this study is to build on previous work and to integrate additional information to better characterize the Deep Aquifer Zone. Information in this section describes the methodology used to incorporate new subsurface information into existing geologic cross sections developed through a joint effort by Alameda County Water District, the City of Hayward, and EBMUD (LSCE, 2003). This updated subsurface information was used along with long-term aquifer tests performed on wells screened in the Deep Aquifer Zone (LSCE, 2003 and Fugro, 2011) to develop updated conceptual and numerical groundwater models.

As introduced in the previous chapter, Holocene to late-Pleistocene alluvial sediments comprise the important groundwater producing zones in the aquifer system of the SEBP Basin. Fine grained sections of the alluvial sequences create confining conditions between the more permeable groundwater producing zones. Near the bay, fine grained estuarine deposits also create confined conditions. It is likely that groundwater producing zones have continuity with similar alluvial and fluvial zones beneath the bay, which are likewise confined by fine-grained estuarine sequences. Franciscan Complex rocks form the base of the aquifer system and limit its easterly extent. As shown in the figure below, in many areas the permeable zones are most likely to be discontinuous, and it is difficult to correlate sand and gravel layers over great distances between wells.

Distribution and Occurrence of Permeable Material Comprising the SEBP Aquifers (Modified from CH2MHill, 2000)



The available geophysical logs, borehole data, and cross sections show that the depth intervals typically containing relatively high percentages of permeable sediments can be grouped into three hydrogeologic units as follows:

- Shallow Aquifer Zone: approximately 30 to 200 feet
- Intermediate Aquifer Zone: approximately 200 to 500 feet
- Deep Aquifer Zone: approximately 400 to 660+ feet

The Shallow Aquifer Zone is present throughout the study area, with permeable zones typically occurring at depths between 30 and 130 feet below land surface (CH2MHill Inc., 2000). The SEBP Basin Shallow Aquifer Zone exists in approximately the same range of depths as the NCGB's Newark and Centerville Aquifers. Groundwater in the Shallow Aquifer Zone is generally confined except near recharge areas along the mountain front. The Intermediate Aquifer Zone generally has discontinuous sand and gravel deposits that are difficult to correlate between wells. It occurs in approximately the same depth range as the NCGB's Fremont Aquifer. The Deep Aquifer Zone contains a significant permeable zone that appears to be continuous throughout the SEBP Basin, but at a greater depth than the NCGB Deep Aquifer. This permeable zone appears to be thickest and most continuous south of San Leandro (Maslonkowski, 1988) and thins, eventually disappearing, to the north (CH2MHill, Inc., 2000). In this area, aquifers are underlain by partly consolidated deposits (Marlow et. al., 1999) having low porosity and low permeability (Izbicki, 2003).

2.12.1 Development of Updated Hydrogeologic Cross Sections

The cross section analysis and update involved integrating and comparing information obtained from numerous sources using ArcHydro Groundwater[3] and other related GIS tools. The information evaluated included published geologic and geophysical cross sections, model surfaces, and hydrogeological and geophysical data. Published cross sections from four sources were reviewed and analyzed.

Figure 2-14 shows the locations and sources of the cross sections evaluated for this study. The first two groups of cross sections were developed by consulting firms Luhdorff & Scalmanini Consulting Engineers (LSCE, 2003) and CH2MHill (CH2MHill. 2000). The third and fourth sets of cross sections reviewed include those prepared by the USGS (Izbicki,2003; Catchings, 2006).

Figure 2-15 shows the locations of the three updated cross sections developed using Arc Hydro Groundwater and other related GIS tools. To fully utilize this existing work, all available cross sections were spatially referenced and new subsurface information was added using GIS tools. This allowed enhanced visual analysis of multiple sets of information in one common environment. The LSCE Cross Sections 1-2, 2-3, 3-4, and 4-9 coincide with the primary north-south cross section updated for this study and designated as Transect A-A' (Figure 2-15). Two east-west sections were developed. The location for B-B' coincides with the A-A' cross section transect provided in Izbicki, 2003. The location for C-C' is midway between Izbicki's B-B' transect (Izbicki, 2003) and the USGS cross section transects in their seismic refraction report (Catchings, 2006).

[3]Arc Hydro Groundwater is a geodatabase design for representing groundwater datasets within ArcGIS. The data models helps archive, display, and analyze multidimensional groundwater data, and includes several components to represent different types of datasets including representations of aquifers and wells/boreholes, 3D hydrogeologic models, temporal information, and data from simulation models (http://www.archydrogw.com/ahgw/Main_Page).

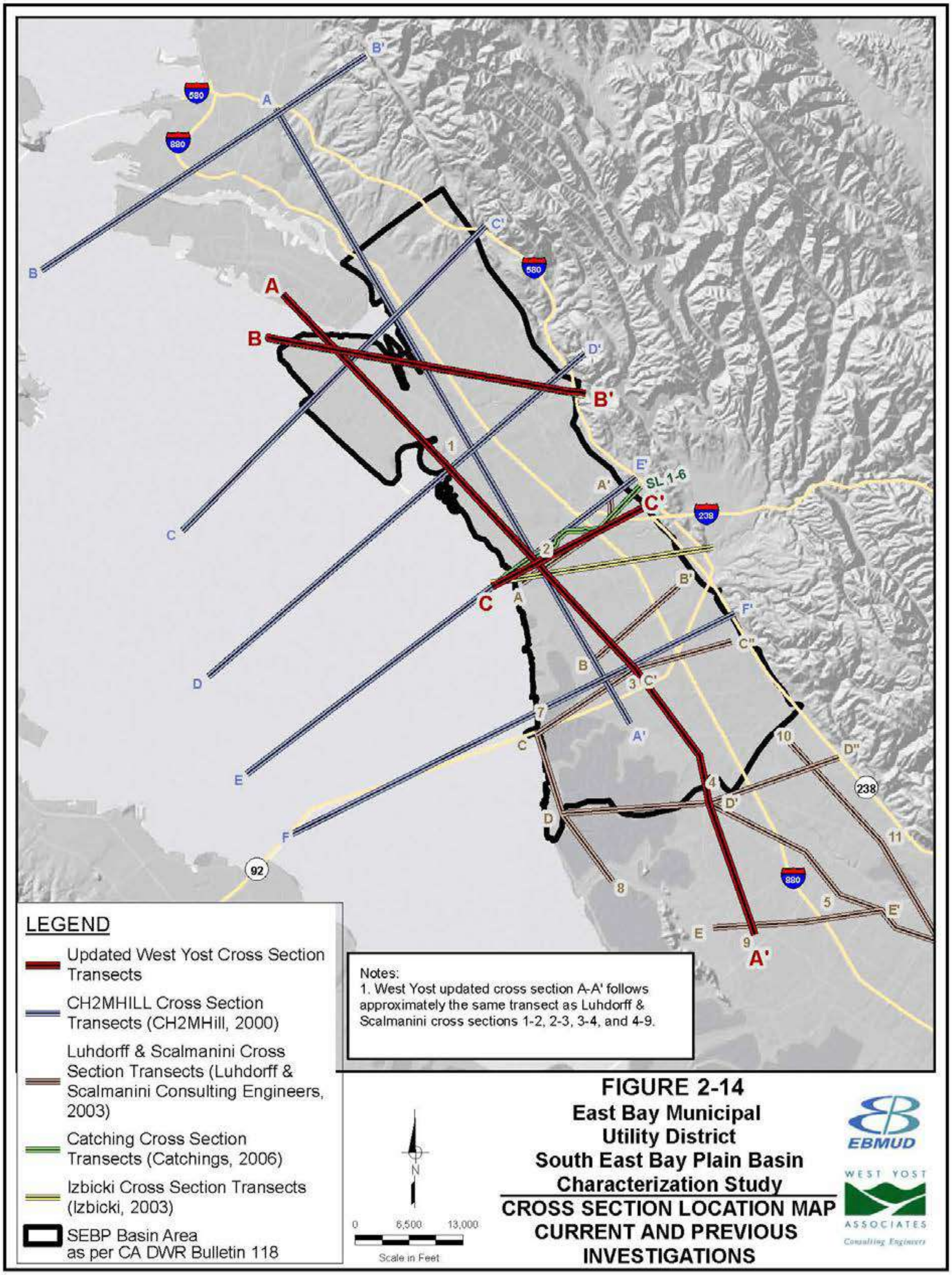


FIGURE 2-14
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
CROSS SECTION LOCATION MAP
CURRENT AND PREVIOUS INVESTIGATIONS

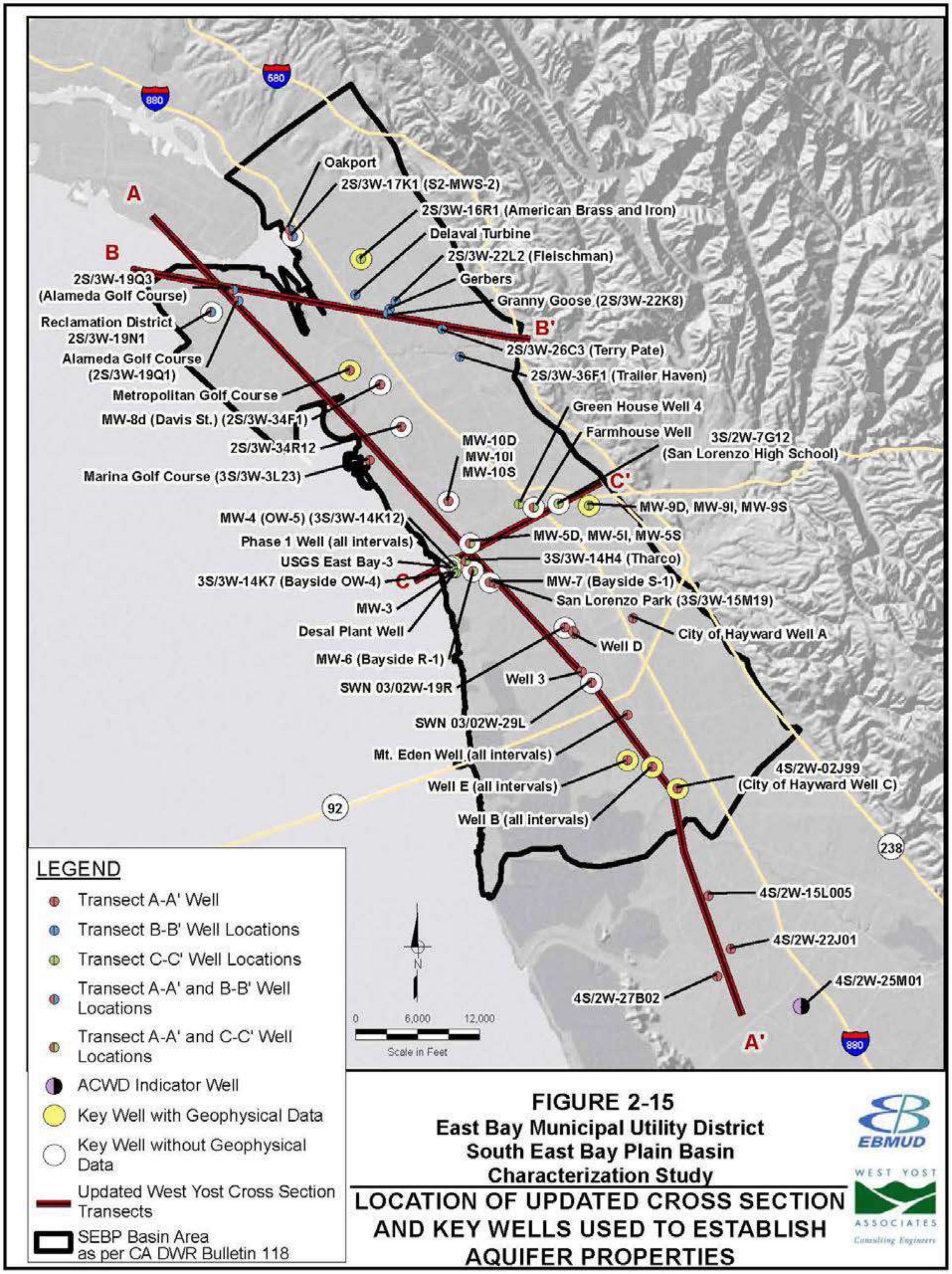


FIGURE 2-15
East Bay Municipal Utility District
South East Bay Plain Basin
Characterization Study

LOCATION OF UPDATED CROSS SECTION AND KEY WELLS USED TO ESTABLISH AQUIFER PROPERTIES

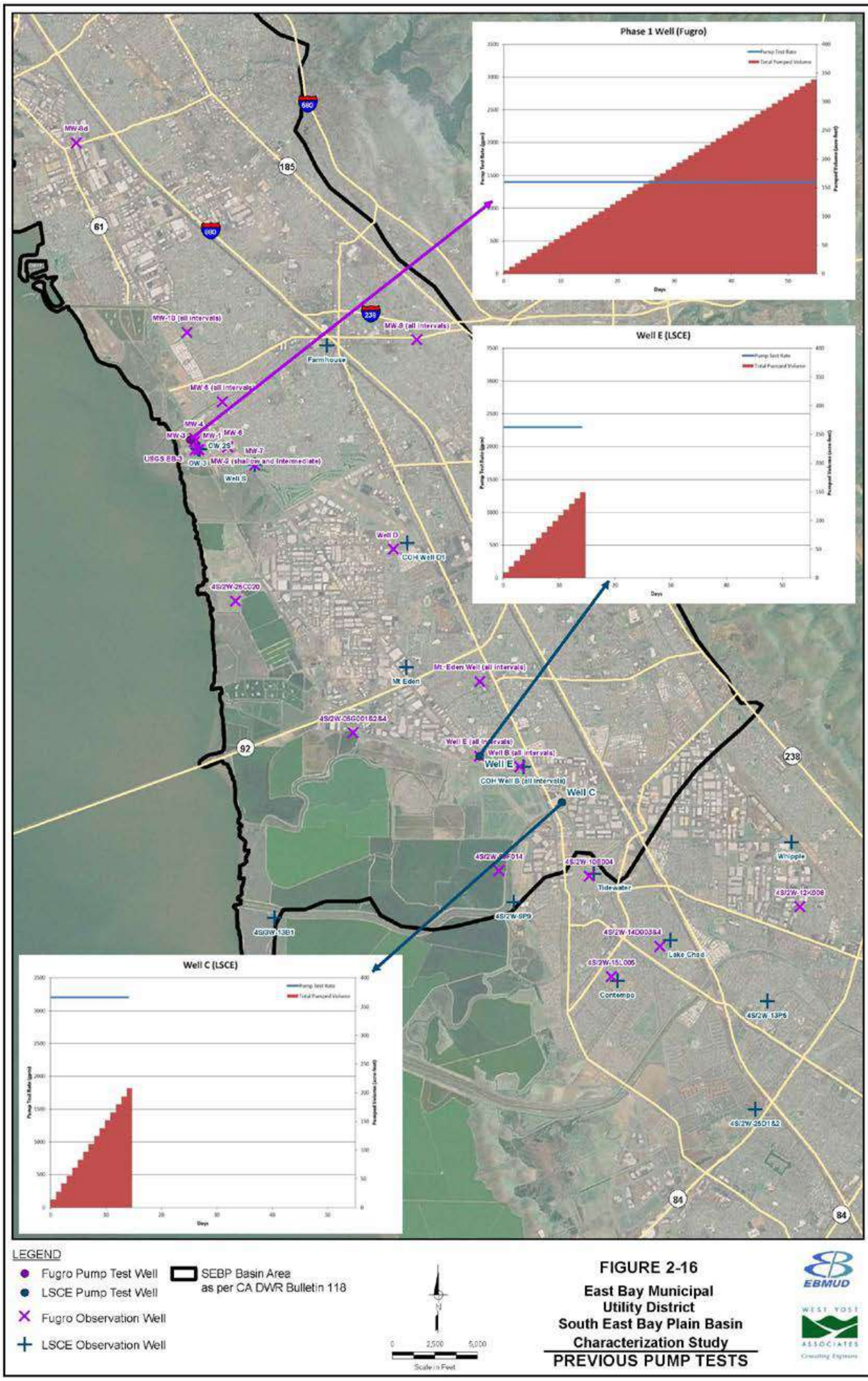
Subsurface Analyst was the primary tool used for cross section analysis. Each transect was georeferenced and digitized so the information was projected in real-world coordinates, within the Arc Hydro Groundwater geodatabase. The benefit of projecting the published literature in real-world coordinates is that it provided a mechanism to overlay external data, enhancing the ability to review existing model input parameters with the most updated hydrogeological information. A complete set of updated cross sections and detailed description of the Arc Hydro approach utilized for the updates is provided in Appendix D.

For this study, the SEBP Basin Deep Aquifer and the NCGB Deep Aquifer are depicted as separate hydrogeologic units. The distinction between the two hydrogeologic units is based largely on work conducted by LSCE (2003). LSCE (2003) documented ten permeable stratigraphic units within the SEBP Basin Deep Aquifer and transition zone based on geophysical and lithologic logs. These were labeled in increasing numerical sequence from deepest to shallowest. With notable exception, units 1 through 6.5 are all located in the SEBP Basin, based on hydraulic responses measured during aquifer testing (LSCE, 2003). Units 7 and 8 are located in the transition zone [LSCE (2003), Figures 2 through 5]. The exception to the previous statement is identified on LSCE (2003) Figure 4, which shows City of Hayward Well B penetrating, from shallowest to deepest, stratigraphic units 8, 7 and 4.5. Units 7 and 8 extend southward to at least City of Hayward Well C, but pinch out to the north in the SEBP Basin. On initial inspection, unit 4.5 appears to be a continuation of stratigraphic unit 4 of the SEBP Basin; however, LSCE (2003) appears to conceptualize units 4 and 4.5 as separate, with unit 4 falling in the SEBP Basin and unit 4.5 falling in the transition zone. This conceptualization is supported by the hydraulic responses to pumping in City of Hayward Wells C and E (LSCE, 2003). Pumping in City of Hayward Well C, which produces water from units 7 and 8 of the Niles Cone Basin, caused a response in City of Hayward Well B that matched the response for a single idealized confined aquifer as represented by the Theis (1935) equation, whereas wells, such as the Mount Eden well, in the SEBP Basin, exhibited hydraulic responses that did not match the idealized response.

Conversely, pumping in City of Hayward Well E, which produces water from units 4 and 6 of the SEBP Basin, caused a response in City of Hayward Well B that proved a hydraulic connection but did not match the response for a single idealized confined aquifer. Other Deep Aquifer wells clearly in the SEBP Basin, such as the Mount Eden well, exhibited hydraulic responses that matched the response for a single idealized confined aquifer.

2.12.2 Deep Aquifer Hydraulic Properties

Hydraulic properties have been estimated from a variety of aquifer tests conducted in the Deep Aquifer Zone as documented in LSCE (2003) and Fugro (2011). Based on review of these results, transmissivity of the Deep Aquifer Zone of the SEBP Basin ranges from approximately 33,000 gallons per day per foot (gpd/ft) to 141,000 gpd/ft and storativity ranges from 0.00005 to 0.005. Figure 2-16 shows the locations of the pumping and observations wells included in aquifer tests conducted by LSCE (2003) and Fugro (2011).



Phase 1 Well (Fugro)
Well E (LSCE)
Well C (LSCE)
Days
Farmhouse
Well S
Well D
COH Well D1
Mt Eden
Mt. Eden Well (all intervals)
Well E (all intervals)
Well B (all intervals)
Well E
COH Well B (all intervals)
Well C
Tidewater
Whipple
Lake Chad
Contempo
LEGEND
Fugro Pump Test Well
LSCE Pump Test Well
Fugro Observation Well
LSCE Observation Well
SEBP Basin Area
as per CA DWR Bulletin 118
0
2,500
5,000
Scale in Feet
FIGURE 2-16
East Bay Municipal
Utility District
South East Bay Plain Basin
Characterization Study
PREVIOUS PUMP TESTS

Generally, the highest transmissivity values were measured in the vicinity of the EBMUD Bayside Project Phase 1 well. In this area, transmissivity ranged from approximately 96,000 gpd/ft to 141,000 gpd/ft. Wells farther to the east tended to have lower transmissivity. For example, transmissivity measured during testing of the Farmhouse well ranged from 33,000 gpd/ft to 52,000 gpd/ft, and testing of City of Hayward Well D resulted in an estimated transmissivity of 30,000 gpd/ft. The lower values cited in these examples may be further evidence for a north-trending fault extending between the EBMUD Oro Loma ASR demonstration well and the Farmhouse well. Offset along the fault may have caused differences in the depositional setting between the east and west sides of the fault, resulting in lower permeability or reduced aquifer thickness to the east. Changes in permeability (hydraulic conductivity) and thickness were evaluated during model development.

The LSCE (2003) and Fugro (2011) transmissivity estimates for City of Hayward Well E differ significantly. The LSCE (2003) estimate of 12,000 gpd/ft was based on limited spatial information gained over a shorter duration of testing than the Fugro (2011) test, and, therefore, is considered to be subject to greater uncertainty. The LSCE (2003) estimate is based on pump testing and water level measurements in Well E. The test was conducted for a period of 14 days. Because the estimate was not based on any other observation wells, any uncertainties related to the site-specific conditions at Well E affected the estimate. These uncertainties include geologic variability, and the adequacy of the well design, construction and development for the site-specific conditions. The Fugro (2011) estimate was based on pumping in the Bayside well while using Well E as an observation well. The aquifer test was conducted for a much longer period of time (approximately 56 days), and included multiple observation wells. The Fugro (2011) transmissivity estimates for Well E ranged from 93,000 gpd/ft to 98,000 gpd/ft. These estimates were consistent with the estimates based on other observation wells in the area. Therefore, the Fugro (2011) transmissivity estimates appear to be characteristic of the SEBP Basin Deep Aquifer near City of Hayward Well E, and these values were used to develop the initial hydraulic property estimates in the updated numerical model.

2.13 GROUNDWATER ELEVATIONS AND FLOW

Figure 2-17 shows the groundwater elevation contours for the Shallow/Newark aquifer (EBMUD, 2006) and changes in groundwater levels over time for key wells throughout the study area (DWR Water Data Library). Groundwater generally flows from east to west across the study area from a high of 30 to 40 ft. msl to at or slightly below sea level in the western portion of the study area. Fewer data points are available to generate groundwater contour maps for wells screened entirely in the deep aquifer, but a review of available data suggests a pattern in the orientation of the potentiometric surface, again indicating that groundwater flows from east to west. However, groundwater elevation in the deep aquifer ranges from a high of 10 to 20 feet above msl in the east to a low of -20 feet above msl on the west (CH2MHill, 2000). Because the deeper aquifer zone has lower head than the shallow aquifer(s), the potential exists for downward movement of water through non-pumped wells, if hydraulic cross connectivity exists. The upper and lower systems may also be connected through corroded and failed casings of abandoned wells (Izbicki, 2003).

Changes in groundwater elevation data for key wells in the study are available online at DWR's water data library, http://www.water.ca.gov/waterdatalibrary/.

Changes in groundwater levels over time are shown for eight wells throughout the study area. Many of these hydrographs show a recovery in groundwater levels from a low of -120 to -60 ft. sml in the

1960s to very near sea level in the 1990s.Wells in the east central portion of the study area (0302W008, 0302W29F, 0302W36L) have had more stable groundwater levels ranging generally between 5 to 40 ft. msl over the period of record. DWR discontinued monitoring water levels in these wells 10 to 15 years ago, and more recent data were not available for this study. Also, DWR does not specify well depths for these key wells, so much of the variability seen between hydrographs may be the result of wells screened in different aquifer zones.

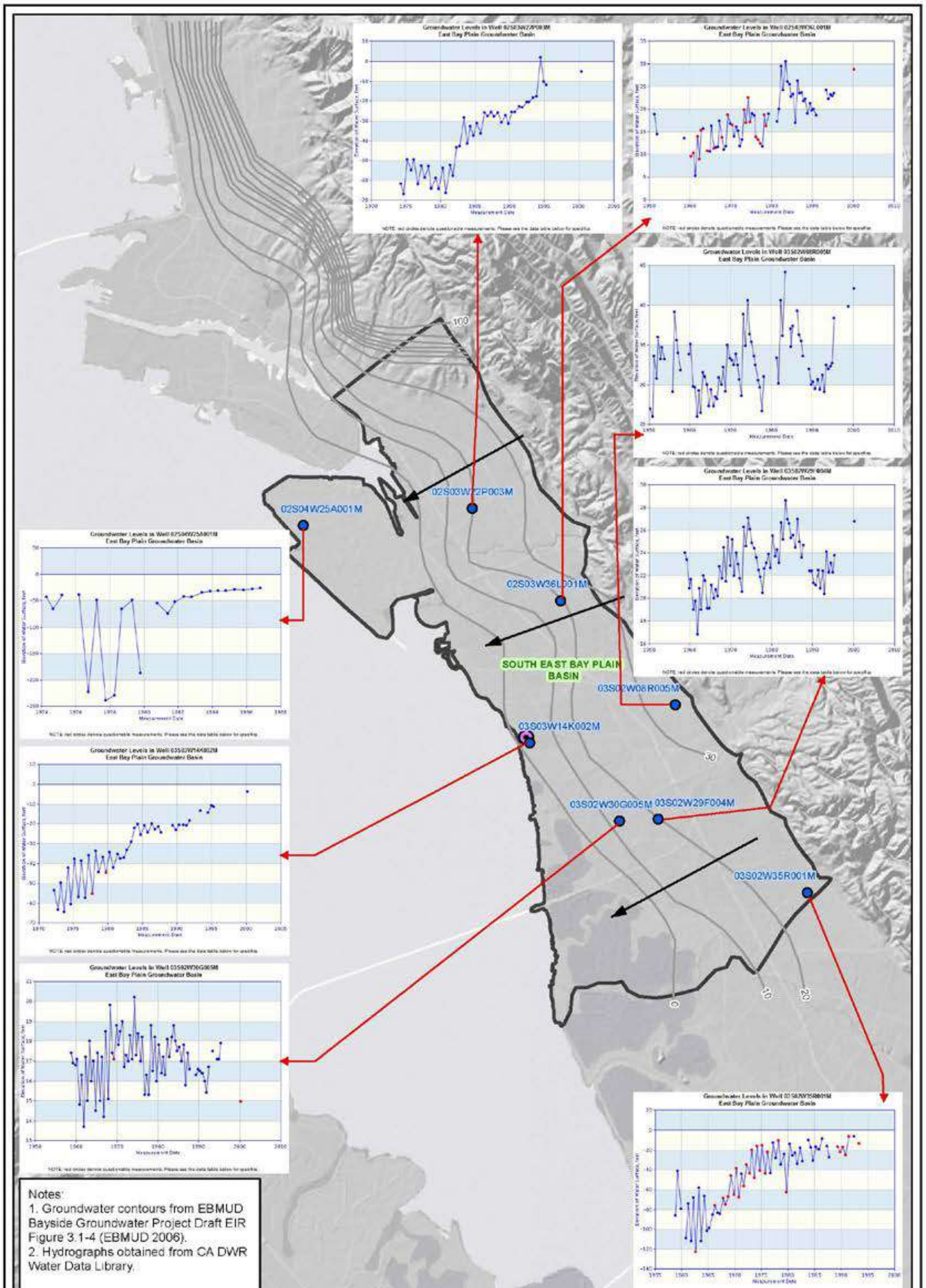


FIGURE 2-17

East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
GROUNDWATER ELEVATIONS

2.14 GROUNDWATER QUALITY

2.14.1 General Chemistry

Four key sources of information were utilized in the documentation of general groundwater quality provided in this section. These sources are listed and key findings summarized below.

2.14.2 Regional Hydrogeologic Investigation, South East Bay Plain (CH2MHill, 2000)

This report evaluated the distribution of water quality parameters as a function of depth within the SEBP Basin and makes the following observations:

- Compared to deeper levels, groundwater less than 200 ft below ground surface (ft. bgs) is characterized by relatively high concentrations of total dissolved solids (TDS), chloride, nitrate, and sulfate. Shallow wells exceed the MCL for nitrate (45 mg/L as NO_3), and the secondary MCL for TDS (1,000 mg/L), chloride (250 mg/L), sulfate (250 mg/L), iron (0.30 mg/L) and manganese (0.05 mg/l). Nitrate is elevated in large parts of the San Leandro/San Lorenzo area, probably due to septic tank effluent and past farming activities in these areas.
- Wells with total depths greater than 500 ft. bgs are located primarily in the southern portion of the study area. These wells have high iron and manganese levels that commonly exceed their secondary MCLs. Elevated TDS and chloride concentrations are probably related to the presence of shallow well screens in the deeper wells.

2.14.2.1 Hydrogeology and Geochemistry of Aquifer Underlying the San Lorenzo and San Leandro Areas of the East Bay Plain, USGS Water-Resource Investigation Report 02-4259 (Izbicki, 2003)

The purpose of this report was to evaluate hydrogeologic, and geochemical conditions in aquifers underlying the SEBP. Key findings relevant to the current study include the following:

- Water level measurements in observation wells and downward flow measured in selected wells during non-pumped conditions suggest that water may flow through wells from the upper aquifer system into the lower aquifer system during non-pumped conditions. Even given the potentially large number of abandoned wells in the study area, the total quantity of flow through abandoned wells and subsequent recharge to the lower/deep aquifer system is still considered small on a regional basis. However, where this water contains contaminants from overlying land uses, flow through abandoned wells may be a potential source of low-level contamination.
- Oxygen-18 and deuterium data do not indicate that leaking water supply pipes are a significant source of recharge. Rather, noble-gas data indicate recharge results from highly focused recharge processes from infiltration of winter stream flow and more diffuse recharge from infiltration of precipitation within the study area.
- Groundwater in the deep aquifer tends to be higher in sodium and potassium relative to calcium and magnesium, likely the result of precipitation of calicite and ion exchange reaction occurring as groundwater passes through the aquifer from recharge areas to the deeper aquifer system.
- Arsenic concentrations ranged from non-detect to 37 ppb, and the USEPA MCL for arsenic is 10 ppb.

- Carbon-14 ages (time since recharge) of deep groundwater ranged from 500 years before present (in water from wells near recharge areas along the mountain front) to 20,000 years before present (in partly consolidated deposits underlying the Oakport injection site).These data suggest that the lower aquifer system is isolated from surface sources of recharge.
- The presence of poor quality water at depth may limit extended pumping of deeper aquifer in excess of injection, especially near faults where partly consolidated deposits may have been uplifted and are adjacent to freshwater aquifers.

2.14.2.2 Characterization of Existing Groundwater Quality for Bayside Groundwater Project, (Fugro, 2007)

This report documents the sampling and analysis of groundwater collected from two deep monitoring wells in the vicinity of the Bayside Phase I well. In July of 2007, Fugro West Inc. collected samples from MW-5d and MW-6, both screened in the deep aquifer, and performed full Title 22 analysis. Table 2-1 is modified from this report, includes well construction information, and summarizes the analytical results. Both samples include a water quality that is sodium chloride to sodium bicarbonate in chemical character. The TDS concentrations in MW-5d and MW-6 were 460 and 420 mg/l. Selenium was present in only MW-5d at 0.39 ug/l.Arsenic was detected in MW-5d and MW-6 at very low concentrations of, 0.45 and 0.77 ug/l, respectively.

2.14.2.3 USGS National Water System Information Database

West Yost obtained water quality data maintained by the USGS and available at the National Water Information System (NWIS) Database, http://waterdata.usgs.gov/nwis. NWIS is a comprehensive database of historic and recent water quality data obtained from public agencies including local water purveyors, DWR, and federal agencies, such as the USGS. West Yost prepared summary tables of TDS, chloride, and nitrate included in Appendix E which presents analytical results sorted by well depth. These data are visually displayed on maps showing the aerial distribution of TDS (Figure 2-18), chloride (Figure 2-19), and nitrate (Figure 2-20). The highest concentrations of TDS and chloride occur in two shallow wells adjacent to the San Francisco Bay. Appendix E also provides a summary of median concentrations of TDS, Cl^-, and NO_3- with depth in SEBP Basin Study Area.

Table 2-1. Summary of Deep Aquifer Water Quality Data near the Bayside Project – South East Bay Plain Basin

Constituent	Basin Water Quality Objective	California MCL	Bayside Phase 1 Well[1]	MW-5D 4" diameter PVC, 500-630 fbgs	MW-6 4" diameter PVC, 480-650 fbgs
pH (pH units)	MCL	NA	7.7	7.47	7.57
Total dissolved solids	MCL	500 (2)	410	460	420
Residual Cl_2, Total	--	--	0.02	0.04	0.08
Fluoride	--	--	0.23	0.16	< 0.79
Chloride	MCL	250 (2)	71	93	57
Nitrite as N	MCL	1	< 0.004	< 0.035	< 0.35
Nitrate as N	MCL	10	< 0.003	< 0.085	< 0.085
Sulfate	MCL	250 (2)	48	51	52
Alkalinity, Total (as $CaCO_3$)	--	--	220	240	230
Ammonia: Total	--	--		< 0.30	< 0.30
Cyanide	MCL	0.15	NA	< 0.1	< 0.1
Hardness (as $CaCO_3$)	--	--	130	150	110
Total Coliform (CFU/100 ml)	--	--	0	110	< 1.0
Total Colony Count (CFU/100 ml)	--	--	74	ND	< 1.0
Heterotrophic Plate Count, Avg. (CFU/ml)	--	--	53	28	< 1.0
Haloacetic Acids and Dalapon (EPA 552.2)	MCL	0.06	ND	ND	ND
Volatile Organics (EPA 524.2)	--	--	ND	ND	ND
Semi-volatile Organics (EPA 525.2)	--	--	ND	ND	ND
Metals (EPA 200.7)	–				
Aluminum	MCL	0.2 (2)	< 0.055	< 0.050	< 0.050
Boron	--	--	0.37	0.467	0.436
Calcium	--	--	35.4	41	30
Iron	MCL	0.3 (2)	< 0.07	< 0.1	< 0.1
Potassium	--	--	1.78	2	1.6
Magnesium	--	--	9.98	10	7.9
Manganese	MCL	0.05 (2)	0.113	0.205	0.168
Sodium	--	--	123.2	130	110
Silicon	--	--	NA	12	11.4
Element Scan (EPA 200.8)	–				
Barium (EPA 200.8)				0.0970	0.0650
Chromium (EPA 200.8)				0.0010	0.0021
Copper (EPA 200.8)				<.0.0004	0.0082
Nickel (EPA 200.8)				<0.0002	0.0073
Zinc (EPA 200.8)				0.0012	<.0.0001
Arsenic				0.0005	0.0077
Selenium				0.0004	<0.0003

Note: 1 – Sample Date: November 18, 1998
2 – Secondary Maximum Contaminant Level
MCL – Maximum Contaminant Limit
NA – Not analyzed
ND – Analyte not detected at or above the CaDPH DLR (detection limit for reporting)

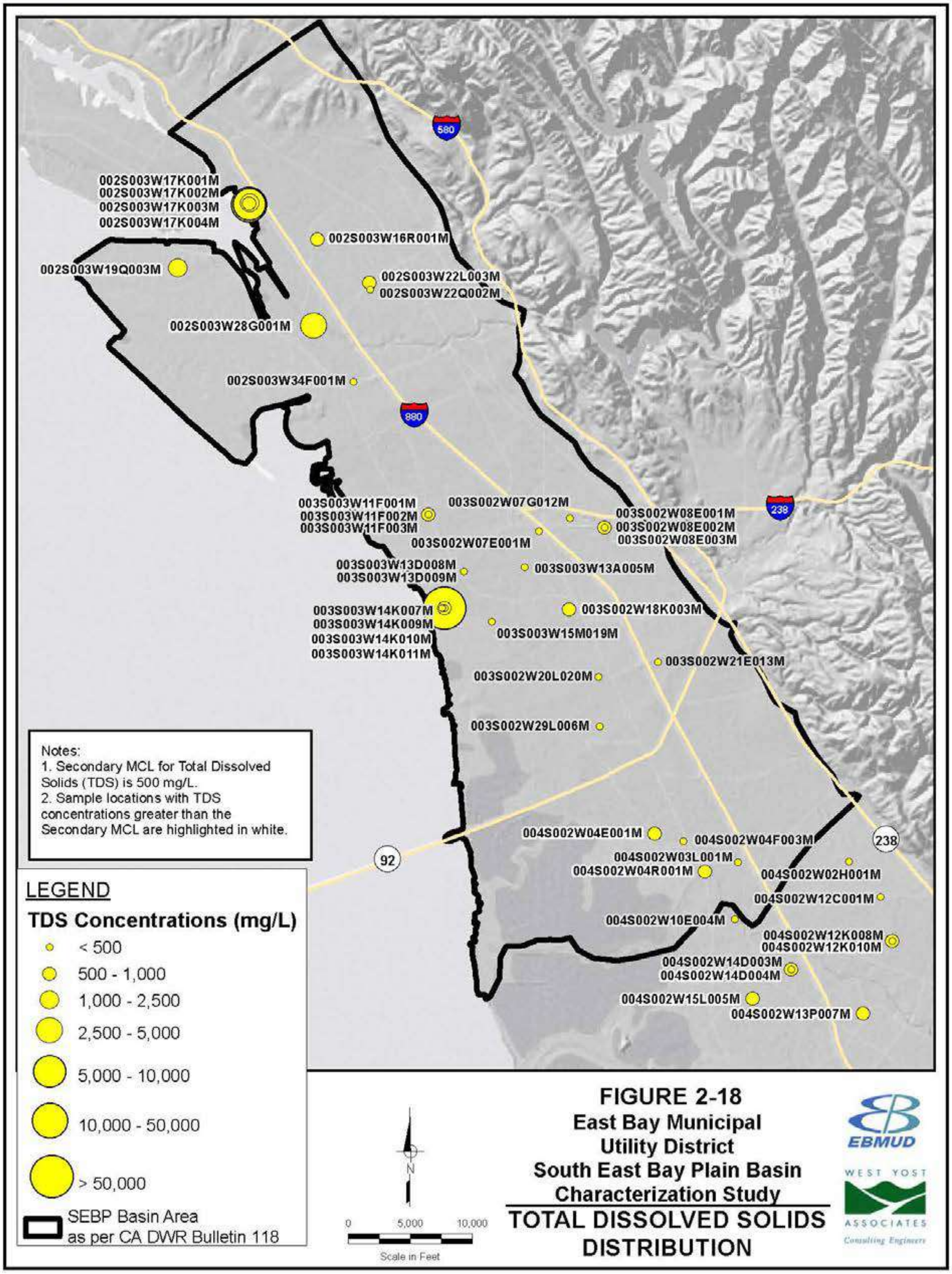


FIGURE 2-18
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
TOTAL DISSOLVED SOLIDS DISTRIBUTION

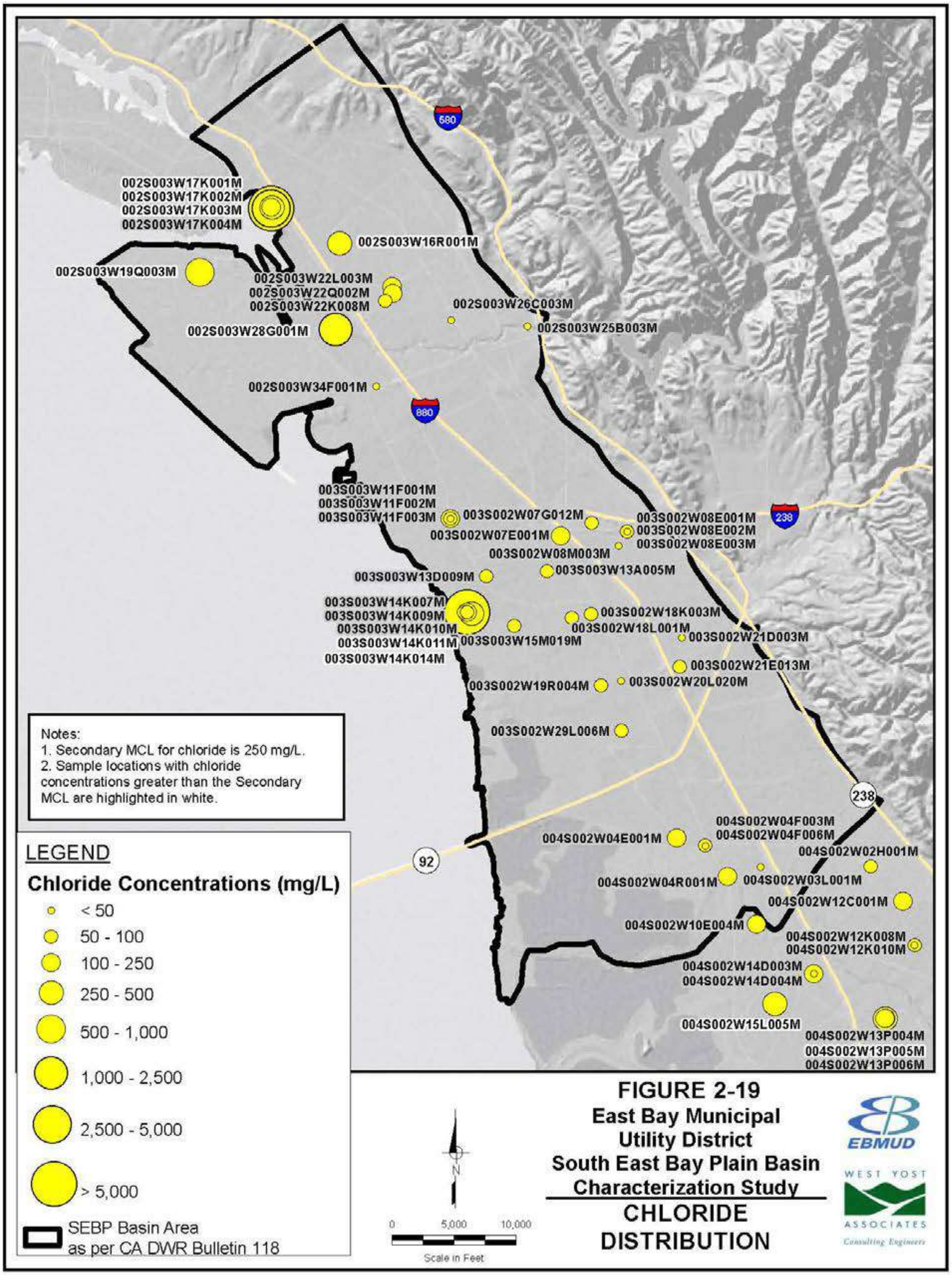
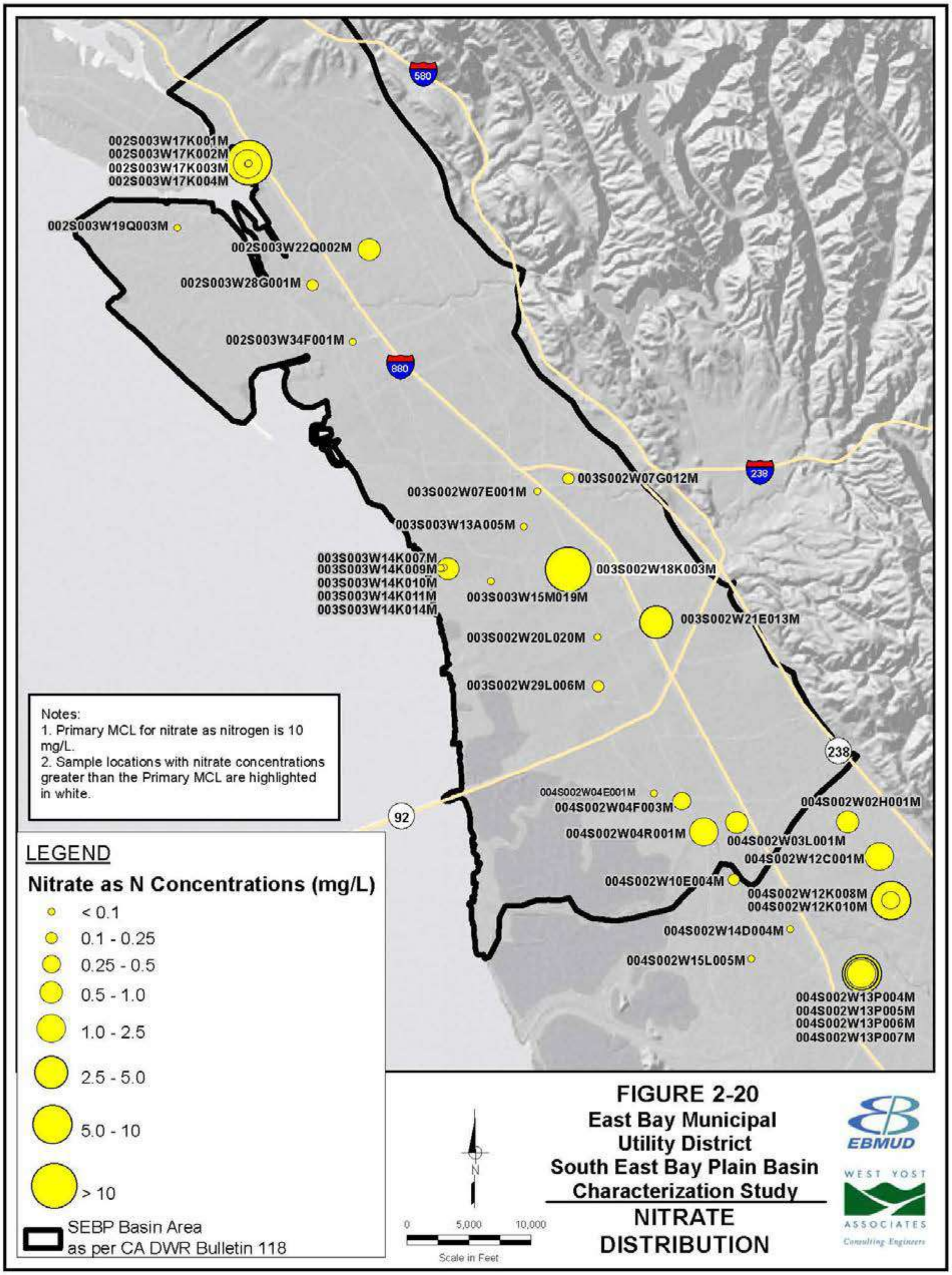


FIGURE 2-19
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
CHLORIDE DISTRIBUTION


002S003W17K001M
002S003W17K002M
002S003W17K003M
002S003W17K004M
002S003W19Q003M
002S003W22Q002M
002S003W28G001M
002S003W34F001M
580
880
238
003S002W07G012M
003S002W07E001M
003S003W13A005M
003S003W14K007M
003S003W14K009M
003S003W14K010M
003S003W14K011M
003S003W14K014M
003S003W15M019M
003S002W18K003M
003S002W21E013M
003S002W20L020M
003S002W29L006M
Notes:
1. Primary MCL for nitrate as nitrogen is 10 mg/L.
2. Sample locations with nitrate concentrations greater than the Primary MCL are highlighted in white.
238
92
004S002W04E001M
004S002W04F003M
004S002W02H001M
004S002W04R001M
004S002W03L001M
004S002W12C001M
004S002W10E004M
004S002W12K008M
004S002W12K010M
004S002W14D004M
004S002W15L005M
004S002W13P004M
004S002W13P005M
004S002W13P006M
004S002W13P007M
LEGEND
Nitrate as N Concentrations (mg/L)
< 0.1
0.1 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 2.5
2.5 - 5.0
5.0 - 10
> 10
SEBP Basin Area as per CA DWR Bulletin 118
N
0
5,000
10,000
Scale in Feet
FIGURE 2-20
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
NITRATE DISTRIBUTION
EBMUD
WEST YOST ASSOCIATES
Consulting Engineers

2.14.3 Threats to Water Quality

Locations of contaminant sites were obtained from the California State Water Resources Control Board (SWRCB). Sites were downloaded from SWRCB's Geotracker website on March 15, 2012 and represent all open-status contaminant sites determined by the SWRCB to potentially impact groundwater in the East Bay Plain and Niles Cone Basins. Within the SEBP Basin GMP area, there are 672 sites. Of those 672 sites, only 212 are still open cases in varying stages of remediation. Figure 2-21 shows the locations of these open cases in the SEBP Basin. Thirty-five have a status of "Verification Monitoring;" 138 have a status of "Site Assessment;" 18 have a status of "Remediation;" 14 have a status of "Inactive;" and 7 have a status of "Assessment & Interim Remedial Action."

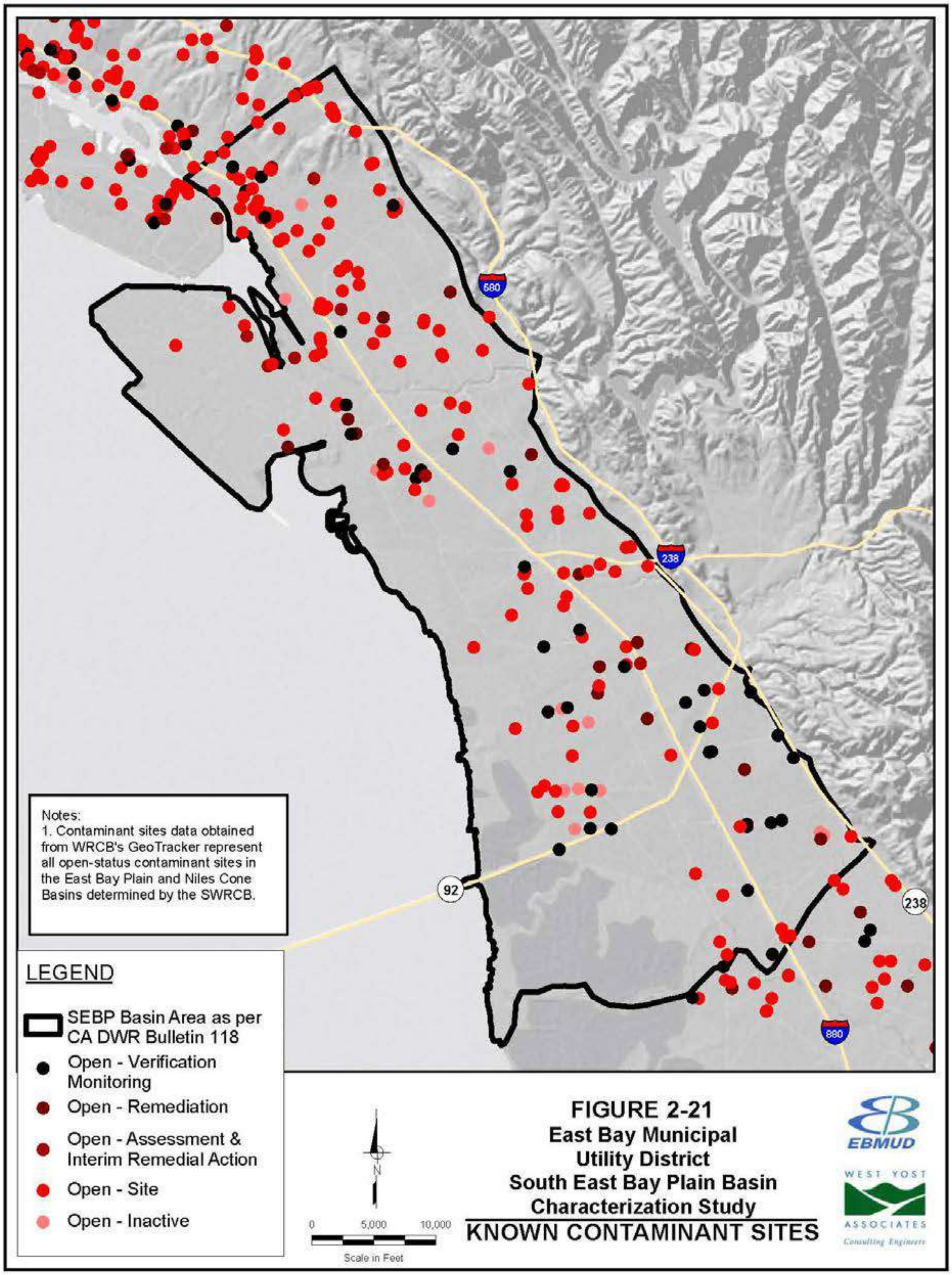
Figure 2-22 shows the locations of local and regional groundwater contaminant plumes in the SEBP Basin. This information was prepared in 1999 by the Bay Area RWQCB (RWQCB, 1999) and represents the most current published information on the nature and extent of these contaminant plumes based on verbal communications with RWQCB and DTSC staff during the course of this study. This map should be updated using more recent groundwater quality information.

2.15 GROUNDWATER RECHARGE

San Leandro and San Lorenzo Creeks were important areas of recharge to the SEBP Basin before development occurred in the area. The predevelopment estimate of stream recharge was about 3,500 acre-ft per year (afy) and infiltration of precipitation was about 800 afy (Muir 1996). As the result of urbanization, natural recharge may have decreased because of the channelization of streams and an increase in pavement covering permeable soil surfaces. Figure 2-23 shows the amount of recharge used for the groundwater model. The source of information for the estimated recharge amounts, by model subregions, was ACWD's NEBIGSM (WRIME, 2005). Factors considered in assigning recharge or net deep percolation as shown on Figure 2-23 include:

- Surface geology/soil type
- Land use
- Applied Water
- Precipitation
- Steamflow

Average annual recharge for the SEBP Basin study area is the sum of Hayward North, San Leandro and Oakland subregions, approximately 5,446 afy, which is about 33 percent of the 16,452-afy total for the entire IGSM model area.


580
238
92
238
880
Notes:
1. Contaminant sites data obtained from WRCB's GeoTracker represent all open-status contaminant sites in the East Bay Plain and Niles Cone Basins determined by the SWRCB.
LEGEND
SEBP Basin Area as per CA DWR Bulletin 118
Open - Verification Monitoring
Open - Remediation
Open - Assessment & Interim Remedial Action
Open - Site
Open - Inactive
N
0
5,000
10,000
Scale in Feet
FIGURE 2-21
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
KNOWN CONTAMINANT SITES
EBMUD
WEST YOST ASSOCIATES
Consulting Engineers

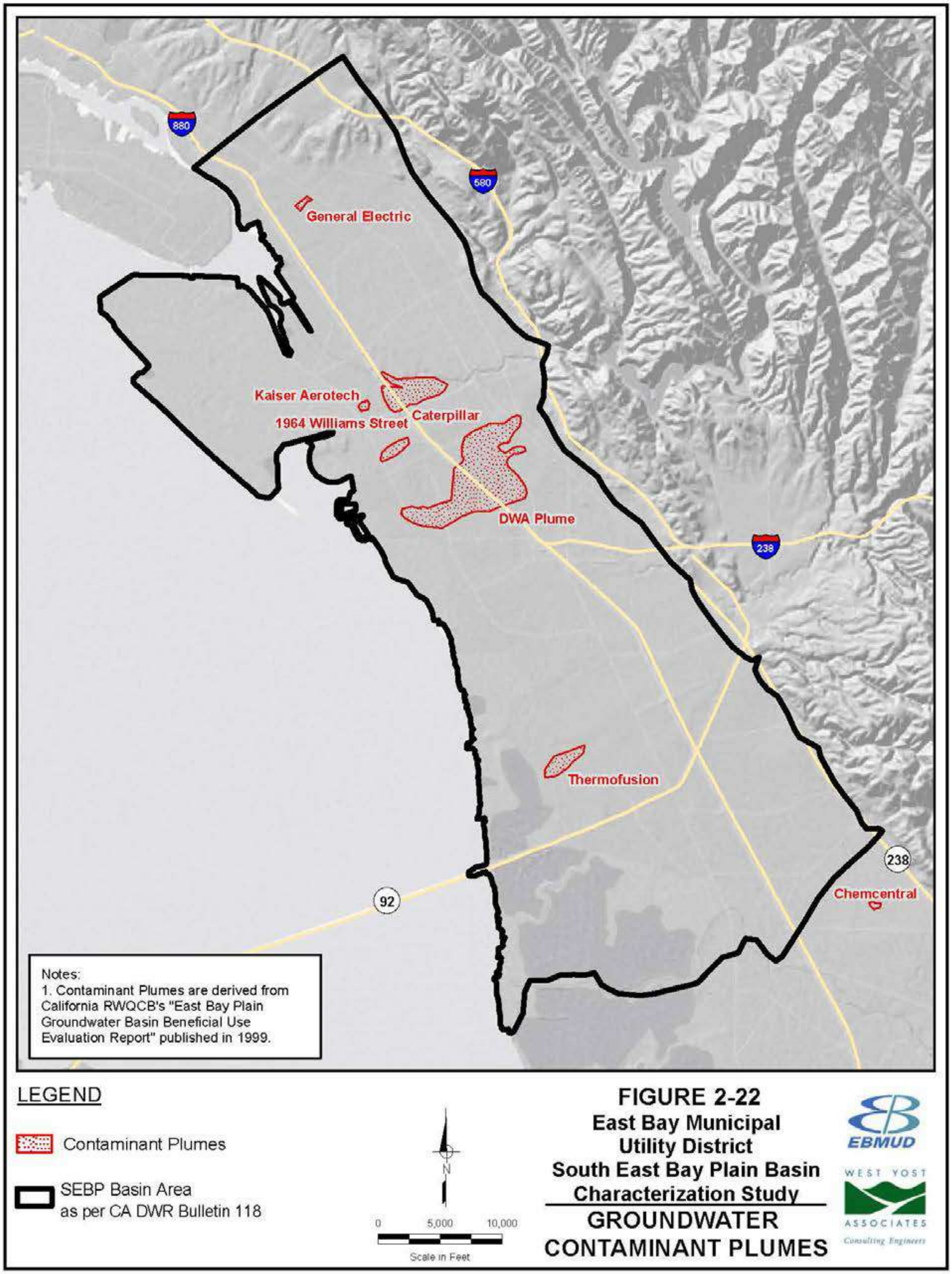
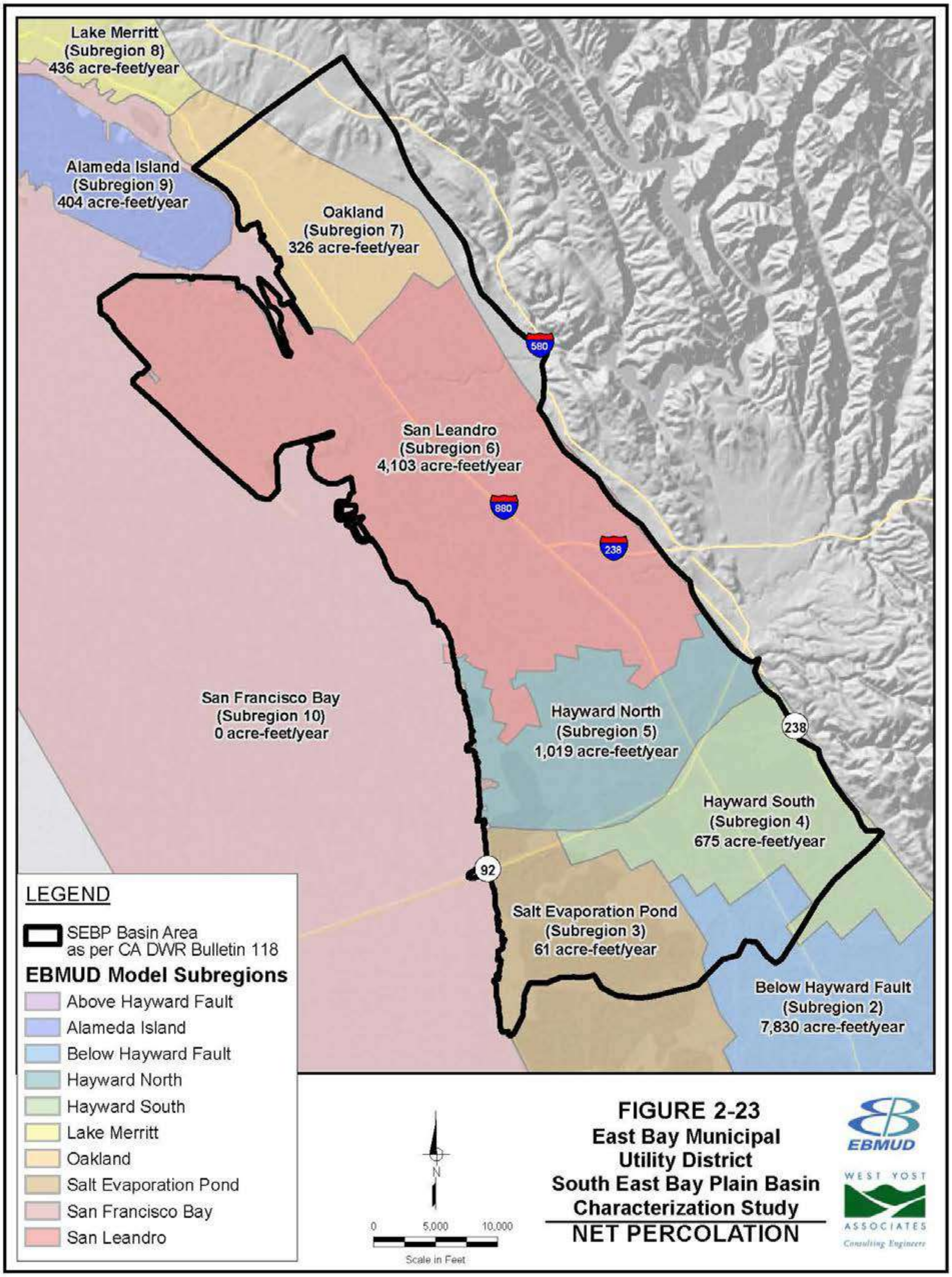
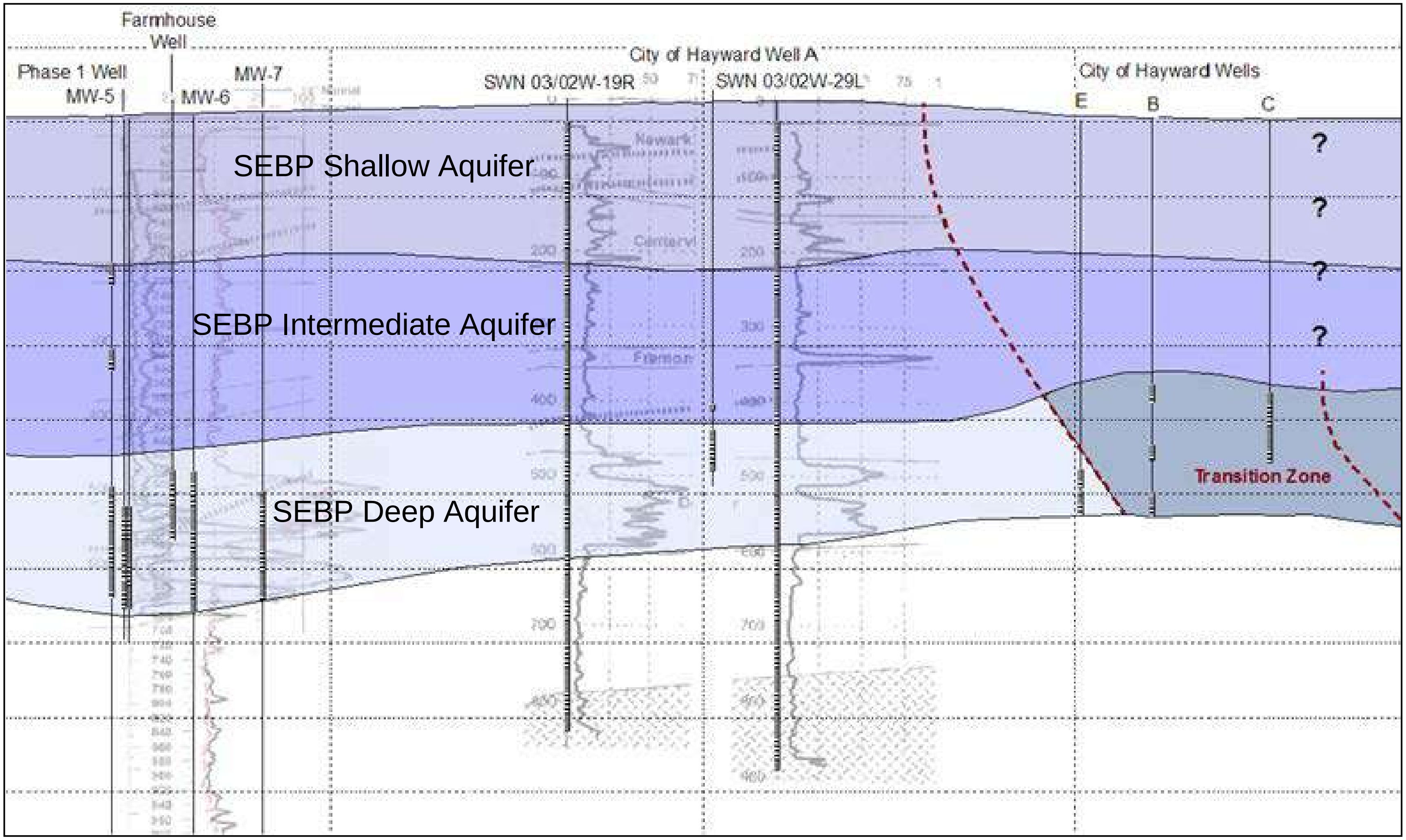


FIGURE 2-22
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
GROUNDWATER CONTAMINANT PLUMES


Lake Merritt
(Subregion 8)
436 acre-feet/year
Alameda Island
(Subregion 9)
404 acre-feet/year
Oakland
(Subregion 7)
326 acre-feet/year
San Leandro
(Subregion 6)
4,103 acre-feet/year
San Francisco Bay
(Subregion 10)
0 acre-feet/year
Hayward North
(Subregion 5)
1,019 acre-feet/year
Hayward South
(Subregion 4)
675 acre-feet/year
Salt Evaporation Pond
(Subregion 3)
61 acre-feet/year
Below Hayward Fault
(Subregion 2)
7,830 acre-feet/year
580
880
238
238
92
LEGEND
SEBP Basin Area as per CA DWR Bulletin 118
EBMUD Model Subregions
Above Hayward Fault
Alameda Island
Below Hayward Fault
Hayward North
Hayward South
Lake Merritt
Oakland
Salt Evaporation Pond
San Francisco Bay
San Leandro
N
0
5,000
10,000
Scale in Feet
FIGURE 2-23
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
NET PERCOLATION
EBMUD
WEST YOST ASSOCIATES
Consulting Engineers

Cross Section Update



2.16 GROUNDWATER RIGHTS IN CALIFORNIA[4]

Water is protected for the use and benefit of all Californians. Article 10, Section 2 of the California Constitution, enacted in 1928, prohibits the waste of water and requires reasonable use, reasonable method of use and reasonable method of diversion for all surface and groundwater rights. The doctrine of reasonable and beneficial use is the basic principle defining California water rights.

Surface Water Rights: The chronological order of surface water rights starts from pre-1848 "Pueblo Rights", to "federally reserved right", the common law "riparian rights", and "appropriated rights". Prior to 1914, appropriative rights could be acquired simply by posting or filing a notice, and then diverting and using the water for reasonable, beneficial purposes (referred to as "pre-1914 water rights"). Since 1914, California statutory law has required that an application be filed and a permit obtained from a State agency, currently from the State Water Resources Control Board.

Groundwater Rights: Like surface water, use of groundwater is not only dependent upon water rights but is also subject to environmental and water quality consideration.

In 1903, the "Correlative Rights" doctrine was introduced by a well-known California water rights case (Katz v. Walkinshaw). It established a "sharing" rule similar to that achieved under the torts doctrine. Under the correlative rights doctrine, the right to groundwater is a usufructuary right that is appurtenant to the overlying land. The right to use groundwater is shared by all overlying owners of a groundwater basin.

Unlike prior appropriation, correlative rights do not allow a precise definition of an individual's water rights. In the event of conflict, parties are forced to seek an optimal solution that allows all competing uses to continue with as little conflict as possible. A groundwater shortage is likely shared among all users.

Solutions to conflicts between rights: In the history of California groundwater management, legal and regulatory solutions to the conflict between the correlative rights of landowners overlying a groundwater basin and the long-held prior appropriation rights of users both outside and inside the groundwater basin have had a major impact on the distribution of groundwater but also on the conjunctive use of groundwater and surface water.

Unlike surface water rights, groundwater rights in California are not governed by a permit system, except in the case of basin adjudication. Through the adjudication process, courts have rendered decisions establishing precedents including doctrine of "mutual prescription" in key cases – City of Pasadena v. City of Alhambra by Supreme Court of California in 1949; City of Los Angeles v. City of San Fernando, the Supreme Court of California in 1975; Alameda County Water District v. Niles Sand and Gravel by California Court of Appeal, 1st District in 1974; High Desert County Water District v. Blue Skies Country Club, Inc. by California Appellate Court in 1994, City of Barstow v. Mojave Water Agency by the California Supreme Court in 2000.

If contending water users in the same groundwater basin cannot resolve their issues, and one or more individuals pursue resolution through a lawsuit, the result may be adjudication. Under

---

[4] Reference: Watersheds, Groundwater and Drinking Water: A Practical Guide by Thomas Harter and Larry Rollins, University of California Agriculture and Natural Resources Publication 3497

adjudication, courts establish the safe yield of the basin and decide how much each individual water user can extract annually. The process can take a long time (years to multiple decades), because of the number of parties involved, general lack of judicial experience in water law and science, and California's lack of special water courts. These are costly legal battles involving hired experts, attorneys, and multiple studies. By all accounts, it is preferable to manage groundwater basins by basin users through collaboration. This GMP process enacted by AB3030 and SB 1938 is now the common practice to manage groundwater basin for sustainable use of all basin users.

3.0 GROUNDWATER MANAGEMENT PLAN ELEMENTS

The elements of the plan include the overarching goal, management objectives and components that identify and discuss relevant actions to meet these goal and objectives of the plan.

3.1 GROUNDWATER MANAGEMENT GOALS

The overarching goal of the plan is to – ***preserve the local groundwater resource as a reliable and sustainable water supply for current and future beneficial uses.***

3.2 BASIN MANAGEMENT OBJECTIVES

To achieve the goal, the plan outlines four basin management objectives (BMOs):

1. **Preserve groundwater storage by maintaining long-term groundwater elevations in the GMP area to ensure sustainable use of the groundwater basin:** Groundwater elevation is a direct indicator of the volume of groundwater stored in the basin as well as the groundwater gradient. The historical record of groundwater elevations show that the basin experienced the lowest storage in the early 1960s. Since then, groundwater elevations have recovered significantly. Under this management objective, is basin users will work collaboratively to manage groundwater extraction and recharge in the basin to maintain the basin's long-term groundwater elevations.

2. **Maintain or improve groundwater quality in the GMP area to ensure sustainable use of the groundwater basin:** The groundwater quality of the basin in the GMP area is pristine in the deep aquifer of the basin. However, some locations within the basin area present water quality concerns, especially in shallow and intermediate aquifers. This management objective is to preserve the existing water quality condition and prevent it from degradation.

3. **Manage potential inelastic land surface subsidence from groundwater pumping:** If groundwater level declines occur, land subsidence is possible from compaction of underlying formations. Subsidence can be either recoverable elastic subsidence or irrecoverable inelastic subsidence.

   The risk of irrecoverable subsidence from the operation of groundwater extraction depends on basin hydrogeology and, the extent of groundwater pumping and recharge. Groundwater usage therefore can result in changes to the internal water pressure (groundwater levels). This management objective is to avoid irrecoverable land surface changes caused by excessive groundwater extraction by monitoring and managing groundwater levels.

4. **Manage the SEBP basin through coordination and collaboration:** The success of basin management activities depends upon the involvement of key stakeholders including basin users, municipalities, regulatory agencies and the public. This management objective is to foster collaboration and coordination through information sharing and cooperation.

3.3 GMP COMPONENTS

3.3.1 Stakeholder Involvement

The sustainability of the groundwater basin concerns a broad range of stakeholders in both the private and public sectors. Water suppliers consider the basin as a source of emergency and supplemental water supply. Private well owners rely upon the basin for their irrigation water supply. Local entities view it as a future source of water. State and local regulatory agencies are tasked to enforce the water quality standards for the basin. Municipalities like to protect the basin as a local resource for their constituents. As such, the development and implementation of basin management goals and associated management actions must take into account stakeholder interest in achieving the overarching objective of maintaining the basin's sustainability.

For that reason, as a lead agency, EBMUD has taken a set of actions to ensure stakeholder involvement to develop the GMP in accordance with statutory requirements. These actions include:

- Promoting public participation.
- Involving other local agencies and groundwater suppliers within the SEBP basin and neighboring basin in GMP development.
- Forming a stakeholder liaison group to guide the GMP process.
- Developing relationships with state and local agencies.
- Pursuing a variety of key partnerships to achieve a sustainable local water supply.

3.3.1.1 Public Involvement and Outreach

In accordance with CWC § 10753.2, a Notice of Intent (NOI) to prepare a GMP was published in local newspapers. The notice discussed the fact that EBMUD's governing board would meet to pass the NOI, and that the public was invited to said meeting. EBMUD Board of Directors meeting inviting the public to attend. In addition, EBMUD staff reached out to private well owners, state and local agencies, local government entities, local utilities, communities and businesses informing them of the plan to craft a GMP and inviting them to participate in the process. The following entities agreed to participate:

- City of Hayward
- City of Oakland
- Port of Oakland
- City of San Leandro
- City of Alameda
- Alameda County Public Works
- Alameda County Environmental Health Department
- San Lorenzo Unified School District
- Hayward Area Park District
- Alameda County Water District
- San Francisco Bay Regional Water Quality Control Board

On August 16, 2012, EBMUD launched a dedicated web portal for GMP development to provide information to the public on GMP activities. Following GMP certification, the website will be used to disseminate plan implementation activities to the stakeholders and public. On behalf of stakeholders, EBMUD will:

- Continue efforts to encourage public participation as opportunities arise.
- Reach out to local and business communities via EBMUD's Bayside Groundwater Project Community liaison group
- Assist stakeholders in disseminating information through other various meetings and public forums.

3.3.1.2 Collaboration Among Basin Stakeholders and Adjacent Basins

DWR's bulletin 118 delineates the boundary of the East Bay Plain and adjacent basins. Multiple stakeholders such as local communities, overlying water rights holders, regulatory agencies, existing basin users, business entities, municipalities and local governments have various interests and jurisdiction over the basins. Although currently the SEBP Basin is not a primary source of drinking water supply for most of overlying stakeholders, it is considered as an important source for water supply reliability, future water supply planning and irrigation. EBMUD reached out to current and future stakeholders with various interests and formed the Stakeholders Liaison Group.

Among these adjacent basins, Alameda County Water District (ACWD) manages and uses the Niles Cone basin for its public water supply. On average ACWD obtains about 40% of its water supplies from the Niles Cone Groundwater Basin. In fiscal year 2010-2011, about 25,400 acre-feet of groundwater was pumped from the Niles Cone Groundwater Basin. Recognizing the importance of the Niles Cone Basin and the connective relationship between the SEBP Basin and Niles Cone Basin, EBMUD included ACWD in the Stakeholder Liaison Group.

The main purpose of the group is to share information among the stakeholders, solicit input and foster collaboration in developing the GMP and implementing the basin management activities driven by the GMP.

3.3.1.3 Coordination with State and Federal Agencies

State agencies including the California Department of Water Resources all are interested parties in protecting the basin water quality and preserving water quantity (supply).

For example, the State Water Resources Control Board develops and enforces statewide water quality policies. Their regional office, the San Francisco Regional Water Quality Control Board, prepares and implements the Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan). The Basin Plan designates beneficial uses and water quality objectives for the basin, covering both surface water and groundwater. It also includes programs of implementation to achieve water quality objectives. California Department of Toxic Substances Control (DTSC) oversees and regulates the water quality standards, and California Department of Water Resources assists in developing local water resources.

As a part of the stakeholder outreach process, EBMUD sought State agencies' participation. As the lead agency, EBMUD plans to constantly coordinate with these entities during the GMP implementation. EBMUD plans to take the following actions:

- Continue to develop working relationships with local, state and as necessary, federal agencies.
- Coordinate GMP implementation activities with the local, state and federal agencies as appropriate.

3.3.1.4 Pursuing Partnership Opportunities

As the lead agency, EBMUD is committed to facilitating partnership arrangements at the local, state, and federal levels in seeking grant funding opportunities for the preservation and sustainable development of local water resources. To date, EBMUD has fostered partnership opportunities with a number of interested parties. For example, EBMUD has worked with the USGS to construct a subsidence monitoring station in the basin. Under the objectives of the GMP, EBMUD will continue to facilitate and participate in partnership opportunities among stakeholders. EBMUD plans to take the following actions:

- Continue to seek grant opportunities to fund local projects that can improve groundwater management

3.3.2 Monitoring Programs

A key component of the GMP is a monitoring program designed to assess the status of the basin and trigger actions to preserve the basin. The program includes monitoring groundwater elevations, groundwater quality, and land surface referenced elevations for tracking elastic and inelastic land surface subsidence, and salt and nutrients concentrations. The monitoring tasks are to be implemented under the following programs:

- Groundwater Elevation Monitoring Program
- Groundwater Quality Monitoring Program
- Subsidence Monitoring Program

3.3.2.1 Groundwater Elevation Monitoring Program

Groundwater level monitoring is an important component to manage basin storage, groundwater gradients, detect pumping or recharge activities, and develop a replenishment strategy. Currently EBMUD operates a network of 17 monitoring wells covering a part of the basin. Additional monitoring wells are needed to cover the remaining parts of the SEBP basin. A number of stakeholders - such as Port of Oakland, City of Alameda, City of Hayward and Hayward Area Park District - either own or operate wells within the basin. As such, individual monitoring activities can be coordinated to collect comprehensive data for the basin.

Groundwater Elevation Monitoring Protocols: Without standard monitoring protocols, potential differences in data collection techniques, reference datum, monitoring frequencies and documentation methods in groundwater level measurement as well as groundwater quality sampling could lead to incomparable data sets and discrepancies. Although individual groundwater data collection protocol may be adequate to meet a stakeholder's needs, the lack of standardizing protocols could result in misrepresentation of basin-wide groundwater conditions.

EBMUD plans to work with the local stakeholders in developing the groundwater elevation monitoring program for this GMP. Over time, establishing a regional monitoring network, comprising monitoring and production wells to integrate existing monitoring wells with additional wells owned by stakeholders and private owners, would benefit the basin. Although dedicated monitoring wells yield more accurate data, idle production wells can be used as an alternative for data collection.

In accordance with provisions of SBX7 6, State Department of Water Resources (DWR) is implementing the California Statewide Groundwater Elevation Monitoring (CASGEM) program for the DWR Bulleting 118 basins including SEBP basin. EBMUD is one of the monitoring agencies which volunteers to report groundwater elevation data to DWR under the CASGEM program. DWR has developed the groundwater elevation monitoring guideline for the CASGEM program. Hence for the SEBP basin integrated monitoring well network, DWR's monitoring guidelines (Appendix F) are to be used as recommended monitoring protocols.

Monitoring Frequency: A consistent measurement frequency would help identify seasonal and long-term trends in groundwater levels. Semi-annual monitoring of the designated wells could be planned to coincide with the high and low seasonal water-levels of the year for the basin. Ideally, as the SEBP Basin is influenced by daily tidal activities, continual measurement at predetermined frequencies (such as hourly or every four hours using programmable pressure transducers) is recommended for future improved data collection. Currently, EBMUD deploys pressure transducers in its monitoring wells to measure and record groundwater level changes.

Integrated SEBP Basin Monitoring Well Network: Currently EBMUD monitors a portion of SEBP basin by using 17 monitoring wells for its Bayside Groundwater Project Phase 1. As a part of groundwater management effort, EBMUD is working with City of Hayward and City of Alameda to expand the monitoring network coverage by integrating additional wells.

The following Table 3-1 summarizes the EBMUD's Bayside Project monitoring wells designated for the SEBP groundwater elevation monitoring well network. Figure 3-1 shows the location of these existing wells along with potential wells being considered for the proposed integrated regional monitoring well network.

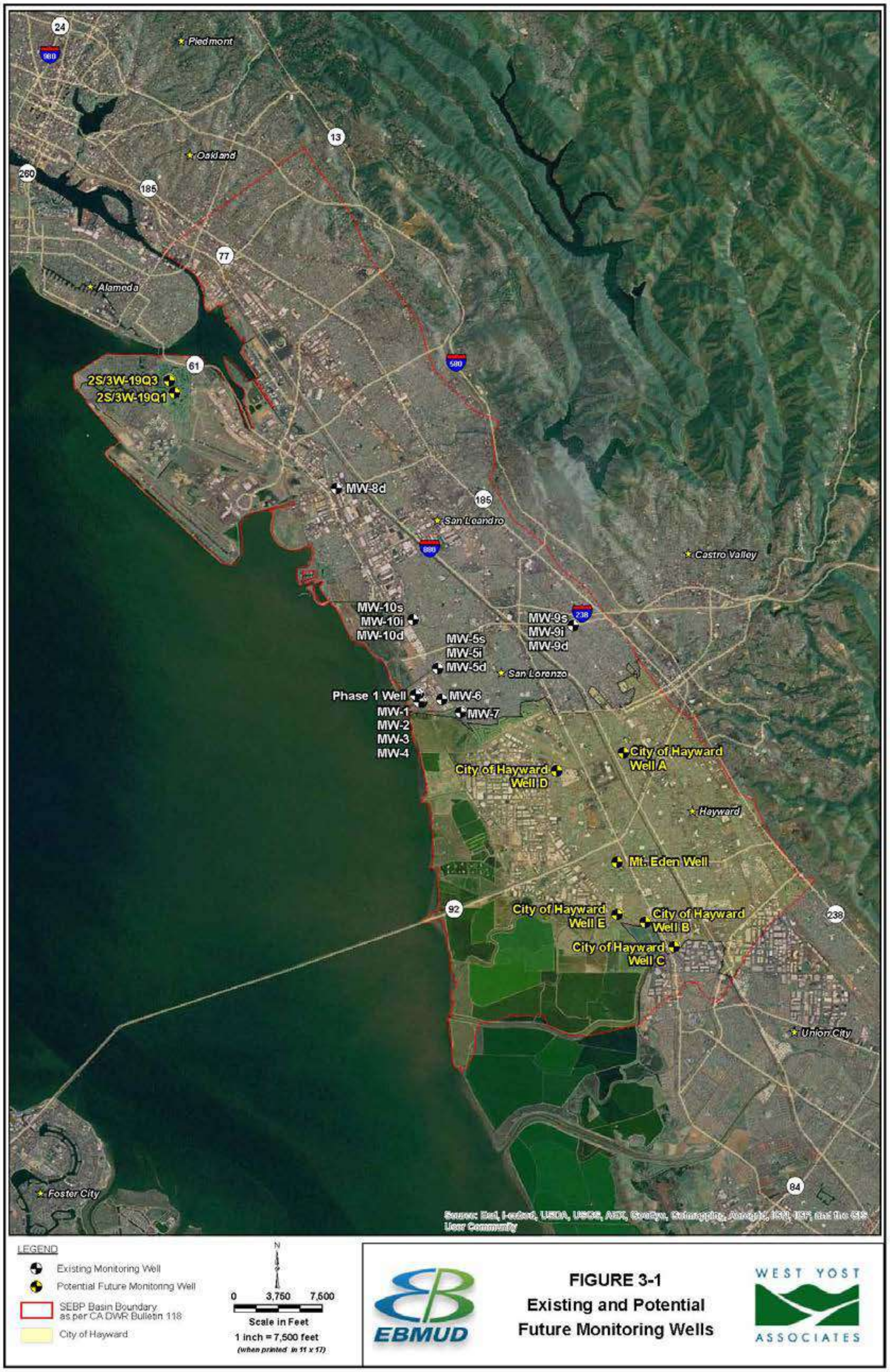


FIGURE 3-1
Existing and Potential Future Monitoring Wells

Table 3-1: Bayside Project Groundwater Monitoring Wells

No.	Well ID	X Coordinate	Y Coordinate	Address	City	Completion Date	Drilled Depth	Casing Depth	Depth of Perforation Begin	Depth of Perforation End	Casing Diameter	Remark
							ft	ft	ft	ft	inches	
1	MW-1	6082071	2069939	2600 Grant Ave	San Lorenzo	-	665	650	520	640	2	Deep Well
2	MW-2S	6082078	2069948	2600 Grant Ave	San Lorenzo	-	210	60	40	60	2	Shallow Well
3	MW-2I	6082078	2069948	2600 Grant Ave	San Lorenzo	-	210	200	160	190	2	Intermediate Well
4	MW-3	6081842	2069940	2600 Grant Ave	San Lorenzo	-	665	660	520	650	2	Deep Well
5	MW-4	6081803	2070628	2575 Grant Ave	San Lorenzo	-	705	650	520	650	2	Deep Well
6	MW-5S	6083469	2072797	2006 Via Barrett	San Lorenzo	Sep-08	460	210	200	210	2	New Shallow Well
7	MW-5I	6083469	2072797	2005 Via Barrett	San Lorenzo	Sep-08	460	325	315	325	2	New Intermediate Well
8	MW-5D	6083469	2072797	2007 Via Barrett	San Lorenzo	Feb-01	1025	640	500	630	4	Deep Well
9	MW-6	6083784	2070120	15600 Worthley	San Lorenzo	Nov-00	1000	655	480	650	4	Deep Well
10	MW-7	6085379	2069033	Westrern tip of San Lorenzo Park	San Lorenzo	Nov-00	972	680	510	630	4	Deep Well
11	MW-8D	6074793	2088139	1970 Davis Street	San Leandro	-	910	490	420	480	2	Deep Well
12	MW-9S	6094992	2076460	589 E. Lewelling Ave	San Lorenzo	Jan-08	460	120	110	120	2	New Shallow Well
13	MW-9I	6094992	2076460	589 E. Lewelling Ave	San Lorenzo	Jan-08	460	210	200	210	2	New Intermediate Well
14	MW-9D	6094992	2076460	589 E. Lewelling Ave	San Lorenzo	Jan-08	460	335	325	335	2	New Deep Well
15	MW-10S	6081364	2076905	15528 Wick Blvd	San Leandro	Sep-08	680	120	100	120	2	New Shallow Well
16	MW-10I	6081364	2076905	15528 Wick Blvd	San Leandro	Sep-08	680	360	340	360	2	New Intermediate Well
17	MW-10D	6081364	2076905	15528 Wick Blvd	San Leandro	Sep-08	680	610	590	610	2	New Deep Well

This page intentionally left blank.

Actions:

The following actions are planned to monitor and manage groundwater elevation:

- Use CASGEM Groundwater Elevation Monitoring Guidelines for water level data collection.
- Provide stakeholder agencies with guidelines on the collection of water quality data as per USEPA sampling standards.
- Assist stakeholders in developing and implementing monitoring programs.
- Coordinate with stakeholder agencies to develop standardized reference elevations for monitoring well.
- Coordinate with stakeholders and request that the timing of water level data collection occurs on or about April 15 and October 15 of each year.
- Provide a periodic assessment of groundwater elevation trends and conditions to stakeholders.
- Assess the adequacy of the groundwater elevation monitoring well network periodically.

3.3.2.2 Groundwater Quality Monitoring Program

For basin management, managing water quality is as important as managing basin groundwater quantity. Significant use of the SEBP Basin for drinking water supply ceased in the early 20th century, therefore historic water quality data is not available. While regulatory agencies and various entities have collected water quality data in specific locations and various purposes, comprehensive and historical water quality data sets are not available.

In the last decade, the USGS has completed research and analysis of the East Bay Plain Basin water quality in collaboration with EBMUD also as a part of State's Groundwater Ambient Monitoring and Assessment (GAMA) Program. The USGS study shows that the water quality of deep aquifer in the SEBP Basin remains pristine and the age of groundwater is dated at 9,200 years since it was recharged. This is attributed to the basin hydrogeology consisting of protective thick clay layers shielding contaminants. However, multiple perforated wells and improperly constructed or abandoned wells could act as artificial conduits by allowing contaminants from shallow zones to penetrate deeper aquifers, which is a potential threat to basin water quality. Accordingly, this GMP proposes well standards for existing wells and future wells to preserve basin water quality from threats of contaminants including salts and nutrients.

It is a future goal of this GMP to eventually develop and maintain an integrated groundwater database using a GIS platform. For that purpose, annual water quality sampling would be planned and groundwater quality data from stakeholder and public sources would be integrated into a water quality database. Appendix G contains a possible groundwater quality sampling plan listing the water quality constituents to be analyzed when resources are available. The water quality monitoring well network would continue to be modified to cover greater basin area as resources available.

Actions:

The following actions are planned to monitor and manage groundwater quality:

- Coordinate with stakeholders to assist in using standardized water quality sampling protocols

- Maintain stakeholder's existing monitoring well network for purposes of groundwater quality monitoring
- Collaborate with local, state, and federal agencies such as USGS to identify opportunities to continue conducting water quality analysis in less known areas of the basin
- Review and assess the effectiveness of the groundwater quality monitoring program periodically and recommend improvements as necessary
- Secure grant funding to initiate a GIS based groundwater quality database, and
- To collect, compile and integrate groundwater quality data

3.3.2.3 Subsidence Monitoring Program

Land subsidence can result from compaction of underlying formations caused by groundwater level decline. Subsidence can be categorized as recoverable elastic subsidence or irrecoverable inelastic subsidence. Subsidence concerns, within the SEBP basin, while certainly not as serious as in other areas of California are nevertheless present.

The risk of irrecoverable subsidence from operation of groundwater extraction depends on basin hydrogeology, the extent of groundwater pumping and the resulting change in the internal water pressure (groundwater levels). Groundwater contained within aquifers and aquitards helps support the weight of the overlying sediments because the water contained in the pore spaces in the sediments creates an internal water pressure. Land subsidence can occur if groundwater pumping reduces the water pressure within the pore space of the saturated sediments over a period of time, thereby causing the sediments to compress.

Elastic Subsidence: Subsidence in the coarser-grained materials of the aquifers is elastic. A small amount of elastic subsidence is expected to occur over a broad area of the SEBP Basin in response to pumping, which is what happens when any well in a confined aquifer produces water. Under conditions of elastic subsidence, the compaction is relatively small and is reversed when pore pressures increase due to rising water levels, including during injection of groundwater. The amount of this elastic subsidence is a function of the amount of drawdown. As occurs in nearly any basin with groundwater pumping, elastic subsidence will completely reverse following each groundwater pumping cycle as water levels recover.

Inelastic Subsidence: Under certain conditions, groundwater pumping can result in a permanent change in the structure of the sediments, known as *inelastic* subsidence. These conditions may result in a non-recoverable compaction of the aquifer system. Inelastic subsidence occurs when the water pressure in finer-grained sediments is reduced beyond their historic low water levels. The result is a permanent change to the intergranular structure of the sediments that cannot be reversed when water levels recover. The compressibility of sediments under inelastic conditions is much greater than it is under elastic conditions, and may require decades to millennia to complete.

The potential for inelastic subsidence depends on both the magnitude and duration of drawdown. Inelastic subsidence is highly unlikely to occur if water levels are maintained above historical lows.

Subsidence Monitoring in the SEBP basin: In coarser-grained materials, such as the sands and gravels that comprise the East Bay Plain Deep Aquifer, the change in pore pressure is roughly uniform throughout the thickness of the sediments and can be monitored by measuring changes in water levels in observation wells. As a part of the EBMUD's Bayside Project, direct measurement of ground elevation changes for Bayside Phase 1 are being accomplished using high-resolution extensometers, as shown in Figure 3-2. These instruments which were constructed and calibrated by the USGS detect compression in the deep and shallow aquifer sediments. The accuracy of well-constructed extensometers is on the order of 0.001 millimeters. Extensometer data is being reviewed continuously by EBMUD to assess whether subsidence is occurring and whether it is elastic or inelastic. If any inelastic subsidence is detected the accuracy of the extensometers is such that it will be a very small amount measurable near the Bayside Well No. 1.

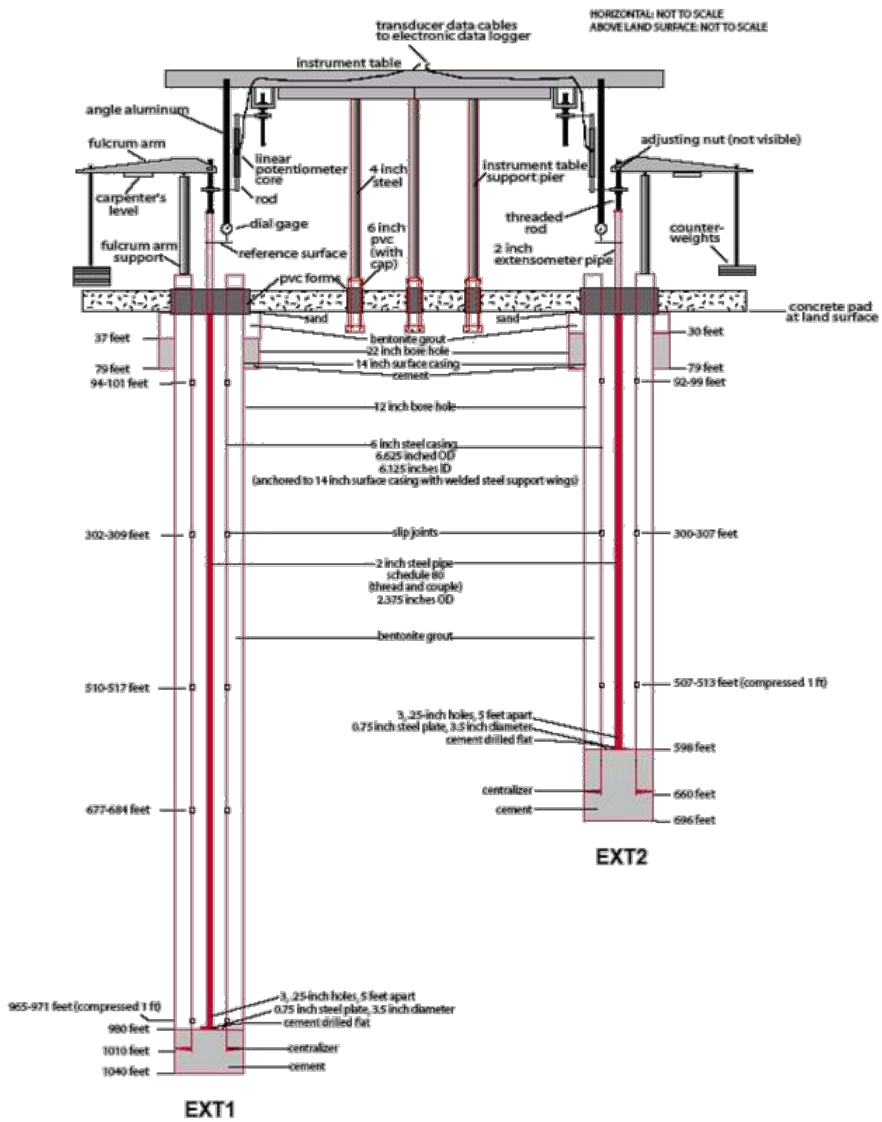


Figure 3-2
Bayside Groundwater Project Extensometer

Along with measurement of land surface movement using the above mentioned extensometer, contingent upon availability of funding, a periodic survey of reference elevations for the monitoring network would enable stakeholders to better track land surface movements including subsidence of the SEBP Basin.

Actions:

The following actions are identified to monitor and manage potential subsidence. The program will continue to monitor land subsidence and pursue additional actions as necessary if resources are available. These will include:

- Periodically re-survey the established reference elevations at groundwater monitoring locations.
- Collaborate with State and federal agencies, particularly USGS, to collect and analyze land surface movement data for potential land subsidence using various methodologies including InSAR remote sensing.

3.3.2.4 Data Management and Data Sharing

Groundwater data management requires data compilation and database maintenance. As the lead agency, EBMUD will continue to collect data required for the operation of the Bayside Groundwater Project Phase 1 and maintain a database of well information, well logs, groundwater quality and elevation data, and, when readily available, known groundwater contamination sites. These databases support water resources development, basin management, and groundwater model calibration.

3.3.3 Groundwater Basin Management Tools

3.3.3.1 SEBP Groundwater Model

As a part of GMP development, a groundwater model of the SEBP Basin and the NCGWB using the USGS finite difference flow model, MODFLOW was created to simulate groundwater management strategies. Further refinements and/or verification of the model will become necessary to accurately define basin sustainability and interbasin relationships to better manage the SEBP basin under increased levels of groundwater use.

Hydrologic Model of the SEBP Basin: The new model was constructed utilizing two existing models.

One model was developed by CH2M Hill in 2001. It was developed on behalf of EBMUD as part of the planning for their Bayside Groundwater Project. The model was constructed using the USGS's MODFLOW groundwater modeling code. That MODFLOW model consisted of seven layers.

The other model was developed also in the early 2000s by Wrime, Inc. on behalf of the Alameda County Water District, EBMUD and the City of Hayward. Titled the NCGB-SEBPB model (NEBIGSM), it uses the finite element IGSM model code.

The NEBIGSM model consists of four layers. The NEBIGSM model has been used extensively by ACWD as a basin management tool. Since its development, significant updates/contributions have been made to the model.

Code Selection: The USGS MODFLOW code was selected as the primary platform to develop the new groundwater flow model (NEB MODFLOW Model), as it provided the option to support both immediate and future modeling needs for basin stakeholders. Specifically, it is the most widely used groundwater modeling code publically available. MODFLOW has an ability to simulate three-dimensional problems involving recharge and evapotranspiration, wells, drains, and stream-aquifer interactions. It also has a suite of technically sound companion modules that have been reviewed and validated throughout the groundwater community that provide options (at some future date) to simulate the basin's response to groundwater contamination (predicting contaminant transport). It also allows one to identify and predict the risk of saltwater intrusion and basin subsidence. In addition, MODFLOW is integrated into the Arc Hydro Groundwater (AHGW) suite of tools that were used to support the data management, data analysis and visualization work completed for the technical study prepared as part of the GMP development effort.

For the new model development, the NEBIGSM model was selected as the primary data source for the new MODFLOW model.

Model Description: The NEB MODFLOW model, prepared for this GMP, is a seven-layer, finite difference groundwater flow model developed using the USGS MODFLOW code. The new model establishes/calculates a water balance for the GMP area. It also provides baseline estimates of key parameters (e.g., water levels, boundary flow conditions, etc.) for basin management purposes.

The simulation period of the NEB MODFLOW model starts from October 1, 1964 and runs through October 1, 2012. The model simulation period is monthly, except for the duration from August 2010 through September 2010. Additional stress periods were added during this time period to match the actual pumping that occurred during 2010 from EBMUD's pump test at the Bayside Well (Fugro, 2011). The models ability to replicate water level changes in observation wells was then assessed.

3.3.4 Groundwater Resource Protection

In this GMP, resource protection entails both prevention of contamination from entering the groundwater basin and remediation of existing contamination. Prevention measures include adoption and enforcement of relevant well standards including proper well construction and destruction practices, development of wellhead protection measures, protection of recharge areas, controlling groundwater contamination, and managing salts and nutrients.

3.3.4.1 Well Standards

As per authority provided by County General Ordinance Code, Chapter 6.88, the Alameda County Public Works Agency (ACPWA), administers the well permitting program for Alameda County. The code authorizes ACPWA to regulate groundwater wells and exploratory holes as required by the California Water Code. The provisions of these laws are administered and enforced through ACPWA's Well Standards Program.

ACPWA's Water Resources Section is responsible for all well permitting activities for nine cities and unincorporated western Alameda County including the SEBP Basin area. The Water Resources Section manages all drilling permit applications within its jurisdiction, and oversees compliance via guidelines for well construction and destruction, geotechnical and well contamination investigations, well data searches that meet specific criteria, and other activities.

To better protect the SEBP basin from water quality degradation, pollution or contamination caused by improper construction, use, operation, maintenance, repair, reconstruction, improvement, inactivation, decommissioning, or destruction of wells, exploratory holes, other excavations, and appurtenances, the current well standards were reviewed and updated to meet current well standard enforcement needs. The updated standards are included in the Appendix H. These standards are derived from water well industry procedures and processes deemed most effective at meeting local groundwater protection needs and are based on the standards developed by ACWD and the State of California Department of Water Resources (DWR). Note that following GMP adoption, stakeholders will work to see that these updated standards are considered for adoption by Alameda County.

Actions:

The GMP will implement the following tasks:

- Ensure that all stakeholders are provided a copy of the County well ordinance and understand the proper well construction procedures.
- Support ACPWA in adopting the updated well standards.
- Support stakeholders in educating public about the updated well standards and in adopting local ordinances to implement the well standards.

3.3.4.2 Wellhead Protection

EBMUD and City of Hayward serve the SEBP Basin area primarily from surface water sources. Both these water suppliers have developed supplemental drought supply and/or emergency sources using groundwater. These sources are subject to permitting requirements of California Department of Public Health (DPH). DPH requires water suppliers to identify wellhead protection areas under the Drinking Water Source Assessment and Protection (DWSAP) Program administered by the DPH in order to issue a drinking water supply permit. EBMUD has completed a DWSAP assessment in 2012 by completing the following three major components required by DPH:

- A delineation of capture zones around sources (wells); an inventory of Potential Contaminating Activities (PCAs) within protection areas.
- A vulnerability analysis to identify the PCAs to which the source is most vulnerable.
- A delineation of capture zones using groundwater gradient and hydraulic conductivity data to calculate the surface area overlying the portion of the aquifer that contributes water to a well within specified time-of-travel periods. Areas are delineated representing 2, 5, and 10 year time-of-travel periods.

Protection areas are managed to protect the drinking water supply from viral, microbial, and direct chemical contamination. Inventories of PCAs include identifying potential origins of contamination to the drinking water source and protection areas. PCAs may consist of commercial, industrial, agricultural, and residential sites, or infrastructure sources such as utilities and roads. Depending on the type of source, each PCA is assigned a risk ranking, ranging from “very high” for such sources such as gas stations, dry cleaners, and landfills, to “low” for such sources such as schools, lakes, and non-irrigated cropland. Vulnerability analysis includes determining the most significant threats to the quality of the water supply by evaluating PCAs in terms of risk rankings, proximity to wells, and Physical Barrier Effectiveness (PBE). PBE takes into account factors that could limit infiltration of contaminants including type of aquifer, aquifer material (for unconfined aquifers), pathways of contamination, static water conditions, hydraulic head (for confined aquifers), well operation, and well construction. The vulnerability analysis scoring system assigns point values for PCA risk rankings, PCA locations within wellhead protection areas, and well area PBE; the PCAs to which drinking water wells are most vulnerable are apparent once vulnerability scoring is complete.

Actions:

The GMP will recommend the following actions:

- Obtain an updated coverage of potentially contaminating activities and provide that information to stakeholders.
- Share current wellhead protection measures and provide a summary of actions taken by others as a tool in managing their individual wellhead protection programs.

3.3.4.3 Protection of Recharge Areas

Although the productive aquifers in most parts of the SEBP Basin are confined by thick clay layers and the surface water does not directly contribute to aquifer recharge, it is important to recognize the link between activities that take place on the surface and the potential impact of these activities on the long-term quality and quantity of groundwater recharge. As such, the GMP includes delineation of recharge areas to be protected and recognized for planning purposes. It is recommended that land use authorities recognize the need to protect groundwater recharge areas and pay special attention to overlying land use practices that either impede (e.g., large pavement areas) or could pollute (e.g., proper oil disposal) water as it makes its way from the surface to the aquifer.

Actions:

The GMP recommends the following action:

- Inform and assist groundwater authorities and the land-use planners to consider the need to protect prominent groundwater recharge areas in land use planning processes.

3.3.4.4 Groundwater Contamination

The known contaminated sites in the SEBP basin area are in the shallow zone. The shallow zone in the Basin area is not considered to be a water source for industrial and municipal water supply but traditionally has been used for irrigation purposes. However, there is a concern that the contaminants in the shallow zone could be transmitted through multiple-perforated wells into productive intermediate and deep aquifer units. As the Basin area has industrial and manufacturing activities, sources of contaminants known are recorded in environmental databases such as GeoTracker. Thus far, there is no significant adverse impact to the deeper production zones of the groundwater basin. However, the concern of potential contaminations from various sources does exist.

Although the GMP stakeholders do not have authority or the direct responsibility for taking action against responsible parties, they are committed to coordinating with responsible parties and regulatory agencies to foster appropriate actions and remediation. For example, should any contaminants exceeding water quality standards be detected or a spill event is observed, the GMP stakeholders will inform and coordinate with SFRWQCB and DTSC.

Actions:

The GMP stakeholders will take the following actions:

- If contaminants exceeding water quality standards are detected in monitoring wells, contact appropriate regulatory agencies
- Coordinate with SFRWQCB and DTSC to encourage these agencies to take necessary actions

3.3.4.5 Salt and Nutrient Management (SNM)

3.3.4.5.1 Background

The California State Water Resources Control Board (SWRCB) adopted the Recycled Water Policy on February 3, 2009. The purpose of the Policy is to increase the use of recycled water in a manner that implements state and federal water quality laws. The policy encourages water recycling with the stated goals of:

- Increasing recycled water use by at least one million acre-feet per year (AFY) by 2020 and by at least two million AFY by 2030.
- Substituting as much recycled water for potable water as possible by 2030.

The SWRCB is also encouraging every region in California to develop a salt/nutrient management plan by 2014. Because each groundwater basin or watershed is unique, the plan detail and complexity will depend on the extent of local salt and nutrient problems. Plan components include:

- Basin-wide water quality monitoring
- Water recycling goals and objectives
- Salt and nutrient source identification
- Basin loading - assimilative capacity estimates
- Salt mitigation strategies
- Anti-degradation analysis
- Emerging constituents consideration (e.g., PPCPs, EDs)

Currently, only limited recycled water supply is available within the SEBP Basin area. However, in the future, recycled water supply could become a significant source. In addition, because of the proximity to the San Francisco Bay, high concentrations of TDS are observed in shallow zones of the Basin.

3.3.4.5.2 Objectives

The primary goal of SNM is to facilitate basin-wide management of salts and nutrients from all sources in a manner that optimizes recycled water use while ensuring protection of groundwater supply and beneficial uses, agricultural beneficial uses, and human health. In addition, SNM is required for seawater intrusion related salt loading. Considering that limited to no recycled water use is taking place within the most productive area of the SEBP Basin, and as based on existing hydrogeology, the following are the objectives of the SNM plan for the SEBP Basin:

- To recognize the importance of monitoring salt and nutrient compounds.
- To evaluate the need for SNM.
- To establish a base line water quality condition for the basin.
- To evaluate existing and potential future sources.
- To integrate additional constituents in water quality monitoring for salt and nutrients management.
- To collect water quality data.

3.3.4.5.3 Salt & Nutrient Source Analysis

Existing Salt and Nutrient Composition of the SEBP basin: The SEBP Basin interfaces with San Francisco Bay. The shallow aquifer unit of the Basin is exposed to seawater and higher concentrations of TDS are detected in the shallow zone.

Section 2.13 of the GMP details the current water quality condition in the Basin area. As discussed in that section, previous studies evaluate the distribution of water quality parameters as a function of depth within the SEBP Basin and make the following observations:

- Compared to deeper levels, groundwater less than 200 ft bgs is characterized by relatively high concentrations of total dissolved solids (TDS), chloride, nitrate, and sulfate. Shallow wells exceed the MCL for nitrate (45 mg/L as NO3), and the secondary MCL for TDS (1,000 mg/L), chloride (250 mg/L), sulfate (250 mg/L), iron (0.30 mg/L) and manganese (0.05 mg/l).Nitrate is elevated in large parts of the San Leandro/San Lorenzo area, probably due to septic tank effluent and past farming activities in these areas.
- Wells with total depths greater than 500 ft bgs are located primarily in the southern portion of the study area. These wells have high iron and manganese levels that commonly exceed their secondary MCLs. Elevated TDS and chloride concentrations are probably related to the presence of shallow well screens in the deeper wells.

Potential Source of Salt and Nutrient: Depending upon the quality of recycled water, recycled water use could become an additional source of salt and nutrients for the basin. Currently, all existing recycled water uses are in the least productive area of the basin portion that is not used for public water supply). As a part of the basin management activities, recycled water use within the basin will be periodically observed and the monitoring plan will be modified as needed to manage the basin water quality.

3.3.4.5.4 Salt & Nutrient Plan and Implementation

- Options: As a part of the water quality monitoring program, the water quality sampling and analysis is to be done periodically to monitor the basin water quality. In addition, the water supply wells are to be sampled and analyzed for permit compliance purposes.
- Strategies: Although the water quality monitoring network is sufficient to track water quality objectives, the network can be improved by adding dedicated monitoring wells and sampling events. To improve water quality monitoring capabilities, under the implementation of this GMP, available state and federal grants will be pursued. In addition, periodic bi-lateral

meetings with San Francisco Regional Water Quality Control Board (SFRWQB) will be planned to review and discuss the water quality data and plan actions. The stakeholders will seek collaboration and support in obtaining grant funding and in developing any necessary actions.

- Implementation: A key component of the GMP is monitoring basin water quality. Section 3.3.2.2 of this document details the groundwater quality monitoring program including aater quality monitoring constituents and sampling protocols. Salt and nutrient constituents will be included as a part of monitoring program. Details of the monitoring plan are discussed in these sections.

3.3.5 Groundwater Sustainability

3.3.5.1 Coordinated Management Activities

Following GMP adoption, basin stakeholders recognize the need to perform various activities on a routine basis that when combined serve as the means to manage the basin thereby insuring its conjunctive capabilities (Conjunctive Management Activities). Activities are grouped into the following categories:

- Stakeholder Efforts;
- Basin Monitoring;
- Groundwater Protection Measures (& Enforcement);
- Other Sustainability Measures; and
- Integration with Other Agency & Organization Planning Efforts.

Stakeholder Efforts (Public Outreach & Coordinated Stakeholder Activities): Maintaining and strengthening stakeholder involvement in the groundwater management effort will be a key conjunctive management activity moving forward. The process of encouraging broad involvement will be successful if the public is engaged.

Public Outreach and Involvement: The stakeholder committee formed for the GMP preparation will spearhead outreach efforts. Initially, those efforts will focus on informing key elected officials and the public about the GMP.

Communication activities could be within or outside the SEBP basin boundary, depending on the audience and their interest(s). However, the focus of public outreach will be to reach residents and business owners that overlie the basin.

The following actions may be used to encourage public involvement:

- Hold an annual stakeholders workshop with public involvement as a standing agenda item.
- Agency leads for GMP implementation shall work with stakeholders to assure continued communication following GMP adoption (including participation in discussion with stakeholders, electeds and staff)
- Make available printed copies of the GMP at public libraries within the basin footprint
- Make available an electronic version of the GMP
- Maintain the EBMUD-hosted website for the SEBP basin GMP

- Through the stakeholder group, coordinate outreach to inform the public and key elected officials
- Present GMP details at community forums, in conjunction with existing neighborhood outreach efforts
- Maintain a mailing list of those interested in participating on any GMP-related committees
- Meet with representatives from business groups and other interested organizations as appropriate

Coordinated Stakeholder Activities: Stakeholders are committed to advancing the knowledge of the Basin to promote Basin sustainability. The following activities are future means to meet that commitment:

- Working together to seek grant funding for key projects and planned actions beneficial for the Basin
- Working proactively to address potential conflicts of groundwater interests

Basin Monitoring: Comprehensive, long-term monitoring provides data needed to evaluate changes in the Basin over time. GMP implementation will call for continued groundwater monitoring coupled with updated groundwater modeling when appropriate in order to assist in decision making as it pertains to basin management.

Monitoring of the groundwater basin shall include the following elements:

- Groundwater elevation monitoring
- Groundwater quality monitoring
- Land subsidence monitoring
- Data management/storage

Groundwater Elevation Monitoring: While agencies such as EBMUD have been performing groundwater elevation monitoring for a number of years, there is an interest to continue and perhaps expand that effort over time. As funding is available, the following activities could be performed on a periodic basis:

- Surveys of existing monitoring wells: The City of Hayward and EBMUD have wells that are routinely monitored as part of their ongoing operations. Additional known wells can be added to monitoring program assignments based on whether such information is necessary and additional resources are available
- Expansion of monitoring activities: If additional resources become available, monitoring could be expanded beyond those wells which have been instrumented by the City of Hayward and EBMUD
- Data Sharing: Data would be shared with a stakeholder team (likely led by EBMUD) and can be made available to the public and interested parties to track basin sustainability over time

The following actions are planned regarding groundwater elevation monitoring:

- Assess groundwater elevations collected as part of ongoing agency activities for network adequacy
- Work with private well owners who wish to continue to operate their groundwater wells to 1) comply with well standards and 2) collect and share groundwater data.
- Seek grant funding to expand the monitoring program.

Groundwater Quality Monitoring: Water quality information has been collected over the years by several of the basin stakeholders. The following actions are proposed moving forward:

- Stakeholders will review groundwater quality data collected as part of on-going activities associated with agency operations to determine trends, conditions and adequacy of the groundwater quality monitoring network. If there appears to be an acute need for additional modeling, the stakeholders will work to identify funding mechanisms.

Land Subsidence Monitoring: EBMUD has a program in place, in partnership with the U.S. Geological Survey, to monitor Land Subsidence adjacent to its Bayside Groundwater Project facilities in San Lorenzo, CA. Plans are to continue to use that facility to monitor land subsidence in that general portion of the SEBP Basin. Additional subsidence monitoring performed by stakeholders such as the City of Alameda will be periodically reviewed to assess the behavior of the SEBP Basin.

Monitoring Protocols: Stakeholders are to adhere to water quality data collection procedures developed by the State of California Department of Public Health.

Data Management: Assuming a source of funding can be secured, EBMUD could serve as a centralized agency for the purpose of data management as it pertains to the SEBP basin. Specifically, EBMUD could:

- Maintain and update a data management system to store information collected by the various stakeholders in regards to groundwater elevations and groundwater quality.
- Use the data collected to prepare periodic evaluations of the groundwater condition in the SEBP basin, which in turn can be shared with other stakeholders and the general public.

Groundwater Protection Measures: Groundwater quality protection is a key factor to ensuring the sustainability of a groundwater resource. As part of this GMP, groundwater quality protection includes both the prevention and minimization of groundwater quality degradation, as well as measures for the minimization of contamination. Prevention measures include proper well construction and deconstruction practices, development of wellhead protection measures, and source control of potential contaminants.

Well Construction, Abandonment and Deconstruction: Alameda County Public Works Department, a GMP stakeholder, is responsible for rules and procedures associated with well construction, abandonment and deconstruction. Those rules and procedures are detailed in Appendix H.

Wellhead Protection: Identification of wellhead protection areas is a component of the Drinking Water Source Assessment and Projection (DWSAP) Program administered by DPH. EBMUD, as part of its Bayside Groundwater Project, has provided DPH with the following information:

- A delineation of the capture zone around the Bayside Groundwater Project's extraction well.
- An inventory of potential contaminating activities (PCAs) within the project's protection areas.
- A vulnerability analysis to identify the PCAs to which the project is most vulnerable.

The following are potential future/further actions regarding this topic:

- Continue to identify source areas and protection zones as needed when and if the SEBP Basin is used as part of any future activity (such as the expansion of the Bayside Groundwater Project by EBMUD).
- Update management approaches that can be used to provide better protection to the water supply from PCAs including voluntary control measures and expanded public education.

Controlling Migration and Remediation of Contaminated Groundwater: The known groundwater contamination plumes within the SEBP Basin are discussed in Section 2.13.

To address contamination, the stakeholders will coordinate with responsible parties and regulatory agencies to keep those interested informed on the status of potential contamination in the SEBP Basin. The actions listed below are to be considered as a means to improve protection of groundwater quality from contamination:

- Provide well owners with information regarding DPH and ACPWD well requirements.
- Incorporate any new known high risk PCAs into the data management system(s) created for the SEBP Basin.
- Make contaminant plume information available to well owners through various informational avenues (the SEBP Basin GMP webpage, etc).

Control of Saline Water Intrusion: Seawater intrusion from San Francisco Bay is a challenge, particularly for the upper most aquifers in the SEBP Basin. Section 3.3.4.5 addresses salt and nutrient management efforts proposed, however, aside from those efforts, this GMP proposes that the following additional actions could be implemented over time, particularly if and when seawater intrusion issues become problematic for the lower-most aquifer:

- Track saline water movement from San Francisco Bay through on-going groundwater monitoring efforts.
- Examine TDS, chloride and sulfate concentrations collected for the Bayside Groundwater Project monitoring to identify any trends over time.
- Perform studies (when and if funding can be secured) to review salinity sources and their distribution; to identify mitigation alternatives.
- Develop projects (when and if funding can be secured and assuming mitigation is needed) to address saline water intrusion.

Other Sustainability Measures: Various water management options are available to address groundwater supply sustainability. The primary method in play for the deep aquifer of the SEBP Basin is direct aquifer recharge/groundwater banking, managed as a strategy to replenish the Basin and serve as a secure storage means for water that could be sourced during times of drought. As EBMUD and others (such as the City of Hayward) utilize the basin for water supply, there are no plans at this point in time to consider alternatives such as storm water recharge and/or recycled water recharge. However, the use of other supplies (such as recycled water) for irrigation, etc. can be promoted as a means to limit the use of groundwater supplies. Similarly, conservation and demand reduction measures can be employed that will reduce the reliance on the SEBP Basin.

Direct Aquifer Recharge/Groundwater Banking: The deep aquifer in the SEBP Basin is being utilized by EBMUD to store treated water for later use during droughts. The project, the Bayside Groundwater Project is an Aquifer Storage and Recovery Project, and demonstrates how direct aquifer recharge can be utilized to assure the long term sustainability of the basin. The following planned actions are possible to build upon this concept:

- Possible expansion studies to assess the feasibility of a larger, Phase 2 of the Bayside Groundwater Project (moving from an existing 1 mgd operation to as large as a 10 mgd operations)
- Full scale Phase 2 project development (based on the results of feasibility studies and the ensuing planning efforts)

If or when other parties are shown to have depleted storage within the lower aquifer, there is the possibility that direct aquifer recharge could be utilized to counter or correct for the depletion.

Integration with Other Agency and Organization Planning Efforts: There are various planning efforts underway within basin stakeholder organizations where integration is possible, however the three that are most-likely to benefit from integration include:

- Urban Water Management Plans
- General Plans/Land Use Plans
- Integrated Regional Water Management Plans

Urban Water Management Plans: Two Basin stakeholders (EBMUD and the City of Hayward) have developed Urban Water Management Plans (UWMP). These UWMPs, are required by the State of California for all retail water purveyors who have more than 3,000 customers. UWMPs are designed to encourage efficient water use and identify ways to meet future customer demands and issues such as the sustainability of groundwater resources, should such resources play a factor.

General Plans/Land Use Plans: Stakeholder agencies are committed to providing GMP information to those entities responsible for the preparation and update of land use plans and general plans for cities and counties. The goal of such interaction will be to enable all land use agencies to have access to information regarding activities taking place for the protection and availability of groundwater resources within the SEBP basin.

3.3.5.2 Water Conservation and Recycling

EBMUD and the City of Hayward are the two water suppliers within the SEBP Basin. Each has water conservation programs in place to reduce the demand for water. The following section briefly discusses the programs of the two agencies.

EBMUD's Water Conservation Program: EBMUD provides technical and financial assistance to encourage customers to help assure an adequate water supply by using water efficiently. Their water conservation staff advises customers on selecting water-efficient products, implementing best management practices, and designing/maintaining *WaterSmart* landscaping and efficient irrigation methods. Water conservation services include water use surveys, incentives for high-efficiency plumbing fixtures, appliances, process equipment and irrigation systems, and free distribution of conservation self-survey kits and water efficient devices (*i.e.*, showerhead, faucet aerators) that reduce water use. EBMUD is also very active in new water conservation technology research and the development of education and demonstration projects. In 2011, EBMUD updated its Water Conservation Master Plan ("WCMP") to help meet long-term water supply needs through the year 2020. The WCMP serves as a blueprint for implementation strategies, goals and objectives for achieving additional water savings consistent with the targets identified in EBMUD's 2010 Urban Water Management Plan as well in their recently adopted Water Supply Management Program 2040 (WSMP 2040). The WCMP incorporates elements of the State of California's Water Conservation Act of 2009 (SB7) which calls for achieving a statewide goal of a 20 percent reduction in urban per capita water use by 2020.

City of Hayward's Water Conservation Program: The City of Hayward has one of the lowest per capita water usage among agencies that purchase water from the San Francisco Public Utilities Commission (SFPUC). This is perhaps partially due to the fact that, as one of the original signatories to the California Urban Water Council (CUWC) Memorandum of Understanding Regarding Urban Water Conservation in California (MOU), Hayward has long been committed to effective water conservation. The CUWC was created to increase water use efficiency through partnerships among urban water agencies, public interest organizations and private entities that provide services and equipment to promote water conservation.

Hayward has and will continue to actively participate in regional demand management efforts, including development and implementation of the regional Water Conservation Implementation Plan as developed by Bay Area Water Supply and Conservation Agency (BAWSCA) in 2009. Hayward evaluates each regional conservation program individually to assess the benefits to Hayward customers. To date, Hayward has participated in regional programs such as:

- High efficiency clothes washing machine rebates
- High efficiency toilet rebates
- Indoor water efficiency standards for new development
- Residential water efficient landscape classes
- School education programs (in-class and assembly)
- Distribution of pre-rinse spray valves
- Adoption of bay friendly landscape ordinances and standards

Hayward intends to continue to implement cost effective water conservation programs. Moving forward, the City will continue to assess and implement additional cost effective water conservation measures in order to achieve SB7 targets and to carry Hayward City Council's mission of efficient and sustainable use of resources. Potential future programs may include:

- Rebates for weather-based irrigation controllers and efficient irrigation systems
- Water use surveys for commercial/industrial sites, including hotels and motels
- Incentives to replace inefficient commercial and industrial equipment

3.3.5.3 Periodic Basin Assessment and Reporting

Contingent upon available funding, the basin management actions will be reviewed and analyzed to evaluate effectiveness of the actions. Necessary modification may be considered to achieve the GMP objectives. These analyses and findings are to be reported to the basin stakeholders.

3.3.5.4 Basin Replenishment

Using the GMP as a guide, all stakeholders led by EBMUD are to collaboratively manage the Basin. EBMUD has not committed to exclusively taking on basin management authority, although the agency will continue to provide guidance and coordination for other stakeholders. When basin storage conditions warrant the need to address replenishment matters, EBMUD will work with GMP stakeholders to undertake necessary actions.

3.3.5.5 Basin Water Budget

The new groundwater flow model (NEB MODFLOW) for the SEBP Basin area as well as the water budget prepared for the Basin are primarily intended for groundwater planning purposes to assist in managing ground water resources.

As a numerical analysis tool, a groundwater model assists water managers and basin stakeholders in understanding the general dynamics of the groundwater flow system within the SEBP Basin. During the GMP preparation, upon completion of model calibration, the model was used to generate a water balance and baseline estimates for the GMP area. In addition, major components of the groundwater budget were developed using the model.

From model results, groundwater elevations within the SEBP Basin appear to be reaching an equilibrium. Groundwater levels have been increasing since the 1960s, primarily as a result of the decrease in volume of groundwater extraction throughout the area since that time.

Based on a technical review of current information, the primary inflow into the GMP area can be categorized as recharge to the aquifers as a result of deep percolation of precipitation and applied water, subsurface inflow, and inflow from ungauged watersheds. The source of groundwater flow in the shallow zone is percolation primarily from the foothill region that lies to the east. That water move from east to west in the shallow aquifer, flowing towards San Francisco Bay. It is believed that the flow entering the intermediate and deep aquifers systems consists of contributions from beneath the San Francisco Bay.

If there are modifications to the volume and/or rate of groundwater extraction in the SEBP Basin, it would likely influence the overall flow balance and distribution of inflow into the GMP area. The overall water balance for the GMP area is provided in the Figure 3-3. Table 3-2 provides a summary of the simulated water budget for the GMP area for a 20-year period from 1993 through 2012. On average, inflows and outflows were in balance across the period, resulting in relatively small changes in storage in the aquifer. The average annual change in storage for the period was 152 acre-feet, a small annual increase. This is consistent with the relatively stable groundwater elevation trends over the same period as detailed in previous basin studies. Those studies indicated that the basin was refilling at a rate of 1,300 acre-feet per year in the mid-1990s (CH2MHILL, 2000). The results from the hydrologic study performed as part of this GMP preparation indicates that the basin has nearly stabilized, and the rate of increase in storage is decreasing as a consequence.

These estimates and findings are influenced by the assumptions necessary to create an "initial condition" for the Basin (as well as by how the model conceptualized various operational details of the Basin). Modifications to either of these components could be called for when and if additional Basin data becomes available in the years ahead. In turn, the water balance as prepared for the SEBP Basin should be updated.

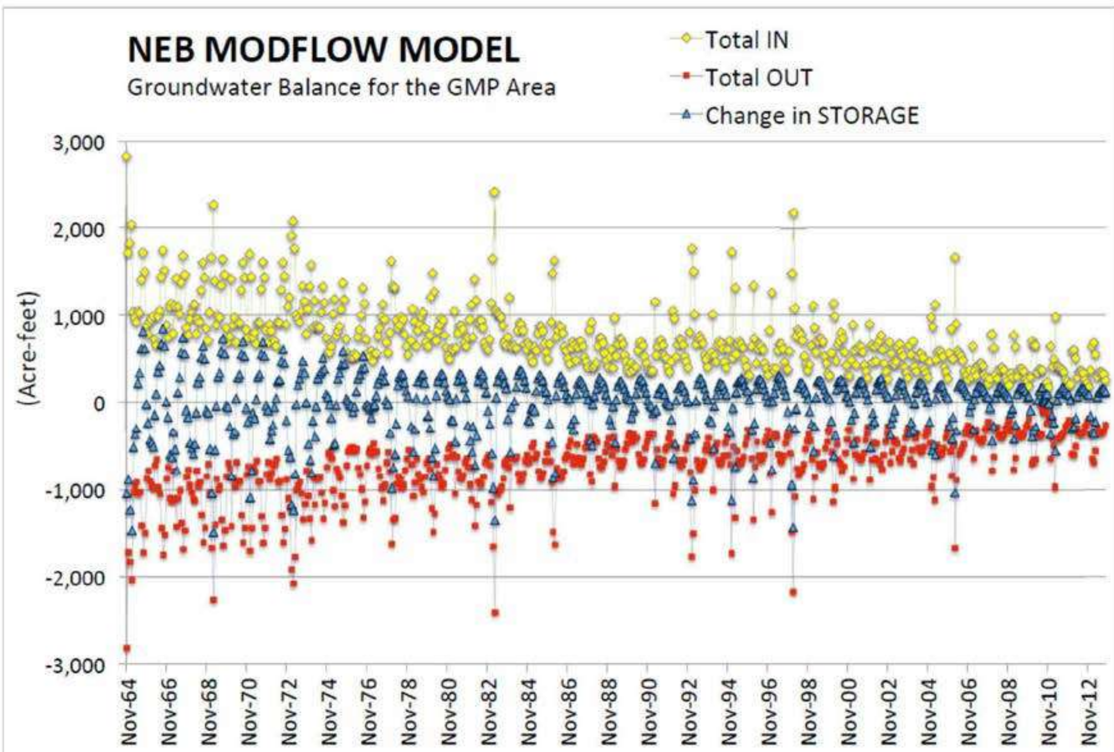


FIGURE 3-3
East Bay Municipal Utility District
South East Bay Plain Basin Characterization Study
NEB MODFLOW MODEL WATER BALANCE

Table 3-2: Simulated Annual Water Budget for the SEBP Groundwater Basin, 1993 through 2002

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Inflows										
Recharge	4,207	2,157	4,027	2,547	2,290	4,325	2,508	2,393	1,947	2,355
Ungauged Watersheds	472	0	552	571	262	997	246	265	10	87
Lake Seepage	74	68	61	101	98	50	36	44	49	55
Subsurface Inflow From:										
Below Hayward Fault	645	624	418	212	311	847	799	739	524	571
Salt Evaporation Ponds	576	587	340	161	251	630	639	578	469	450
Hayward South	723	631	477	296	356	837	806	724	568	599
Hayward North	3	2	3	2	2	3	2	2	2	2
San Leandro	8	6	7	4	4	6	5	5	4	4
Oakland	61	53	48	57	54	34	31	36	33	40
Alameda Island	157	141	125	135	131	105	90	97	97	106
Beneath San Francisco Bay	1,551	1,448	1,234	1,252	1,271	1,191	1,151	1,137	1,058	1,110
Total Subsurface Inflow	3,724	3,493	2,652	2,119	2,380	3,652	3,523	3,318	2,755	2,883
Total Inflows	8,476	5,719	7,291	5,338	5,030	9,024	6,312	6,019	4,761	5,380
Outflows										
Groundwater Extraction	3,549	3,359	3,100	3,125	3,135	3,097	3,053	3,344	2,661	3,115
Lake Evaporation	1,244	862	1,224	760	755	1,419	1,197	1,099	933	960
Subsurface Outflow To:										
Below Hayward Fault	480	255	565	615	473	617	409	382	323	322
Salt Evaporation Ponds	224	194	155	144	122	291	307	242	227	203
Hayward South	132	65	203	259	191	154	81	89	88	100
Hayward North	0	0	0	0	0	0	0	0	0	0
San Leandro	4	4	3	2	2	3	3	3	3	2
Oakland	32	34	34	27	29	39	35	31	36	33
Alameda Island	101	86	91	86	86	80	79	81	83	89
Beneath San Francisco Bay	1,126	1,046	815	483	619	1,260	1,291	1,049	994	872
Total Subsurface Outflow	2,100	1,684	1,866	1,616	1,523	2,443	2,205	1,875	1,754	1,621
Total Outflows	6,893	5,906	6,190	5,501	5,414	6,959	6,456	6,318	5,348	5,696
Change in STORAGE	1,583	-187	1,102	-164	-384	2,064	-143	-299	-586	-316

Future Governance Plans: It is anticipated that at some point in time, there may be a need to enter into a more formal governance structure. Such a structure would enable the following:

- Collective management of a well protection program, well destruction program/policies, well installation policies, etc.
- Integration of Basin objectives into the Bay Area Integrated Regional Water Management Plan.
- Collective means to apply for grant monies.
- Development of means and procedures whereby Basin replenishment is managed (should one or more entities be deemed responsible for extracting groundwater from the Basin to cause overdraft).
- Collective preparation of updates to the GMP as well as of periodic State-of-the-Basin reports.
- While undertaking all the sustainability measures, if the Basin becomes overdrafted, EBMUD will collaborate with stakeholders to develop a replenishment plan.

SECTION 4.0 PLAN IMPLEMENTATION AND INTEGRATION

4.1 PERIODIC GMP IMPLEMENTATION MEETINGS

Working with other Basin stakeholders, EBMUD will review the progress made implementing the GMP. Stakeholders will hold meetings to facilitate the review process, tentatively assumed to be annual State of the Basin meetings. Those meetings will discuss the groundwater conditions in the SEBP Basin area and document groundwater management activities from the previous year. Much of the data reviewed as part of preparing annual State of the Basin summaries will come from the monitoring and successful implementation of the action items as developed and detailed in Section 3.0 of this GMP.

During periods where significant changes have occurred within the Basin, the stakeholders (as an action item following the State of the Basin meeting) may elect to craft a summary report. That summary will document conditions that have occurred since last State of the Basin meeting. The report may include:

- A summary of monitoring results that includes a discussion of historical trends and an interpretation of water quality and groundwater elevation data.
- A summary of management actions during the period covered by the report.
- A discussion of the need (if any) to collected additional groundwater basin data to aid in the analysis of conditions observed.
- A discussion, supported by monitoring results, of whether management actions are achieving progress in meeting Basin management objectives.
- A discussion of the need to modify any GMP component, including the Basin management objectives.

Description of Action	Implementation Schedule (approximate time for commencing activity following GMP adoption)
I. Stakeholder Involvement	
Involving the Public	
▪ Continue efforts to encourage public participation as opportunities arise. ▪ Reach out to local and business communities via EBMUD's Bayside Groundwater Project's Community Liaison Group. ▪ Assist stakeholders in disseminating the information through other various public forums.	On-going 6 months 6 months
Coordinate with State and Federal Agencies	
▪ Continue to develop working relationships with local, state, and federal regulatory agencies. ▪ Coordinate GMP implementation activities with local, state and federal agencies as appropriate.	On-going On-going

Pursuing Partnership Opportunities	
▪ Continue to foster partnership opportunities to achieve both local supply reliability and broader regional and statewide benefits. ▪ Continue to seek grant opportunities to fund local projects that can improve groundwater management and improve local water infrastructure.	On-going On-going
II. Monitoring Programs	
Groundwater Elevation Monitoring	
▪ Use CASGEM groundwater elevation monitoring guidelines for water level data collection. ▪ Provide stakeholder agencies with guidelines on the collection of water quality data as per USEPA sampling standards. ▪ Assist stakeholders in developing and implementing monitoring programs. ▪ Coordinate with stakeholder agencies to develop standardized reference elevations for monitoring wells. ▪ Coordinate with stakeholders and request that the timing of water level data collection occur on or about April 15 and October 15 of each year. ▪ Provide a period assessment of groundwater elevation trends and conditions to stakeholders. ▪ Assess the adequacy of the groundwater elevation monitoring network periodically.	On-going On-going and as needed On-going and as needed On-going and as needed On-going On-going 12 months
Groundwater Quality Monitoring Programs	
▪ Coordinate with stakeholders in using standardized water quality sampling protocols. ▪ Monitor stakeholder's existing monitoring well network for purposes of groundwater quality monitoring. ▪ Collaborate with local, state, and federal agencies such as USGS to identify opportunities to continue conducting water quality analyses in less known areas of the basin. ▪ Review and assess the effectiveness of the groundwater quality monitoring program periodically and recommend improvements as necessary. ▪ Develop a GIS based groundwater quality database. ▪ Apply for state and federal grants to collect, compile and integrate groundwater quality data.	On-going and as necessary On-going On-going 12 months 12 months (if grant funding is available) 12 months (depending on grant program opportunities)

Subsidence Monitoring Program	
▪ Periodically re-survey the established reference elevations at groundwater monitoring stations. ▪ Collaborate with state and federal agencies, particularly the USGS, to collect and analyze land surface movement data for potential land surface subsidence using various methodologies including InSAR remote sensing.	36 months (if grant funding is available) 36 months (if grant funding is available)
III. Groundwater Management Tools	
Groundwater Resources Protection	
▪ Ensure that all stakeholders are provided a copy of the county well ordinance and understand the proper well construction procedures. ▪ Support ACPWA in adopting the updated well ordinance. ▪ Support stakeholders in educating the public about the updated well standards and in adopting local ordinances to implement those well standards.	6 months+ (assumes county passes new well ordinance) 3 months 6-12 months
Wellhead Protection	
▪ Obtain an updated coverage of potentially contaminating activities and provide that information to stakeholders. ▪ Share current wellhead protection measures and provide a summary of actions taken by others as a tool in managing their individual wellhead protection programs.	24 months 24 months
Protecting Recharge Areas	
▪ Inform and assist groundwater authorities and land use planners to consider the need to protect prominent groundwater recharge areas in the land use planning process.	24 months
Groundwater Contamination	
▪ If contaminants exceeding water quality standards are detected in monitoring wells, initiate facilitation between the responsible parties and the potentially impacted stakeholders to manage the contamination. ▪ Inform and coordinate with SFRWQCB and DTSC to encourage these agencies to take necessary actions.	On-going and as needed On-going and as needed

IV. Groundwater Sustainability	
Public Outreach and Involvement	
▪ Hold an annual stakeholders workshop whereby the matter of public involvement is a standing agenda item.	12 months
▪ Agency leads for GMP implementation shall work with other stakeholders to assure continued communication following GMP adoption (including participation in discussions with stakeholders, electeds and staff).	3 months
▪ Make available printed copies of the GMP at select public libraries within the basin footprint.	3 months
▪ Alert the public as to the availability of an electronic version of the GMP (by mentioning it in existing newsletters, newspaper articles, etc.).	1 month – 12 months
▪ Maintain the EBMUD-hosted website for the SEBP basin GMP.	On-going
▪ Through the stakeholders group, develop a coordinated outreach plan to inform the public and key electeds.	3 months
▪ Present GMP details at community forums, in conjunction with existing neighborhood outreach efforts.	3-12 months

4.2 FUTURE REVIEW OF THE SEBP BASIN GMP

This GMP is intended to be a framework for future coordinated management efforts in the South East Bay Plain area. As such, many of the identified actions will likely evolve as the stakeholder agencies begin to work together to cooperatively manage and learn more about the basin. Over time, and in the event that the basin usage grows such that it becomes an even greater relied-upon resource to the various stakeholders, the potential need for a more formal groundwater management entity may be considered.

There is the potential, as described in section 4.1, that additional actions could also be identified as part of the GMP implementation periodic review process. The GMP is therefore intended to be a living document, and it will be important to evaluate all of the actions and objectives over time to determine how well they are meeting the overall goal of the plan.

4.3 FINANCING

Implementation of the GMP, as well as many other groundwater management-related activities could be funded from a variety of sources including in-kind services by agencies; state or federal grant programs; and local, state, and federal partnerships. Some of the items that would require additional resources include:

- Monitoring for groundwater quality or elevations in non-purveyor wells
- Preparation of GMP annual reports

- Updates of the overall GMP
- Updates of data sets and recalibration/improvement of the groundwater model produced for the SEBP Basin
- Collection of additional subsidence data (beyond what EBMUD is required to collect as part of its operation of their Bayside Groundwater Project Phase 1)
- Construction of monitoring wells where critical data gaps exist
- Stream-aquifer interaction studies
- Implementation of the GMP including:
  - Committee coordination
  - Project management

4.4 INTEGRATED WATER RESOURCES MANAGEMENT

Integration of various water management programs that are underway in the Bay Area is a complex activity, as part of the update of the Bay Area Integrated Regional Water Management Plan (Bay Area IRWMP). The Bay Area IRWMP will reference the GMP effort and document moving forward as part of the periodic updates of the Bay Area IRWMP.

Bay Area IRWMP

Integrated Regional Water Management Plan

BAY AREA IRWMP Project Form

March 2012

This form need not be completed in its entirety in order to propose a project for inclusion in the Bay Area Integrated Regional Water Management Plan (IRWMP). Items denoted with an asterisk (*) are required.

Complete "Part 1: Project Concept" as much as possible to identify and describe the project. The second section of this part, "Collaboration Information," will help provide sponsors of other projects with sufficient information so they know whether or not there may be value in working with you to develop a more integrated and multipurpose project.

Complete "Part 2: Detailed Project Information" so that a project may be thoroughly described and prioritized in the IRWMP. Projects cannot be scored without information provided in Part 2.

Review "Part 3: Benefit-Cost Analysis" which enables the Bay Area IRWMP Project Selection Committee to better score projects for inclusion in a grant proposal. The information is also is used by the Department of Water Resources (DWR) in scoring grant proposals. This section does not need to be completed at this stage but will be required as the project review and selection process moves forward. Please review this section to become familiar with information requirements typical for grant applications and use it to complete Table A in Section 3.

Complete "Table A in Part 3: Benefit-Cost Analysis" to enable the Bay Area IRWMP Project Selection Committee to understand to what degree projects have cost:benefit information and what additional support is needed to gather this information, which is required by DWR to score the grant proposals. See Tables 1 through 14 prior to completing Table A for detail on the information required

PART 1: PROJECT CONCEPT

Basic Project Information

1 Name of Project*				
2 Sponsoring Agency/Organization*				
3 Subregion (check all that apply)	North Bay ☐	East Bay ☐	South Bay ☐	West Bay ☐
4 County(ies)				
5 Watershed Tributary				
6 Public or private land?	Public ☐	Private ☐	Both ☐	
7 Other Participating or Partnering Agencies/Organizations (separate with commas)				

8	Contact Person Name*	
9	Email*	
10	Phone* (###) ###-###	

11	Basic Project Description (1-2 Sentences)
12	Project Website (if any)
13	Estimated Project Cost
14	What percentage of project costs does the agency/organization have in matching funds? (does not apply to non-governmental organizations and disadvantaged communities)
15	Estimated time to complete all phases of the project once funding is secured
16	Project deadline and/or expiration date

Collaboration Information (Please complete this portion of the template as much as possible at this time in order to help others determine if this project might be combined with one or more other projects in order to create a more integrated and multipurpose project and share project development costs. Further information can be added at a later date as appropriate.)

1	**Project Type (Check al that apply. Please provide a brief explanation, in a few words, below each of the checked project types)**
☐	Drinking Water Supply
☐	Water Quality Improvement
☐	Water Reuse/Recycling
☐	Stormwater Improvements
☐	Groundwater Benefits
☐	Infiltration
☐	Habitat Protection and Restoration
☐	Flood Protection
☐	Related to a Disadvantaged Community
☐	Related to a Native American Tribe

2	**If this is a conservation effort, does it address long-term drought preparedness by contributing to sustainable water supply and reliability?**
3	**How does this project effectively integrate water management with land use planning?**
4	**What additional partnerships or project activities could make this a multi-benefit project? (see Project Type, above)**
5	**Is the sponsor of this project in a position to financially assist a project partner that may have limited financial resources to help develop a collaborative project?**
6	**Does this project incorporate and implement low impact development (LID) design features, techniques, and practices to reduce or eliminate stormwater runoff?**

PART 2: DETAILED PROJECT INFORMATION

Detailed Project Description (Please complete/answer all questions even if it repeats information provided in the Part 1: Project Concept.)

Projects cannot be scored without information provided in Part 2.

1	**Provide a detailed description (1-2 paragraphs) of the project including the general project concept, what will be constructed and/or implemented, how the project will function, treatment methods employed, how a conservation program would function, water savings achieved, etc.***	
2	**Is the project an element or phase of a regional or larger program?**	Yes ☐ No ☐
	If so, what is the regional or larger program and how does this project relate to it?	
3	**Proposed project start date (Initiation of project activities) (mm/dd/yyyy)**	
4	**Proposed project completion date (mm/dd/yyyy)**	

5 **Please indicate the status of the following:**

Project element	Status (e.g., pending, in process, complete)	Percent completion
Conceptual plans		
Land acquisition/easements		
Preliminary plans		
CEQA/NEPA		
Construction drawings		
Funding		
Readiness to proceed		

6	**List documents that contain information specific to the proposed project description and provide links to those that may be found online.**
•	
•	
•	
•	

7 Project Location

Please provide either Latitude/Longitude or Location Description. To determine the latitude/longitude, use the closest address or intersection. If the project is linear, use the furthest upstream latitude/longitude.

Project Latitude	
Project Longitude	
Location Description	

List any applicable surface water bodies and groundwater basins associated with the proposed project.

•	
•	
•	
•	

8 Project Need

a. It is important to understand the need(s) or issue(s) that the proposed project will address and the benefits that it will provide. Information provided in this section defines the need(s) or issue(s) that the proposed project will address and will help to catalog existing need(s) or issue(s) in the Bay Area.

Provide a 1-2 paragraph description of the need(s) or problem(s) that the project will address. As applicable, discuss the water supply need, operational efficiency need, water quality need, ability to reduce water demand and/or water supply, or resource stewardship need (e.g. ecosystem restoration, floodplain management).

b. Discuss critical impacts that will occur if the proposal is not implemented.

9 Project Benefits

a. Provide a detailed description (1-5 paragraphs) of the benefit(s) that the project will provide. To the extent possible, this description should quantify changes and benefits that will result from implementation of the project. Where not possible, qualitative descriptions may be used. These should include benefits to any of the following that may apply:

i. Water Supply (conservation, recycled water, groundwater recharge, surface storage, etc.)

ii. Water Quality

iii. Flood and Stormwater Management

iv. Resource Stewardship (watershed management, habitat protection and restoration, recreation, open space, etc.)

b. Does the project reduce water supply demands on the Bay/Delta Estuary?

c.	Does the project address any known environmental justice issues?		
	Is the project located within or adjacent to a disadvantaged community?	Yes ☐	No ☐
	Does the project include disadvantaged community participation?	Yes ☐	No ☐

If there is no disadvantage community, please identify and provide the number of low income areas with census tracts, blocks and/or sectors, low income population/total population).

10	**Climate Change (check all those that indicate to what extent the project contributes to climate change response actions)**
a.	Adaptation to Climate Change
☐	Increases Water Supply Reliability
☐	Advances/ Expands Conjunctive Management of Multiple Water Supply Sources
☐	Increases Water Use and/or Reuse Efficiency
☐	Provides Additional Water Supply
☐	Promotes Water Quality Protection
☐	Reduces Water Demand
☐	Advances/Expands Water Recycling
☐	Promotes Urban Runoff Reuse
☐	Addresses Sea Level Rise
☐	Addresses other Anticipated Climate Change Impact (e.g. through water management system modifications)
	Please describe:
☐	Improves Flood Control (e.g. through wetlands restoration, management, protection)
☐	Promotes Habitat Protection
☐	Establishes Migration Corridors
☐	Re-establishes River-Floodplain Hydrologic Continuity
☐	Re-introduces Anadromous Fish Populations to Upper Watersheds
☐	Enhances and Protects Upper Watershed Forests and Meadow Systems
☐	Other (Please Describe):
☐	Other (Please Describe):
b.	Mitigation by Reducing Greenhouse Gas Emissions and/or Energy Consumption
☐	Increases Water Use Efficiency or Promotes Energy-Efficient Water Demand Reduction
☐	Improves Water System Energy Efficiency
☐	Advances/Expands Water Recycling
☐	Promotes Urban Runoff Reuse
☐	Promotes Use of Renewable Energy Sources
☐	Contributes to Carbon Sequestration (e.g. through vegetation growth)
☐	Other (Please Describe):

11	**Project Costs**	
	Lower estimated total capital cost	
	Upper estimated total capital cost	
	Source of funding match for capital cost	
	Land/easement cost	
	Annual operations and maintenance cost	
	Funding source for annual operations and maintenance	
	Life of the project (years)	

12	**Statewide Priorities (check all that the project addresses)**
☐	Drought Preparedness
☐	Use and Reuse Water More Efficiently
☐	Climate Change Response Actions (Adaptation to Climate Change, Reduction of Greenhouse Gas Emissions, Reduce Energy Consumption)
☐	Expand Environmental Stewardship
☐	Practice Integrated Flood Management
☐	Protect Surface and Groundwater Quality
☐	Improve Tribal Water and Natural Resources
☐	Ensure Equitable Distribution of Benefits
☐	Reduce Reliance on the Bay-Delta
13	**California Water Plan Resource Management Strategies (check all that apply). (Please see page 45 of Proposition 84 and Proposition 1E Guidelines dated August 2010.)**
☐	Reduce Water Demand
☐	Improved Operational Efficiency and Transfers
☐	Increase Water Supply
☐	Improve Water Quality
☐	Improve Flood Management
☐	Practice Resources Stewardship
☐	Other Strategies (Please Describe):
14	**Eligibility Criteria. (Please see pages 15 and 16 of Proposition 84 and Proposition 1E Guidelines dated August 2010.)**
☐	Groundwater Management Plan
☐	Urban Water Management Plan
☐	Water Meter Requirements
☐	Groundwater Monitoring Requirements
☐	AB 1420 Compliance
☐	BMP Compliance
☐	CEQA Compliance
15	**Multiple Benefits – for Proposition 84 grants (check all that apply – at least one must be checked)**
☐	Water supply reliability, water conservation and water use efficiency
☐	Stormwater capture, storage, clean-up, treatment, and management
☐	Removal of invasive non-native species, the creation and enhancement of wetlands, and the acquisition, protection, and restoration of open space and watershed lands
☐	Non-point source pollution reduction, management and monitoring
☐	Groundwater recharge and management projects
☐	Contaminant and salt removal through reclamation, desalting, and other treatment technologies and conveyance of reclaimed water for distribution to users
☐	Water banking, exchange, reclamation and improvement of water quality
☐	Planning and implementation of multipurpose flood management programs
☐	Watershed protection and management
☐	Drinking water treatment and distribution
☐	Ecosystem and fisheries restoration and protection
☐	Reduced Reliance on the Bay-Delta
Exceptions to above (if none are checked):	
☐	Projects that directly address a critical water quality or supply issue in a DAC
☐	Urban water suppliers implementing certain BMPs as on page 17 of Guidelines

16	**For Proposition 1E Stormwater Flood Management (check all that apply – Note that to be eligible for funding, the project must address all)**
☐	Be designed to manage stormwater runoff to reduce flood damage (PRC §5096.827)
☐	Be consistent with the applicable Regional Water Quality Control Plans (Basin Plans) (PRC §5096.827)
☐	Not be a part of the State Plan of Flood Control (SPFC) (PRC §5096.827)
17	**Bay Area IRWM Plan Goals and Objectives (check all that apply)**
a.	Promotion of economic, social, and environmental sustainability
☐	Avoiding, minimizing, and mitigating net impacts to environment
☐	Maintaining and promoting economic and environmental sustainability through sound water resources management practices
☐	Maximizing external support and partnerships
☐	Maximizing ability to get outside funding
☐	Maximizing economies of scale and governmental efficiencies
☐	Providing trails and recreation opportunities
☐	Protecting cultural resources
☐	Increasing community outreach and education for watershed health
☐	Maximizing community involvement and stewardship
☐	Reducing energy use and/or use renewable resources where appropriate
☐	Minimizing solid waste generation/maximize reuse
☐	Engaging public agencies, businesses, and the public in stormwater pollution prevention and watershed management, including decision -making
☐	Achieving community awareness of local flood risks, including potential risks in areas protected by existing projects
☐	Considering and addressing disproportionate community impacts
☐	Balancing needs for all beneficial uses of water
☐	Securing funds to implement solutions
b.	Improved supply reliability
☐	Meeting future and dry year demands
☐	Maximizing water use efficiency
☐	Minimizing vulnerability of infrastructure to catastrophes and security breaches
☐	Maximizing control within the Bay Area region
☐	Preserving highest quality supplies for highest use
☐	Protecting against overdraft
☐	Providing for groundwater recharge while maintaining groundwater resources
☐	Increasing opportunities for recycled water use consistent with health and safety
☐	Maintaining a diverse portfolio of water supplies to maximize flexibility
☐	Securing funds to implement solutions
c.	Protection and improvement of hydrologic function
☐	Protecting, restoring, and rehabilitating natural watershed processes
☐	Controlling excessive erosion and managing sedimentation
☐	Maintaining or improving in-stream flow conditions
☐	Improving floodplain connectivity
☐	Preserving land perviousness and infiltration capacity
☐	Securing funds to implement solutions

d.	Protection and improvement of the quality of water resources
☐	Minimizing point and non-point source pollution
☐	Reducing salinity-related problems
☐	Reducing mass loading of pollutants to surface waters
☐	Minimizing taste and odor problems
☐	Preserving natural stream buffers and floodplains to improve filtration of point and non-point source pollutants
☐	Maintaining health of whole watershed, upland vegetation and land cover to reduce runoff quantity and improve runoff quality
☐	Protecting surface and groundwater resources from pollution and degradation
☐	Anticipating emerging contaminants
☐	Eliminating non-stormwater pollutant discharges to storm drains
☐	Reducing pollutants in runoff to the maximum extent practicable
☐	Periodically evaluating beneficial uses
☐	Continuously improving stormwater pollution prevention methods
☐	Securing funds to implement solutions
e.	Protection of public health, safety, and property
☐	Providing clean, safe, reliable drinking water
☐	Minimizing variability for treatment
☐	Advancing technology through feasibility studies/demonstrations
☐	Meeting promulgated and expected drinking water quality standards
☐	Managing floodplains to reduce flood damages to homes, businesses, schools, and transportation
☐	Minimizing health impacts associated with polluted waterways
☐	Achieving effective floodplain management by encouraging wise use and management of flood-prone areas
☐	Maintaining performance of flood protection and stormwater facilities
☐	Partnering with municipalities to prepare mitigation action plans that reduce flood risks to the community
☐	Coordinating resources and mutual aid between agencies to enhance agency effectiveness
☐	Securing funds to implement solutions
f.	Creation, protection, enhancement, and maintenance of environmental resources and habitats
☐	Providing net benefits to environment
☐	Conserving and restoring habitat for species protection
☐	Acquiring, protecting and/or restoring wetlands, streams, and riparian areas
☐	Enhancing wildlife populations and biodiversity (species richness)
☐	Providing lifecycle support (shelter, reproduction, feeding)
☐	Protecting and recovering fisheries (natural habitat and harvesting)
☐	Protecting wildlife movement/wildlife corridors
☐	Managing pests and invasive species
☐	Recovering at-risk native and special status species
☐	Improving structural complexity (riparian and channel)
☐	Designing and constructing natural flood protection and stormwater facilities
☐	Securing funds to implement solutions
g.	List any other project information that merits consideration.
•	
•	
•	
•	

18 Expected project benefits and impacts.

Quantify as much as possible the benefits and impacts of the project for each water management strategy (see the list in #13 above). The following is an example of the format without the benefits and impacts quantified:

Water Management Strategy	Typical Benefits	Typical Impacts
Ecosystem Restoration	*Protection and enhancement of physical and biological processes (ex., increasse average streamflow from 70 cu ft/s to 150 cu ft/s)*	*Temporary construction impacts (ex., 5 acres impacted over 6 months)*
	Increased critical habitat (ex., 5 additional acres of habitat)	*Changes in local species composition and diversity (ex., 2 species potentially impacted)*
	Reduced flooding (ex., reduce probability of sever flooding by 30%)	
	Improved Water Quality (ex., reduce nitrate concentrations to < 10 mg/L)	

PART 3: BENEFIT-COST ANALYSIS

Please access the Section 3 Tab below for Part 3: Benefit-Cost Analysis

BAY AREA IRWMP Project Template
March 2012

PART 3: BENEFIT-COST ANALYSIS

This portion of the project template asks for information that will be critical in determining which projects will be included in a Proposition 84 grant proposal. DWR uses the cost benefit analysis as a major scoring factor for both Proposition 84 and Proposition 1E grant proposals.

After reviewing the ENTIRE Section, (Tables 1 through 14) please complete Table A.

Table A* - Cost:Benefit Information Availability

Benefit Category	Is this benefit addressed by the proposed project? (Yes/No)	Can you provide this C:B information now? (Yes/No)	Will you be able to provide this C:B information for a grant application? (Yes/No)	If you answered "No" in column "C", do you need extra assistance to be able to provide this information?	Additional Comments
Water Supply					
Water Quality					
Ecosystem Restoration					
Recreation and Public Access					
Power Cost Savings and Production					
Flood					
Avoided Cost of Future Projects					
Other (please specify):					

The DWR Economic Analysis Handbook (http://www.water.ca.gov/pubs/planning/economic_analysis_guidebook/econguidebook.pdf) is referred to in the Proposition 84 & Proposition 1E Guidelines dated August 2010 as guidance for determining if project benefits justify project costs.

The following is an excerpt from Chapter 3 of the Handbook that explains in more detail the purpose of the analysis:

Benefit-cost analysis is the procedure where the different benefits and costs of proposed projects are identified and measured (usually in monetary terms) and then compared with each other to determine if the benefits of the project exceed its costs. Benefit-cost analysis is the primary method used to determine if a project is economically justified. A project is justified when: • estimated total benefits exceed total estimated economic costs;
• each separable purpose (for example, water supply, hydropower, flood damage reduction, ecosystem restoration, etc.) provides benefits at least equal to its costs;
• the scale of development provides maximum net benefits (in other words, there are no smaller or larger projects which provide greater net benefits); and
• there are no more-economical means of accomplishing the same purpose.

Integrated Regional Water Management Projects (Proposition 84)

For integrated regional water management projects that may qualify for grants under Proposition 84 for grant funding, please refer to the Handbook and tables and also complete as much as possible the following Project Budget and Project Benefits forms that were used by consultants to gather project information that was included in the Round 1 proposal and that DWR then evaluated to determine the benefit-cost ratio.

Please review this section to become familiar with information requirements typical for grant applications. After reviewing the ENTIRE Section, please complete Table A below.

Table 1 - Project Budget

Project Title:

		(a)	(b)	(c)	(d)	(e)
Budget Category		**Non-State Share* (Funding Match)**	**Requested Grant Funding**	**Other State Funds Being Used**	**Total**	**% Funding Match**
(a)	Direct Project Administration Costs				$0	#DIV/0!
(b)	Land Purchase/Easement				$0	#DIV/0!
(c)	Planning/Design/Engineering/ Environmental Documentation				$0	#DIV/0!
(d)	Construction/Implementation				$0	#DIV/0!
(e)	Environmental Compliance/ Mitigation/Enhancement				$0	#DIV/0!
(f)	Construction Administration				$0	#DIV/0!
(g)	Other Costs				$0	#DIV/0!
(h)	Construction/Implementation Contingency				$0	#DIV/0!
(i)	**Grand Total (Sum rows (a) through (h) for each column)**	**$0**	**$0**	**$0**	**$0**	#DIV/0!

**List sources of funding: Use as much space as required.*

Table 2 - Project Benefits

Project Title:

Benefit Category	**Benefit Detail**	**Measure of Benefit (Units)**	**Level of Benefit Without Project**	**Level of Benefit With Project**	**Benefit Start Year**	**Benefit End Year**
Water Supply Benefits						
Water Supply(1)		AFY				
Water Quality and Other Expected Benefits						
Water Quality		AFY				
Ecosystem Restoration		Acres				
Recreation and Public Access		Acres				
Power cost savings and production		kWh				
Other						
Avoided cost of future projects						
Avoided cost of future projects	Please refer to next tab.					
Flood Damage Reduction						
Flood	Please contact K/J if your project has flood damage reduction benefits.					

Comments: Enter any sources and references, including page numbers, supporting the numbers used above.

[(1)] *At a minimum, each water supply benefit must be described. If possible, each benefit should be quantified in physical terms. For each water supply benefit, the applicant should determine if a monetary value could be placed on the unit of benefit.*

Below is a sample list of project benefits. If you choose to enter a benefit not listed below, please provide a detailed description.

Benefit Category	Benefit Detail
Water Supply	Groundwater Basin Storage
	Conservation program
Water Quality	Improvements related to protecting, restoring or enhancing beneficial uses
	Water quality improvements for impaired water bodies and sensitive habitats
	Avoided water quality projects
	Avoided water treatment
	Avoided wastewater treatment
	Water quality improvements related to providing water supplies (if not already captured as a water supply benefit)
Ecosystem Restoration	Habitat restoration
	Ecosystem improvements and preservation
	Fish and wildlife enhancements
Recreation and Public Access	Types and quality of recreational activities
	Visitor days
Power cost savings and production	Quantity of power saved or produced
Flood	Avoided physical damage (buildings, contents, infrastructure, landscaping, vehicles, equipment, crops, ecosystems)
	Avoided loss of functions (NET loss of business income, NET loss of rental income, NET loss of wages, NET loss of public services, NET loss of utility services, displacement costs of
	Avoided emergency response costs (Evacuation and rescue costs, security costs, dewatering flood management system repairs, humanitarian assistance)
	Avoided public safety and health impacts (population at risk, casualties, displacement/shelter needs, critical facilities)
Avoided cost of future projects	See Table 11 below for details

For benefits that could not be quantified in physical terms, please provide a description below. The description should include a description of economic factors that may affect or qualify the amount of economic benefits to be realized. The description should also include any uncertainty about the future that might affect the level of benefits received.

Description of Qualitative Benefits **:**

Stormwater and Flood Management Projects (Proposition 1E)

For Round 1 of Proposition 1E Stormwater and Flood Management grants the Department of Water Resources (DWR) required the following tables to be completed. It is expected that the same will be the case for Round 2. If the proposed project is for stormwater and flood management please complete the tables with as much detail as possible.

Table 3 - Project Budget

Project Title:

		(a)	(b)	(c)	(d)	(e)
Budget Category		**Non-State Share* (Funding Match)**	**Requested Grant Funding**	**Other State Funds Being Used**	**Total**	**% Funding Match**
(a)	Direct Project Administration Costs				$0	#DIV/0!
(b)	Land Purchase/Easement				$0	#DIV/0!
(c)	Planning/Design/Engineering/ Environmental Documentation				$0	#DIV/0!
(d)	Construction/Implementation				$0	#DIV/0!
(e)	Environmental Compliance/ Mitigation/Enhancement				$0	#DIV/0!
(f)	Construction Administration				$0	#DIV/0!
(g)	Other Costs				$0	#DIV/0!
(h)	Construction/Implementation Contingency				$0	#DIV/0!
(i)	**Grand Total (Sum rows (a) through (h) for each column)**	**$0**	**$0**	**$0**	**$0**	#DIV/0!

**List sources of funding: Use as much space as required.*

Table 4 - Annual Cost of Flood Damage Reduction Project (All costs should be in 2009 Dollars)									
Project Title:									
	Initial Costs	Operations and Maintenance Costs						Discounting Calculations	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Grand Total Cost From Table 3 (row (i), column(d))	Admin	Operation	Maintenance	Replacement	Other	Total Costs	Discount Factor	Discounted Costs
							(b) +…+ (g)		(h) x (i)
2012							$0	1	$0
2013							$0	0.943	$0
2014							$0	0.89	$0
2015							$0	0.84	$0
…								…	
…								…	
Project Life								…	
Total Present Value of Discounted Costs (Sum of Column (j))									**$0**
Transfer to Table 15, column (c): Proposal Costs and Benefits Summaries									
Comments to Table 4:									

Table 5 - Event Damage							
Hydrologic Event	Event Probability	Damage if Flood Structures Fail	Probability Structural Failure		Event Damage		Event Benefit (Million $)
			Without Project	With Project	Without Project	With Project	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
					(c) x (d)	(c) x (e)	(f) – (g)
10-Year					$0	$0	$0
15-Year					$0	$0	$0
20-Year					$0	$0	$0
25-Year					$0	$0	$0
50-Year					$0	$0	$0

Table 6 - Present Value of Expected Annual Damage Benefits			
(a)	Expected Annual Damage Without Project [1]		
(b)	Expected Annual Damage With Project [1]		
(c)	Expected Annual Damage Benefit (a) – (b)		$0
(d)	Present Value Coefficient [2] (c) x (d)		
(e)	**Total Present Value of Future Benefits** Transfer to column (e) Table 15: Proposal Costs and Benefits Summaries.		**$0**
[1] *This program assumes no population growth thus EAD will be constant over analysis period.*			
[2] *6% discount rate; 50-year analysis period (could vary depending upon life cycle of project).*			

Water Supply Projects

Table 7 - Minimum Seismic Failure Economics Data		
Project Title:		
Variables	**Without Project**	**With Project**
Earthquake magnitude which causes structural failure		
Estimated probability of seismic event causing structural failure (%)		
Potential inundation damage ($)		

Table 8- Annual Cost of Water Supply Project

(All costs should be in 2009 Dollars)

Project Title:

	Initial Costs	Operations and Maintenance Costs						Discounting Calculations	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Capital and Other initial Costs from Table 6	Admin	Operation	Maintenance	Replacement	Other	Total Costs	Discount Factor	Discounted Costs
							(b) +…+ (g)		(h) x (i)
2012							$0	1	$0
2013							$0	0.943	$0
2014							$0	0.89	$0
2015							$0	0.84	$0
…								…	
…								…	
Project Life								…	
Total Present Value of Discounted Costs (Sum of Column (j))									**$0**
Transfer to Table 14, column (c): Proposal Costs and Benefits Summaries									

Comments to Table 8:

Table 9- Annual Water Supply Benefits

(All benefits should be in 2009 dollars)

Project Title:

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project[(1)]	Unit $ Value[(1)]	Annual $ Value[(1)]	Discount Factor[(1)]	Discounted Benefits[(1)]
					(e) – (d)		(f) x (g)		(h) x (i)
2012	a				$0		$0	1	$0
	b				$0		$0	1	$0
	c				$0		$0	1	$0
	d				$0		$0	1	$0
	..				$0		$0		$0
2013	a				$0		$0	0.943	$0
	b				$0		$0	0.943	$0
	c				$0		$0	0.943	$0
	d				$0		$0	0.943	$0
	..				$0		$0		$0
2014	a				$0		$0	0.89	$0
	b				$0		$0	0.89	$0
	c				$0		$0	0.89	$0
	d				$0		$0	0.89	$0
…	..				$0		$0	…	
Project Life					$0		$0	…	
Total Present Value of Discounted Benefits Based on Unit Value (Sum of the values in Column (j) for all Benefits shown in table)									**$0**

[(1)] *Complete these columns if dollar value is being claimed for the benefit.*

Comments to Table 9:

Table 10 - Annual Costs of Avoided Projects (All avoided costs should be in 2009 dollars)						
Project Title:						
	Costs				Discounting Calculations	
(a)	(b)[1]	(c)	(d)	(e)	(f)	(g)
Year	Alternative (Avoided Project Name): ___________________				Discount Factor	Discounted Costs
	Avoided Project Description:					
	Avoided Capital Costs	Avoided Replacement Costs	Avoided Operations and Maintenance Costs	Total Cost Avoided for Individual Alternatives		
				(b) + (c) + (d)		(e) x (f)
2012				$0	1	$0
2013				$0	0.943	$0
2014				$0	0.899	$0
2015				$0	0.839	$0
…					…	
Project Life					…	
Total Present Value of Discounted Costs						$0
(Sum of Column (g))						
(%) Avoided Cost Claimed by Project						
Total Present Value of Discounted Avoided Project Costs Claimed by alternative Project						$0
(Total Present Value of Discounted Costs x % Avoided Cost Claimed by Project)						
Comments to Table 10:						

[1] For green infrastructure projects, calculate the avoided capital costs by multiplying each acre treated by $32,526 to get the expected benefit

Table 11 - Annual Other Water Supply Benefits (All benefits should be in 2009 dollars)					
Project Title:					
(a)	(b)	(c)	(d)	(e)	(f)
Year	Type of Benefit	Description of Benefit	Annual Benefits ($)[1]	Discount Factor[1]	Discounted Benefits[1]
					(d) x (e)
2012	a			1	$0
	b			1	$0
	c			1	$0
	..			1	$0
2013	a			0.943	$0
	b			0.943	$0
	c			0.943	$0
	..			0.943	$0
2014	a			0.89	$0
	b			0.89	$0
	c			0.89	$0
	..			0.89	$0
…				…	
Project Life				…	
Total Present Value of Discounted Benefits Based on Unit Value					$0
(Sum of the values in Column (f) for all Benefits shown in table)					

[1] *Complete these columns if dollar value is being claimed for the benefit.*

Comments to Table 11:

Table 12 - Total Water Supply Benefits (All benefits should be in 2009 dollars)			
Project Title:			
Total Discounted Water Supply Benefits	Total Discounted Avoided Project Costs	Other Discounted Water Supply Benefits	Total Present Value of Discounted Benefits
(a)	(b)	(c)	(d)
			(a) + (c) or (b) + (c)
Comments to Table 12:			
Manually enter (a) + (c) or (b) + (c)			

Table 13 - Water Quality and Other Expected Benefits (All benefits should be in 2009 dollars)									
Project Title:									
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project	Unit $ Value[(1)]	Annual $ Value[(1)]	Discount Factor[(1)]	Discounted Benefits[(1)]
					(e) – (d)		(f) x (g)		(h) x (i)
2012	a				$0		$0	1	$0
	b				$0		$0	1	$0
	c				$0		$0	1	$0
	..				$0		$0	1	$0
2013	a				$0		$0	0.943	$0
	b				$0		$0	0.943	$0
	c				$0		$0	0.943	$0
	..				$0		$0	0.943	$0
2014	a				$0		$0	0.89	$0
	b				$0		$0	0.89	$0
	c				$0		$0	0.89	$0
	..				$0		$0	0.89	$0
Project Life								…	
Total Present Value of Discounted Benefits Based on Unit Value									$0
(Sum of the values in Column (j) for all Benefits shown in table)									
Transfer to Table 14, column (f): Proposal Costs and Benefits Summaries									
[(1)] *Complete these columns if dollar value is being claimed for the benefit.*									
Comments to Table 13:									

Summary

Table 14 - Proposal Project Costs and Benefits Summary for Proposition 1E							
Proposal Title:							
Agency:							
Project	Agency	Total Present Value Project Costs[(1)]	Total Present Value Project Benefits				B/C Ratio
			Water Supply[(2)]	Flood Damage Reduction[(3)]	Other[(4)]	Total	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
						(d) + (e) + (f)	(g) / (c)
						$0	#DIV/0!
						$0	#DIV/0!
						$0	#DIV/0!
						$0	#DIV/0!
TOTAL		$0	$0	$0	$0	$0	#DIV/0!
[(1)] *From Table 4, column (j). Or from Table 9, column (j). If project is a multi-purpose project, avoid double-counting costs.*							
[(2)] *From Table 12, column (d)*							
[(3)] *From Table 6, row (e)*							
[(4)] *From Table 13, column (j)*							

Project Information Form (PIF)

A. PROJECT INFORMATION

1. Project Title:
2. Project Sponsor(s):
3. Eligible Applicant Type:
4. IRWM Project Region(s):
5. Does the project provide benefits directly to a Disadvantaged Communities (DAC) and/or Economically Distressed Areas (EDA) (minimum 75% by population or geography)?

   ☐ Yes ☐ No If yes, please complete D.8 and/or D.9. Show on map if applicable.
6. Is the Project Sponsor a Tribe, or does the project provide benefits to a Tribe (minimum 75% by population or geography) as defined by Proposition 1?

   ☐ Yes ☐ No If yes, please complete D.10. Show on map if applicable.
7. Provide project map. Include location of project, project benefit and/or service area, and other applicable information.
8. Funding Category:

   ☐ DAC Implementation Project

   ☐ General Implementation Project
9. Project Type: Other:

   Select most applicable project type. See Section II.C. of the 2019 Guidelines for full description of eligible project types. If "Other" is selected, please write in the space provided the proposed project type.

B. SELECTED ELIGIBILITY REQUIREMENTS

1. Will the project be included in the IRWM Plan, that will be adopted prior to anticipated Agreement Execution?

   ☐ Yes ☐ No
2. Does the project address a critical need(s) and/or priority(ies) of the IRWM Region as identified in the IRWM Plan?

   ☐ Yes ☐ No If yes, complete part a:

   a. What IRWM Plan goal(s)/objective(s) does the project address? Identify and explain.

3. Does the project have an expected useful life consistent with Government Code §16727 (generally 15 years)? If not, explain why this requirement is not applicable.

4. Does the project address and/or adapt to the effects of climate change? Does the project address the climate change vulnerabilities assessed in the IRWM Plan?

☐ Yes ☐ No If yes, please explain below.

5. Does the project contribute to regional water self-reliance?

☐ Yes ☐ No If yes, please explain below.

Project Information Form (PIF)

6. Does the project provide a benefit that meets at least one of the Statewide Priorities as defined in the 2019 IRWM Grant Program Guidelines?

   ☐ Yes ☐ No If yes, please identify below.

7. Will CEQA be completed within 12 months of Final Award?

   ☐ Yes
   ☐ NA, project is exempt under CEQA
   ☐ NA, not a project under CEQA
   ☐ NA, project benefits DAC/EDA/Tribe (minimum 75%), or a Tribe is a local project sponsor
   ☐ No

8. Will all permits necessary to begin construction be acquired within 12 months of Final Award?

   ☐ Yes
   ☐ NA, project benefits DAC/EDA/Tribe (minimum 75%), or a Tribe is a local project sponsor
   ☐ No

Project Information Form (PIF)

C. WORK PLAN, BUDGET, and SCHEDULE SUMMARY

1. Project Description: Provide a brief project description summarizing major components, objectives, goals, and intended outcomes/benefits (quantitative and qualitative).

2. Budget: Provide cost estimates for each Budget Category listed in the table below. (Required for Pre-Application Material Submittal; not required for Final Application Submittal)

Table 1 - Project Budget

Category		(a) Cost Share: Non-State Fund Source	(b) Requested Grant Amount	(c) Other Cost Share (including other State Sources)	(d) Total Cost
(a)	Project Administration				
(b)	Land Purchase/ Easement				
(c)	Planning/Design /Engineering /Environmental Documentation				
(d)	Construction/ Implementation				
(e)	Grand Total (Sum rows (a) through (d) for each				

Note: Provide information or other documentation to support the cost estimate in a separate attachment. Identify the source of all cost share and other funds. If other funds are not used, describe efforts to obtain other funding and/or why other funding sources were not used.

Project Information Form (PIF)

3. Cost Share Waiver Requested (DAC or EDA)? ☐ Yes ☐ No If yes, continue below:
   Cost Share Waiver Justification: Describe what percentage of the proposed project area encompasses a DAC/EDA, how the community meets the definition of a DAC/EDA, and the need of the DAC/EDA that the project addresses. In order to receive a cost share waiver, the applicant must demonstrate that the project will provide benefits (minimum 25% by population or geography) that address a need of a DAC and/or EDA.

<Approximately 250 words>

4. Schedule: Include reasonable estimates of the start and end dates for each Budget Category listed in Table 1 - Project Budget. (Required for Pre-Application Material Submittal; not required for Final Application Submittal)

Table 2 - Project Schedule			
Category		**(a) Start Date**	**(b) End Date**
(a)	**Direct Project Administration**		
(b)	**Land Purchase/Easement**		
(c)	**Planning/Design/Engineering/Environmental Documentation**		
(d)	**Construction/Implementation**		

D. OTHER PROJECT INFORMATION

1. Provide a narrative for project justification. If applicable, include references to supporting documentation such as models, studies, engineering reports, etc. Include any other information that supports the justification for this project, including how the project can achieve the claimed level of benefits.

<Approximately 750 words>

Project Information Form (PIF)

2. Project Benefits Table:

Table 3 - Project Benefits		
Anticipated Useful Life of Project (years):		
Primary (Required)		
Type of Benefit Claimed:		Benefit Units*:
Secondary (Optional)		
Type of Benefit Claimed:		Benefit Units*:
Physical Benefits (At project completion or lifetime, as appropriate)		
(a)	(b)	(c)
Benefit	Added Physical Benefit Description	Quantitative Benefit
Primary	<15 words maximum>	
Secondary	<15 words maximum>	
Qualitative Benefits (For Decision Support Tools, please describe non-physical benefits.)		
Comments: [Include narrative on additional benefits, as warranted.]		

* DWR may require applicant to convert or modify Benefit Claimed and/or Benefit Units. Where applicable, select one of the following units that corresponds to the benefit claimed:

- For water supply produced, saved, or recycled, enter acre-feet per year (AFY)
- For water quality, enter constituent concentration reduced in mg/L
- For flood damage reduction, enter inundated acres reduced in acres
- For habitat improved, restored or protected, enter habitat restored in acres
- For fishery benefits, enter increased fishery flow rate in cubic feet per second (cfs)
- For species protection, enter number of species benefited

3. Does the proposed project provide benefits to multiple IRWM regions [or funding areas]? If the project is located in another funding area, please provide the information requested in the 2019 Guidelines, Section 1.A.

☐ Yes ☐ No If yes, provide a description of the benefits to the various regions.

4. Provide a narrative on cost considerations. For example, were other alternatives to achieve the same types and amounts of physical benefits as the proposed project evaluated? Provide a justification as to why the project was selected (e.g., if the proposed project is not the lowest cost alternative, why is it the preferred alternative? Are there any other advantages that the proposed project provides from a cost perspective?)

5. a. Does the project address a contaminant listed in AB 1249?

☐ Yes ☐ No If yes, complete parts b and c:

b. Describe how the project helps address the contamination.

c. Does the project provide safe drinking water to a small disadvantaged community?

☐ Yes ☐ No If yes, provide an explanation on how the project benefits a small disadvantaged community as defined in the 2019 IRWM Guidelines.

6. Does the project provide safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes (consistent with AB 685) to meet a specific need(s) of a community?

☐ Yes ☐ No If yes, please describe.

7. Does the project employ new or innovative technologies or practices, including decision support tools that support the integration of multiple jurisdictions, including, but not limited to, water supply, flood control, land use, and sanitation?

☐ Yes ☐ No If yes, please describe.

8. If the project provides benefits (75% by population or geography) to a DAC, explain the need of the DAC and how the project will address the described need. Explain how the area/community meets the definition of a DAC.

9. If the project provides benefits (75% by population or geography) to an EDA, explain the need of the EDA and how the project will address the described need. Explain how the area/community meets the definition of an EDA.

10. If the project provides benefits (75% by population or geography) to a Tribe or a Tribe is the sponsor of the project, explain the need of the Tribe and how the project will address the described need.

11. Does the project sponsor have legal access rights, easements, or other access capabilities to the property to implement the project?

☐ Yes — If yes, please describe.
☐ NA — If NA, please describe why physical access to a property is not needed.
☐ No — If no, please provide a clear and concise narrative with a schedule to obtain necessary access.

Project Information Form (PIF)

E. ENVIRONMENTAL

1. Please fill out the CEQA Timeline Table below, if applicable:

Table 4 - CEQA Timeline		
CEQA STEP	COMPLETE? (y/n)	ESTIMATED DATE TO COMPLETE
Initial Study		
Notice of Preparation		
Draft EIR/MND/ND		
Public Review		
Final EIR/MND/ND		
Adoption of Final EIR/MND/ND		
Notice of Determination		

a. If additional explanation or justification of the timeline is needed, please describe below (optional).

2. Permit Acquisition Plan:

List all permits needed to complete the project. If the project does not provide benefits to a DAC, EDA, or Tribe (min 75%), all permits needed to begin construction must be acquired within 12 months of Final Award.

No.	Type of Permit	Permitting Agency	Date Acquired or Anticipated
1.			
2.			
3.			
4.			
5.			
6.			
n.			

For each permit not yet acquired, describe the following:

No.	a. Actions taken to date (include dates of any key meetings, consultations, submittals, etc.)	b. Any issues or obstacles that may delay acquisition of permit
1.		
2.		
3.		
4.		
5.		
n.		

3. Permitting Checklist: This checklist is provided as a courtesy for documentation purposes. Not all permits which may apply are listed. (Required for Pre-Application Material Submittal; not required for Final Application Submittal)

a. Does the project involve any activities that may affect federally or state listed threatened or endangered species or their critical habitat that are known, or have a potential, to occur on-site, in the surrounding area, or in the service area? (i.e. Federal Endangered Species Act Section 7 Consultation and Incidental Take Authorization and Section 10 Incidental Take Permit, California Endangered Species Act Permit, and/or ESA & CESA Consistency Determination)

☐ Yes ☐ No If yes, please explain:

b. Would the proposed project work in, over, or under navigable waters of the US or discharge dredged or fill material in waters of the US? (i.e. Rivers & Harbors Act Section 10 Permit and/or Clean Water Act Section 404 Permit)

☐ Yes ☐ No If yes, please explain:

c. Will the proposed project have the potential to affect historical, archaeological, or cultural resources? (i.e. National Historic Preservation Act and/or State Historic Preservation Officer Consultation)

☐ Yes ☐ No If yes, please explain:

d. Will the proposed project discharge into a water of the US? (i.e. Clean Water Act Section 401 and/or 404 Permit)

☐ Yes ☐ No If yes, please explain:

e. Will the proposed project divert the natural flow of a river, stream, or lake? (i.e. Lake or Streambed Alteration Agreement)

☐ Yes ☐ No If yes, please explain:

f. Will the proposed project change the bed, channel, or bank of a river, stream, or lake? (i.e. Lake or Streambed Alteration Agreement)

☐ Yes ☐ No If yes, please explain:

g. Will the proposed project use any material from the bed, channel, or bank of a river, stream, or lake? (i.e. Lake or Streambed Alteration Agreement)

☐ Yes ☐ No If yes, please explain:

h. Will the proposed project deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into a river, stream, or lake? (i.e. Lake or Streambed Alteration

☐ Yes ☐ No If yes, please explain:

i. For water supply projects, do you need to obtain a water right? (Water Rights Permit)

☐ Yes ☐ No If yes, please explain:

j. Is the proposed project within the defined coastal zone? (Coastal Development Permit)

☐ Yes ☐ No If yes, please explain:

2019 Projects	updated August 2019	
Project Title	**Subregion**	**Sponsoring Agency**
RD1 System Fish Passage Improvements	East	Alameda County Water District
Lower Walnut Creek Restoration	East	Contra Costa County Flood Control and Water Conservation District
River Oaks Stormwater Capture Project	South	City of San Jose
NBWRP Phase 2	North	North Bay Water Reuse Authority (NBWRA)
Calistoga Water and Habitat Project	North	City of Calistoga and Napa County Resource Conservation District
San Francisquito Creek Flood Protection, Ecosystem Restoration, and Recreation Project, Upstream of Highway 101	West	San Francisquito Creek Joint Powers Authority
Bay Area Regional Water Conservation	Multiple	East Bay Municipal Utility District (EBMUD)
San Francisco Zoo Recycled Water Pipeline Project	West	San Francisco Public Utilities Commission
McCosker Creek Restoration	East	East Bay Regional Park District
Palo Alto Flood Basin Tide Gates Improvements	South-West	Santa Clara Valley Water District
OLSD Sewer Pipeline Replacement Project	South	Oro Loma Sanitary District
Sutter Urban Flood Reduction	East	City of San Pablo
Implementing BMPs on Rural Lands	North	Sonoma Resource Conservation District
San Mateo Water Resources Program	West	San Mateo Resource Conservation District
BART Hayward Maintenance Complex Rainwater Catchment, Bio-Retention Basin, and Solar Thermal project	East	BART
Bayfront/Atherton Flood Protection Project	South	County of San Mateo
Belmont Creek Watershed Restoration Project	West	County of San Mateo
Hayward Recycled Water Project Phase-2	East	City of Hayward
Bayfront Recycled Water and SLR Protection	West	West Bay Sanitary District
Graywater Direct Installation Program for Underserved Communities	Multiple	Ecology Action
Athlone Terrace Pump Station Upgrade	West	County of San Mateo Department of Public Works

Walnut/Angus pump stations upgrades	West	San Mateo County Flood Control District
Aging Concrete-Lined Channels	East	Zone 7 Water Agency
Bluff Erosion Protection Preservation Esplanade	West	City of Pacifica
Beach Boulevard South Seawall Replacement	West	City of Pacifica
Chain of Lakes Pipeline	East	Zone 7 Water Agency
Retional Upstream Detention Improvements	East	Zone 7 Water Agency
2015 Projects	updated May 26, 2015	
Bay Area Regional Shoreline Resilience Program	East	State Coastal Conservancy
Coastal San Mateo County Drought Relief Phase II	West	San Mateo Resource Conservation District
2020 Turf Replacement Project		
2014 Projects	updated May 28, 2014	
Bay Area Regional Water Supply and Conservation Project		
Bay Area Regional Recycled Water Project	North	City of Calistoga
Drought Response & Water Supply Reliability on the Central Coast		
Enhancing and Balancing- Beneficial Uses of Water Resources in the Pescadero-Butano Watershed		
Lower Cherry Aqueduct Emergency Rehabilitation Project	West	San Francisco Public Utilities Commission
MMWD WaterSMART Irrigation with AMI/AMR	North	Marin Municipal Water District
Rinconada Water Treatment Plant Powdered Activated Carbon (PAC) Treatment for Drought Water Quality Conflicts		
Zone 7 Water Supply Drought Preparedness Project	East	Zone 7 Water Agency
2013 Project List	updated October 29, 2012	
350 Home and Garden Challenge Bay Area	East North South West	Daily Acts
ACPWA Low Impact Development Implementation and Demonstration Project: Parking Lot Stormwater Treatment Improvements	East	Alameda County Public Works Agency
Agricultural Riparian Buffer and Habitat Enhancement	East	Alameda County RCD

Airway Improvement Project (R5-2)	East	Zone 7 Water Agency
Alameda County Adopt-A-Creek-Spot	East	Alameda County Resource Conservation District
Alameda County Foothill Blvd. Transportation Stormwater Quality Improvement	East	Alameda County
Alameda County Habitat Easements	East	Alameda County Resource Conservation District
Alameda County Healthy Watershed Program	East	Alameda County Resource Conservation District
Alameda County Norbridge/Strobridge Road Transportation Stormwater Quality Improvement	East	Alameda County
Alameda County Patterson Pass Road Transportation Stormwater Quality Improvement	East	Alameda County
Alameda County Riparian Invasive Mapping and Removal	East	Alameda County Resource Conservation District
Alameda County Tesla Road Transportation Stormwater Quality Improvement	East	Alameda County
Alameda County Vasco Road Transportation Stormwater Quality Improvement	East	Alameda County
Alameda Creek Flood Protection, Fish Passage and Habitat Enhancement Project	East	Alameda County Flood Control & Water Conservation District
Alamo Canal Flood Control Program (R9-7)	East	Zone 7 Water Agency
Alamo Canal/South San Ramon Creek Erosion Control (R9-1)	East	Zone 7 Water Agency
Albany Beach Restoration and Public Access Project	East	East Bay Regional Park District
Alhambra Valley Creek Coalition - Erosion Control and Riparian Restoration Project	East	Contra Costa County Public Works Dept.
Alkali Sink Management (R1-2)	East	Zone 7 Water Agency
Almaden Dam Improvements	South	Santa Clara Valley Water District
Altamont and Las Positas Creeks/Springtown Alkali Sink Restoration	East	Natural Resources Conservation Service, Alameda County
Altamont Creek Improvement (R1-1)	East	Zone 7 Water Agency
Anderson Dam Seismic Retrofit	South	Santa Clara Valley Water District
Ardenwood Creek Flood Protection and Restoration Project	East	Alameda County Flood Control & Water Conservation District
Arroyo De La Laguna (ADLL) Improvement Project 1 (R10-1)	East	Zone 7 Water Agency

Arroyo De La Laguna (ADLL) Improvement Project 2 (R10-2)	East	Zone 7 Water Agency
Arroyo De La Laguna (ADLL) Improvement Project 3 (R10-3)	East	Zone 7 Water Agency
Arroyo De La Laguna (ADLL) Improvement Project 4 (R10-4)	East	Zone 7 Water Agency
Arroyo De La Laguna (ADLL) Improvement Project 5 (R10-5)	East	Zone 7 Water Agency
Arroyo las Positas Diversion Project (R5-3)	East	Zone 7 Water Agency
Arroyo las Positas Habitat Enhancement and Recreation Project (R1-5)	East	Zone 7 Water Agency
Arroyo las Positas Multi-Purpose Project (R1-6)	East	Zone 7 Water Agency
Arroyo Mocho Bypass and Regional Storage at Chain of Lakes (R6-2)	East	Zone 7 Water Agency
Arroyo Mocho Management Plan (R6-1)	East	Zone 7 Water Agency
Arroyo Seco Improvements (R2-2)	East	Zone 7
Ash Creek Stormwater Management and Wildlife Enhancement Project	North	Southern Sonoma County Resource Conservation District
Assessment of an urban watershed and implementation of urban stormwater retrofit projects	East	Friends of Sausal Creek
Bay Area Green Infrastructure Initiative: Scientific support related to planning and implementation of water infrastructure upgrades toward green alternatives	East North South West	San Francisco Estuary Institute
Bay Area Regional Desalination Project (BARDP) - Alternative Analysis Report	East South West	EBMUD, CCWD, Zone 7, SCVWD, SFPUC
Bay Area Regional Reliability Interties - EBMUD/CCWD	East South West	EBMUD / Zone 7 / CCWD / SCVWD / SFPUC
Bay Area Regional Water Conservation and Education Program	East North South West	Zone 7 Water Agency, San Francisco PUC and Contra Costa Water District
Bay Area Water Supply and Conservation Agency (BAWSCA) – East Bay Municipal Utility District (EBMUD) Short-Term Water Transfer Pilot Project (Pilot Project)	East South West	Bay Area Water Supply and Conservation Agency (BAWSCA), East Bay Municipal Utility District (EBMUD)
Bay Area Water Supply and Conservation Agency (BAWSCA) Brackish Groundwater Field Investigation Project (Brackish Groundwater Project)	East South West	BAWSCA (Bay Area Water Supply & Conservation Agency)
Bay Point Regional Shoreline Wetland Restoration	East	East Bay Regional Park District

Bay-Friendly Landscape Standards for Green Infrastructure Projects: Maximizing Watershed Benefits	East North South West	Bay-Friendly Landscaping & Gardening Coalition
Bay-Friendly Outreach Campaign for Home Gardeners and Nurseries	East North South West	Bay-Friendly Landscaping & Gardening Coalition
Bay-Friendly Qualified Landscape Professionals Training	East North South West	Bay-Friendly Landscaping & Gardening Coalition
Bayfront Canal Flood Management and Habitat Restoration Project	West	City of Redwood City
Bayside Groundwater Project Phase 2	East	EBMUD
Beach Watch Program	North South West	Farallones Marine Sanctuary Association
Bel Marin Keys Phase of the Hamilton Wetlands Restoration	North	Coastal Conservancy
Berryessa Creek Flood Protection Project	South	Santa Clara Valley Water District
Bockman Canal Area Flood Control Improvement Project	East	Alameda County Flood Control and Water Conservation District
Bolinas Avenue Stormwater Quality Improvements and Fernhill Creek Restoration	North	Town of Ross
Bolinas Lagoon Ecosystem Restoration Project	North	Marin County Open Space District
Breuner Marsh Restoration, Richmond	East	East Bay Regional Park District
Building Climate Change Resiliency Along the Bay with Green Infrastructure & Treated Wastewater	East North South	San Francisco Estuary Partnership
Butano Creek Stream Course Restoration	West	California State Parks
Canal Liner Rehabilitation and Slope Stability at Milepost 23.03	East	Contra Costa Water District
Capacity Improvement at Arroyo las Positas (R1-7)	East	Zone 7 Water Agency
Castro Valley Flood Control Improvement Project	East	Alameda County Flood Control and Water Conservation District
CCCSD Refinery Recycled Water Project	East	Central Contra Costa Sanitary District
CCCSD-Concord Recycled Water Project	East	Central Contra Costa Sanitary District
Central Dublin RW Distribution and Retrofit Project	East	Dublin San Ramon Services District
Central/Eastshore Pump Station Improvement Project	East	City of Alameda
Cesar Chavez Street Flood and Stormwater Managment Sewer Improvement Project	West	San Francisco Public Utilities Commission
Chabot Canal Improvement Project (R8-2)	East	Zone 7 Water Agency
Charcot Storm Pump Station	South	City San Jose

Chelsea Wetlands Restoration Project	East	Ducks Unlimited, Inc. and City of Hercules
City of Berkeley Watershed Management Plan	East	City of Berkeley
City of Hayward Recycled Water Project	East	City of Hayward
City of San Jose Citywide Storm Drain Master Plan	South	City of San Jose
City Watersheds of Sonoma Valley	North	Sonoma County Water Agency
Cleaning up trash in the Bay Area's stormwater	East North South West	Association of Bay Area Governments/SF Estuary Partnership
Collaborative Aquatic Resource Protection in the Watershed Context: Science and Technology to Visualize Alternative Landscape Futures	North	San Francisco Estuary Institute
Conserving Our Watersheds	North	Marin Resource Conservation District
Contra Costa County Green Street Retrofit Network	East	Contra Costa County
Contra Costa County LID School Program	East	The Watershed Project
Contra Costa County Low Impact Development Rebate Program	East	The Watershed Project
Corte Madera Bayfront Flood Protection and Wetlands Restoration Project	North	Marin Audubon Society/Marin Bayland Advocates
Corte Madera Creek Headwaters Restoration Plan	North	Marin County Parks
Corte Madera Creek Tidal Marsh Restoration	North	Friends of Corte Madera Creek Watershed; Marin County Water Conservation and Flood Control District; Marin County Parks Dept.
Corte Madera Creek Watershed - Broadmoor Avenue Bridge Replacement and Creek Bank Restorations	North	Marin County Flood Control and Water Conservation District
Corte Madera Creek Watershed - Fairfax Creek Improvements	North	Marin County Flood Control and Water Conservation District
Corte Madera Creek Watershed - Lefty Gomez Field Detention Basin	North	Marin County Flood Control and Water Conservation District
Corte Madera Creek Watershed - Loma Alta Tributary Detention Basin	North	Marin County Flood Control and Water Conservation District
Corte Madera Creek Watershed - Memorial Park Detention Basin, San Anselmo	North	Marin County Flood Control and Water Conservation District
Corte Madera Creek Watershed - Merwin Avenue Bridge Replacement and Creek Bank Restorations	North	Marin County Flood Control and Water Conservation District
Corte Madera Creek Watershed - Nokomis-Madrone Neighborhood Flood Protection	North	Marin County Flood Control and Water Conservation District

Corte Madera Creek Watershed - San Anselmo Creek Improvements	North	Marin County Flood Control and Water Conservation District
Corte Madera Creek Watershed - Sleepy Hollow Creek Improvements	North	Marin County Flood Control and Water Conservation District
Corte Madera Creek Watershed Infiltration and Storage Assessment	North	Ross Valley Watershed Program, Friends of Corte Madera Creek Watershed
Corte Madera Creek Watershed Sediment Control and Drinking Water Reliability Project	North	Marin Municipal Water District
Corte Madera Creek Watershed: Barriers to Fish Passage in Sleepy Hollow Creek	North	Town of San Anselmo, Marin County Department of Public Works
Corte Madera Creek Watershed: Saunders Fish Barrier Removal	North	Town of San Anselmo, Friends of Corte Madera Creek Watershed, Ross Valley Sanitary District
Corte Madera Creek Watershed: Sedimentation Management	North	Marin County Flood Control and Water Conservation District
Corte Madera Creek Watershed: Smolt Trapping	North	Friends of Corte Madera Creek Watershed
Creek Signage	East	Alameda County Resource Conservation District
Cull Canyon Dam and Reservoir Project	East	Alameda County Flood Control and Water Conservation District
DA 48B Storm Drain Line A at Port Chicago Highway, Bay Point (#201)	East	Contra Costa County Flood Control District
DA 48C Storm Drain Line at Marina Road, Bay Point (#_)	East	Contra Costa County Flood Control and Water Conservation District
Daly City Expansion Recycled Water Project	West	SFPUC, City of Daly City
DDSD Advanced Wastewater Treatment	East	Delta Diablo Sanitation District
DDSD Advanced Water Treatment	East	Delta Diablo Sanitation District
DDSD Recycled Water Distribution System Expansion	East	Delta Diablo Sanitation District
Decoto District Green Streets Phase 3	East	City of Union City
DERWA Pump Station 1 - Phase 2	East	Dublin San Ramon Services District
DERWA Recycled Water Plant - Phase 2	East	Dublin San Ramon Services District
Developing a Conservation Reserve Enhancement Program Proposal (CREP) to improve water quality and protect rangeland habitats in the Bay Area	East North South West	Defenders of Wildlife
Diablo Country Club Satellite Recycled Water Project	East	East Bay Municipal Utility District (EBMUD)
East Bayshore Recycled Water Project Phase 1A	East	East Bay Municipal Utility District (EBMUD)
East Bayshore Recycled Water Project Phase 1B - Alameda	East	EBMUD

East Bayshore Recycled Water Project Phase 1B - Oakland-Alameda Estuary Crossing	East	EBMUD
East Bayshore Recycled Water Project Phase 2	East	East Bay Municipal Utility District (EBMUD)
East Palo Alto Groundwater Supply Conjunctive Use Project	South West	City of East Palo Alto
East Palo Alto Storm Water Conveyance, Tidal Flood Protection, Ecosystem Restoration, and Recreational Enhancement Project	West	San Francisquito Creek Joint Powers Authority
EBMUD - Pretreatment Facilities	East	EBMUD
EBMUD/ZONE 7 Regional Reliability Intertie	East South West	EBMUD / Zone 7 / CCWD / SCVWD / SFPUC
Estudillo Canal Area/San Leandro Flood Control Improvement Project - Phase 1	East	Alameda County Flood Control and Water Conservation District
Estudillo Canal Area/San Leandro Flood Control Improvement Project - Phase 2	East	Alameda County Flood Control and Water Conservation District
Estudillo Canal Area/San Leandro Flood Control Improvement Project - Phase 3	East	Alameda County Flood Control and Water Conservation District
Exterior Painting of Skyline Tanks	West	Westborough Water District
Fish Barrier Removal at Railroad Overcrossing (R3-5b)	East	Zone 7 Water Agency
Fish Passage Improvements at Memorial County Park, San Mateo County	West	San Mateo County Resource Conservation District
Goat Island Marsh Tidal Marsh Restoration & Interpretive Nature Trail	North	Solano Land Trust
Grant Avenue Green Street Water Quality/Flood Protection Demonstration Site	East	Alameda County Flood Control and Water Conservation District
Grayson and Murderer's Creek Subregional Improvements, Pleasant Hill (#106)	East	Contra Costa County Flood Control District
Grayson Creek Levee Raising and Rehabilitation, Pacheco (#_)	East	Contra Costa County Flood Control and Water Conservation District
Grayson Creek Levee Rehabilitation at CCCSD Treatment Plant, Pacheco (#107)	East	Contra Costa County Flood Control District
Grayson Creek Sediment Removal, Pacheco (unincorp.)(#109)	East	Contra Costa County Flood Control District
Grimmer Greenbelt Gateway (Line G Channel Enhancement)	East	Alameda County Flood Control and Water Conservation District
Hayward Marsh Restoration and Enhancement Project	East	East Bay Regional Park District
Headquarters Facility - Landscaping	East	Alameda County Water District
Hillman Area Improvements Project	West	City of Belmont

Holmes Street Sedimentation Basin and Granada/Murrieta Protection and Enhancement Project (R3-4)	East	Zone 7 Water Agency
Implementation of High Priority Projects Identified in the Pilarcitos Creek Integrated Watershed Management Plan	West	San Mateo County Resource Conservation District (RCD)
Implementation of Pond Management Plan	West	Midpeninsula Regional Open Space District
Implementation of the Napa River Watershed Assessment Framework	North	Napa County Resource Conservation District
Implementing "Slow It, Spread It, Sink It!" in Sonoma and Napa Counties	North	Southern Sonoma Resource Conservation District
Implementing LandSmart Plans to Improve Water Quality	North	Napa County Resource Conservation District
Implementing TMDLs in the Napa River, Sonoma and Suisun Creek watersheds with the Fish Friendly Farming/Fish Friendly Ranching programs	North	California Land Stewardship Institute
Improving Quantitative Precipitation Information for the San Francisco Bay Area	East North South West	Zone 7 Water Agencies for Bay Area Flood Protection Agencies Association (BAFPAA)
Installation of a New Seismic Valve at Skyline Tanks	West	Westborough Water District
Laguna Creek Flood Protection and Restoration Project	East	Alameda County Flood Control & Water Conservation District
Lagunitas Booster Station	North	Marin Municipal Water District
Lagunitas Creek Watershed Sediment Reduction and Management Project	North	Marin Municipal Water District
Lagunitas Creek Winter Habitat Enhancement Implementation	North	Marin Municipal Water District
Lake Chabot Raw Water Expansion Project	East	East Bay Municipal Utility District (EBMUD)
LID and Stormwater Management - Lagunitas Watershed	North	The Watershed Project
Line G-1-1 Maintenance Plan (R9-6)	East	Zone 7 Water Agency
Line T Crossing Retrofit (R9-4)	East	Zone 7 Water Agency
Lower Arroyo del Valle Restoration and Enhancement Project (R7-3)	East	Zone 7 Water Agency
Lower Arroyo Mocho Improvement Project (R8-3)	East	Zone 7 Water Agency
Lower Walnut Creek Restoration Project, Martinez (#110)	East	Contra Costa County Flood Control District
Lynch Canyon Watershed Improvements	North	Solano Land Trust
Mapping Marin County's Flood Control Levees	North	Marin County Flood Control and Water Conservation District

Marin County Flood Control Asset Management	North	Marin County Flood Control and Water Conservation District
Marin County Sea Level Rise Land Use Adaptation	North	Marin County CDA
Martinez Adult School Flood Protection & Creek Enhancement	East	Martinez Unified School District
Martinez Water Quality and Supply Reliability Improvement Project	East	City of Martinez / Contra Costa Water District
McInnis Marsh Habitat Restoration Project	North	Marin County Parks
Memorial Park Waste Water Treatment	West	San Mateo County
Mercury Reduction Benefits of Low Impact Development	East	Contra Costa County
Miller Avenue Green Street Plan	North	City of Mill Valley
Milliken Creek Flood Reduction, Fish Passage Barrier Removal and Habitat Restoration	North	Napa County
Milliken Diversion Dam Flow Control	North	City of Napa Water Division
Mission Boulevard to Meek Estate Creekside Trail and Habitat Improvements	East	Alameda County Flood Control and Water Conservation District
Mission Creek Flood Protection and Restoration Project	East	Alameda County Flood Control & Water Conservation District
Montalvin Manor Stormwater Harvest and Use, Bioretention, and Flood Risk Reduction Project	East	Contra Costa County
Montezuma Creek Rehabilitation and Fish Passage Project	North	Marin County Parks Department
Mountain View/ Sunnyvale Recycled Water Intertie Alignment Study	South	City of Mountain View
Napa County Groundwater/Surface Water Monitoring Wells	North	Napa County
Napa River Arundo Removal Lodi Lane to Zinfandel Lane	North	Napa County Flood Control and Water Conservation District
Napa River Restoration, Bioassessment & Education Project	North	Napa County Resource Conservation District
Napa River Restoration: Oakville to Oak Knoll Reach	North	Napa County
Napa River Rutherford Reach Restoration Project	North	Napa County
New Pressure Reducing Valve (PRV) Station	West	Westborough Water District
New Tank Mixer for Skyline Tanks	West	Westborough Water District
Niles Cone Groundwater Basin Monitoring Well Construction Project	East	Alameda County Water District
NMWD Gallagher Well and Pipeline Project	North	North Marin Water District

North Bay Water Reuse Program	North	North Bay Water Reuse Authority (NBWRA)
North Marin Water District Marin Country Club Recycled Water Expansion	North	North Marin Water District
North Richmond Pump Station - Retrofit and Replumb	East	Contra Costa County Flood Control District
Pacheco Marsh Restoration, Martinez (#111)	East	Contra Costa County Flood Control District / Muir Heritage Land Trust / East Bay Regional Park District
Palo Alto Golf Course Redesign Wetlands Enhancement and Restoration Project	South	City of Palo Alto
Palo Alto Recycled Water Project	South West	City of Palo Alto
Parks Floodplain Dedication and Levee Construction (R3-3)	East	Zone 7 Water Agency
Peacock Gap Recycled Water Extension Project	North	Marin Municipal Water District
Permanente Creek Flood Protection	South	Santa Clara Valley Water District
Pescadero Water Supply and Sustainability Project	West	County of San Mateo Department of Public Works and Parks
Petaluma Flood Impact Reduction, Water & Habitat Quality, Recreation, Phase IV	North	City of Petaluma, Southern Sonoma County Resource Conservation District
Pilarcitos Creek Equestrian Bridge	West	California State Parks
Pine Creek Dam Seismic Assessment, Walnut Creek (#122)	East	Contra Costa County Flood Control District
Pine Creek Reservoir Sediment Removal and Capacity Restoration, Walnut Creek (#124)	East	Contra Costa County Flood Control District
Pinole Creek Fish Passage Improvements project at I-80 Culverts	East	Contra Costa RCD
Pinole Creek Habitat Restoration (1135 Project), Pinole (#12)	East	Contra Costa County Flood Control District
Portola Redwood State Park Wastewater System	West	(unknown)
Recycled Water Distribution and Retrofit for County and Federal Facilities	East	Dublin San Ramon Services District
Recycled Water Facility Renewable Energy System	East	Delta Diablo Sanitation District
Redwood City Recycled Water Project Phase 2 – Central Redwood City	West	City of Redwood City
Redwood Creek Restoration at Muir Beach, Phase 5	North	Golden Gate National Parks Conservancy
Refugio Creek and North Channel Restoration	East	City of Hercules

Regional Green Infrastructure Capacity Building Program	East North South West	SFEP
Regional Groundwater Storage and Recovery Project	West	SFPUC, Cities of Daly City and San Bruno and California Water Service Company
Regional Sea Level Rise Adaptation Strategy	East North South West	Bay Area Joint Policy Committee
Reliez Valley Recycled Water Project	East	EBMUD
Removing Fish Passage Barriers in the Napa River Watershed	North	Napa County Resource Conservation District
Resilient Landscapes Climate Adaptation Strategy: Tools for Designing Sustainable Bay Area Stream, Wetland, and Riparian Habitats	East North South West	San Francisco Estuary Institute - Aquatic Science Center
Rheem Creek Conservation Project (Shortcut Pipeline Improvement Project)	East	Contra Costa Water District
Richardson Bay Erosional Shoreline Adaptation to Sea Level Rise: Draft Conceptual Designs and Opportunity/Constraints Assessment	North	Marin County Flood Control and Water Conservation District
Richmond Advanced Recycled Expansion (RARE) Water Project - Future Expansion	East	East Bay Municipal Utility District (EBMUD)
Richmond Advanced Recycled Expansion (RARE) Water Project Phase 2	East	East Bay Municipal Utility District (EBMUD)
Rindler Creek: Habitat Restoration and Erosion Control	North	Solano Resource Conservation District
Robertson Park Enhancement Project and Levee Construction (R3-2)	East	Zone 7 Water Agency
Rodeo Creek Sediment Removal, Rodeo (#14)	East	Contra Costa County Flood Control District
Rodeo Creek Stabilization near Christie Road, Rodeo (#16)	East	Contra Costa County Flood Control District
Rodeo Recycled Water Project	East	East Bay Municipal Utility District (EBMUD)
Roseview Heights Mutual Water Tanks & Main upgrades	South	Roseview Heights Mutual Water Company
Rossmoor Well Replacement Project	East	City of Pittsburg
Rubber Dam No. 1 Fish Ladder	East	Alameda County Water District
Rubber Dam No. 3 Fish Ladder	East	Alameda County Water District
Rush Ranch HQ Storm Water Management, Public Access & Rangeland Improvements	North	Solano Land Trust
Salvador Creek Intregrated Flood and Watershed Improvements	North	Napa County Flood Control and Water Conservation District

San Catanio Creek culvert repair and enhancement	East	City of San Ramon
San Francisco Bay Livestock and Land Program	East North South West	Ecology Action
San Francisco Bay Tidal Marsh-Upland Transition Zone Decision Support System (DSS)	East North South West	San Francisco Bay Bird Observatory
San Francisco Eastside Recycled Water Project	West	San Francisco Public Utilities Commission
San Francisco Groundwater Supply Project	West	San Francisco Public Utilities Commission
San Francisco International Airport Industrial Waste Treatment Plant and Reclaimed Water Facility	West	City and County of San Francisco, Airport Commission
San Francisco Westside Recycled Water Project	West	San Francisco Public Utilities Commission
San Francisquito Creek Flood Reduction, Ecosystem Restoration and Recreation Project, Highway 101 to El Camino Real	South West	San Francisquito Creek Joint Powers Authority
San Francisquito Watershed Plan	South West	San Francisquito Creek Joint Powers Authority
San Geronimo Landowner Assistance Program-Habitat Restoration Projects	North	Marin County Department of Public Works/SG Planning Group
San Gregorio Creek Tributary Water Quality and Flow Monitoring	West	San Gregorio Environmental Resource Center
San José Green Alleys Demonstration Project	South	City of San Jose
San José Green Streets Demonstration Project	South	City of San Jose
San Leandro Creek Environmental Education Center, Alameda County	East	Alameda Count Flood Control and Water Conservation District
San Leandro Creek Hazard Tree Management and Riparian Habitat Restoration	East	ACFCWCD
San Leandro Water Reclamation Facility Expansion Project	East	East Bay Municipal Utility District (EBMUD)
San Lorenzo Creek Flood Control Project - Phase 1	East	Alameda County Flood Control and Water Conservation District
San Lorenzo Creek Flood Control Project - Phase 2	East	Alameda County Flood Control and Water Conservation District
San Lorenzo Creek Tidal Wetlands Restoration	East	Alameda County Flood Control and Water Conservation District
San Lorenzo Creek Watershed Fisheries Restoration Project - Major Fish Passage Barrier Removal (MB-10) Phase 2	East	Alameda County Flood Control and Water Conservation District
San Lorenzo Creek Watershed Fisheries Restoration Project - Phase 1	East	Alameda County Flood Control and Water Conservation District

San Lorenzo Creek Watershed Stewardship Program	East	Alameda Flood Control and Water Conservation District
San Pablo Bay South Watershed Awareness and Action Plan	East	The Watershed Project
San Pablo Bay South Watershed Community Stewardship Program	East	The Watershed Project
San Ramon Valley Recycled Water Program - Phase 2A (DSRSD-EBMUD Recycled Water Authority)	#N/A	DSRSD-EBMUD Recycled Water Authority
San Ramon Valley Recycled Water Program - Phase 3 - 4 (DSRSD-EBMUD Recycled Water Authority)	#N/A	DSRSD-EBMUD Recycled Water Authority
San Ramon Valley Recycled Water Program - Phase 5-6 (DSRSD-EBMUD Recycled Water Authority)	#N/A	DSRSD-EBMUD Recycled Water Authority
Santa Clara Valley Water District Advanced Recycled Water Treatment Facility Expansion Project	South	Santa Clara Valley Water District
Satellite Recycled Water Treatment Plant Project	East	EBMUD
Sausal Creek Restoration Project	East	City of Oakland
SCADA System Major Upgrades	East	Alameda County Water District
School District Green Infrastructure Capacity Building/Pilot Projects	East West	San Francisco Estuary Partnership
Sears Point Restoration Project	North	Sonoma Land Trust
SEDIMENT MANAGEMENT PLAN FOR THE GRAVEL CREEK WATERSHED	North	Vedanta Society of San Francisco
SFPUC Eastside Watershed Green Infrastructure Early Implementation Projects	West	SFPUC
SFPUC Westside Watershed Green Infrastructure Early Implementation Projects	West	San Francisco Public Utilities Commission
Shinn Pond Fish Screen	East	Alameda County Water District
Sinbad Creek Project (R11-2)	East	Zone 7 Water Agency
Solano Project Terminal Reservoir Seismic Mitigation	North	Solano County Water Agency
Sonoma Valley Groundwater Banking Program	North	Sonoma County Water Agency
Sonoma Valley Integrated Water Management Program	North	Sonoma County Water Agency
Soulajule Mercury Remediation	North	Marin Municipal Water District
South Bay Aqueduct Turnout Construction and Low-Flow Crossings (R3-1)	East	Zone 7 Water Agency

South Bay Salt Pond Restoration Project & South San Francisco Bay Shoreline Study: Early Implementation Activities	South	California State Coastal Conservancy
South East Bay Plain Basin Groundwater Model Enhancements	East	EBMUD
South East Bay Plain Basin Subsidence Monitoring Network	East	EBMUD
South San Francisco Recycled Water Facility	West	South San Francisco/SFPUC
Southwestern Solano County Open Space Acquisition and Watershed Assessment	North	Solano Land Trust
Spring Branch Creek Tidal Marsh & Seasonal Creek Restoration	North	Solano Land Trust
Springtown Golf Course Improvements (R1-4)	East	Zone 7 Water Agency
Springtown Improvements (R1-3)	East	Zone 7 Water Agency
Stanley Enhancement and Restoration Project (R3-5a)	East	Zone 7 Water Agency
Stinson Beach flood protection and habitat enhancement project	North	Marin County Department of Public Works
Stivers Lagoon Marsh Project	East	Alameda County Flood Control and Water Conservation District
Streambank and Habitat Restoration Projects	East	Alameda County Resource Conservation District
Study of Mercury methylation in South San Francisco Bay in Relation to Nutrient Sources	South	San Francisco Estuary Institute
Suisun City Flood Management and Habitat Restoration Project	North	City of Suisun City
Suisun Valley Flood Management	North	Solano County Water Agency
Sulphur Creek/Hayward Flood Control Improvement Project	East	Alameda County Flood Control and Water Conservation District
Sycamore Grove Recharge Bypass Project (R4-1)	East	Zone 7 Water Agency
Tassajara Creek Improvement Project (R8-1)	East	Zone 7 Water Agency
The Bay Area Creek Mouth Assessment Tool	East North South West	San Francisco Estuary Partnership
The Students and Teachers Restoring A Watershed (STRAW) Project	East North West	PRBO Conservation Science
Tice Creek Bypass (Drainage Area 67), Walnut Creek, CA (#117)	East	Contra Costa County Flood Control District
Tomales Bay Watershed Water Quality Monitoring and Improvement Program	North	Tomales Bay Watershed Council Foundation
Total Dissolved Solids Reduction/Salinity Management Project	East	Delta Diablo Sanitation District

Tule Ponds Education Center Rehabilitation	East	Alameda County Flood Control & Water Conservation District
Upland Transition Zone Mapping for Southern San Pablo Bay (West):	North	Gallinas Watershed Council/Marin County DPW/marin County Parks and Openspace
Upper Alameda Creek Filter Gallery Project	East	SFPUC
Upper Arroyo de la Laguna (ADLL) Improvement Project (R8-4)	East	Zone 7 Water Agency
Upper Napa River Water Quality Improvement and Habitat Enhancement Project	North	California Land Stewardship Institute
Upper York Creek Dam Removal -- St. Helena, Napa River Watershed	North	City of St. Helena/U.S. Army Corps of Engineers
Velocity Control Project (R2-1)	East	Zone 7 Water Agency
Veterans' Court Seawall Reconstruction	East	City of Alameda
Vista Grande Drainage Basin Improvement Project	West	San Francisco Public Utilities Commission
Walnut Creek Levee Rehabilitation at Buchanan Field Airport, Concord (#119)	East	Contra Costa County Flood Control District
Walnut Creek Sediment Removal - Clayton Valley Drain to Drop Structure 1 , Concord (#118)	East	Contra Costa County Flood Control District
Wastewater Renewable Energy Enhancement	East	Delta Diablo Sanitation District
Water Conservation and Mobile Water Lab Program	North	Southern Sonoma Resource Conservation District
Water Dog Lake Sediment Removal	West	City of Belmont
Water Supply and Instream Habitat Improvements in Suisun Creek	North	Ca. Land Stewardship Institute
Water Treatment Plant Improvement Project	East	City of Pittsburg
Watershed Information Center & Conservancy of Napa County	North	County of Napa
Westborough Main Pump Station Generator	West	Westborough Water District
Western Dublin Recycled Water Distribution Expansion and Retrofit Project	East	Dublin San Ramon Services District
White Slough Flood Control and Improvement Project	North	Vallejo Sanitation and Flood Control District
Wildcat and San Pablo Creeks Restoration and Management Plan	East	Contra Costa County Flood Control and Water Conservation District
Wildcat Creek Fish Passage and Habitat Restoration (1135)(#7)	East	Contra Costa County Flood Control and Water Conservation District
Wildcat Creek Watershed Erosion and Sediment Control Project	East	East Bay Regional Park District

Wildcat Sediment Basin Desilt, North Richmond (#5)	East	Contra Costa County Flood Control District
Wildcat/San Pablo Creeks Phase II Channel Improvements, San Pablo (#9)	East	City of San Pablo
Zone 1 Recycled Water- Pleasant Hill Build Out	East	Contra Costa Sanitary District

Appendix D: Local and Regional Water Resource Plan Inventory

Agency	IRWM Subregion	Title of Plan	Year	Water Management Activity Addressed in Plan	Jurisdiction or Area	Is Plan Updated Periodically (Y/N)? (Update Interval in Years)	Link
San Francisco Bay Conservation and Development Commission	All	San Francisco Bay Plan		Watershed Management and Habitat Restoration	San Francisco Bay	Amended periodically	http://www.bcdc.ca.gov/laws_plans/plans/sfbay_plan.shtml
San Francisco Bay Conservation and Development Commission	All	Living With a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its Shoreline.	2011	Multiple activities within the Baylands	San Francisco Bay	No	http://www.bcdc.ca.gov/BPA/LivingWithRisingBay.pdf
San Francisco Bay Joint Venture	All	Restoring the Estuary: A Strategic Plan for the Restoration of Wetlands and Wildlife in the San Francisco Bay		Watershed Management and Habitat Restoration	San Francisco Bay		http://www.sfbayjv.org/strategy.php#implementation_strategy
San Francisco Estuary Project	All	Comprehensive Conservation and Management Plan	2007	Watershed Management and Habitat Restoration	San Francisco Bay	Yes	http://www.sfestuary.org/pages/index.php?ID=7
San Franscisco Bay Regional Water Quality Control Board	All	Watershed Management Intiative Integrated Plan	2004	Watershed Management and Habitat Restoration	Bay Area Region	No	
San Franscisco Bay Regional Water Quality Control Board	All	San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan).	2011	Water Quality	Bay Area Region	Yes (periodically)	http://www.waterboards.ca.gov/rwqcb2/basin_planning.shtml
SFBA Wetland Ecosystem Goals Project	All	Baylands Ecosystem Habitat Goals	1999	Watershed Management and Habitat Restoration	San Francisco Bay	No	
State Coastal Conservancy, Ocean Protection Council, NOAA National Marine Fisheries Service and Restoration Center, San Francisco Bay Conservation and Development Commission, and San Francisco Estuary Partnership	All	San Francisco Bay Subtidal Habitat Goals Report, Conservation Planning for the Submerged Areas of the Bay	2010	Watershed Management and Habitat Restoration	San Francisco Bay	No	
USFWS	All	Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California	2009	Watershed Management and Habitat Restoration			http://www.fws.gov/sacramento/es/Recovery-Planning/Tidal-Marsh/es_recovery_tidal-marsh-recovery.htm
Bay Area Open Space Council	All	The Conservation Lands Network, San Francisco Bay Area Upland Habitat Goals Project Report	2011	Watershed Management and Habitat Restoration	Bay Area Region		http://www.bayarealands.org/
Bay Area Stormwater Management Agencies Association	All	Start at the Source, Design Guidance Manual for Stormwater Quality Protection	1999	Stormwater Management	Bay Area Region	No	
California Coastal Commission	All	California's Critical Coastal Areas, San Francisco Bay Region	2012	Watershed Management and Habitat Restoration	Bay Area Region	Yes (periodically)	
Bay Area Regional Reliability	All	Drought Contingency Plan	2018	Multiple activities within the Baylands	Bay Area Region		http://www.bayareareliability.com/top-menu/documents/
Alameda County	E	Clean Water Program, Stormwater Management Plan	no date	Stormwater management	Alameda County	Yes (every 5 years)	www.acgov.org/sustain/what/water/cwpc.htm

Appendix D: Local and Regional Water Resource Plan Inventory

Agency	IRWM Subregion	Title of Plan	Year	Water Management Activity Addressed in Plan	Jurisdiction or Area	Is Plan Updated Periodically (Y/N)? (Update Interval in Years)	Link
Alameda County Water District, Santa Clara Valley Water District, and Zone 7 Water Agency	E	South Bay Aqueduct Watershed Protection Program Plan	2008	Watershed Management and Habitat Restoration	Alameda County Water District, Santa Clara Valley Water District, and Zone 7 service areas	Yes (as needed)	http://www.acwd.org/?nid=161
Alameda County Water District	E	2015-2020 Urban Water Management Plan	2016	Urban Water Management	Alameda County Water District service area.	Yes (every 5 years)	https://www.acwd.org/DocumentCenter/View/1264/ACWDs-2015---2020-UWMP?bidId=
City of Berkeley	E	Watershed Management Plan	2011	Flood Protection and Stormwater Management, Watershed Management and Habitat Restoration	City of Berkeley		http://www.ci.berkeley.ca.us/uploadedFiles/Clerk/Level_3_-_City_Council/2011/10Oct/Watershed%20Management%20Plan.pdf
City of Hayward	E	Urban Water Management Plan	2016	Urban Water Management	City of Hayward	Yes (every 5 years)	https://www.hayward-ca.gov/sites/default/files/documents/City%20of%20Hayward%20Final%202015%20UWMP.pdf
City of Livermore	E	Urban Water Management Plan	2016	Urban Water Management	City of Livermore	Yes (every 5 years)	
City of Pittsburg	E	Urban Water Management Plan	2016	Urban Water Management	City of Pittsburg	Yes (every 5 years)	http://www.ci.pittsburg.ca.us/Modules/ShowDocument.aspx?documentid=8283
City of Pleasanton	E	Urban Water Management Plan	2016	Urban Water Management	City of Pleasanton	Yes (every 5 years)	http://admin.cityofpleasantonca.gov/civicax/filebank/blobdload.aspx?BlobID=33966
Contra Costa County	E	Stormwater Management Plan, 1999 2004		Stormwater management	Contra Costa County		http://www.cccleanwater.org/_pdfs/CCCWPSWMP99-04.pdf
Contra Costa Clean Water Program	E	Contra Costa Watersheds Stormwater Resource Plan	2019	Stormwater management	Contra Costa County		https://www.cccleanwater.org/resources/stormwater-resource-plan
Contra Costa Flood Control and Water Conservation District	E	The 50 Year Plan	2009	Flood Protection and Stormwater Management	Contra Costa Flood Control and Water Conservation District service area		http://www.co.contra-costa.ca.us/DocumentView.aspx?DID=6853
Contra Costa Water District	E	Historical Freshwater and Salinity Conditions in the Western Sacramento-San Joaquin Delta and Suisun Bay	2010	Salt and Salinity Management	Contra Costa Water District service area		http://www.swrcb.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/swrcb/swrcb_ccwd2010.pdf
Contra Costa Water District	E	Urban Water Management Plan	2016	Urban Water Management	Contra Costa Water District service area	Yes (every 5 years)	https://www.ccwater.com/DocumentCenter/View/2216/2015-Urban-Water-Management-Plan-PDF

Appendix D: Local and Regional Water Resource Plan Inventory

Agency	IRWM Subregion	Title of Plan	Year	Water Management Activity Addressed in Plan	Jurisdiction or Area	Is Plan Updated Periodically (Y/N)? (Update Interval in Years)	Link
Contra Costa Water District	E	Water Management Plan	2017	Urban Water Management	Contra Costa Water District service area		https://www.ccwater.com/DocumentCenter/View/3881/2017-Water-Management-Plan-Draft-PDF
Contra Costa Water District	E	Treated Water Master Plan	2015	Urban Water Management	Contra Costa Water District service area		https://www.ccwater.com/DocumentCenter/View/545/2015-Treated-Water-Master-Plan-Update-PDF
Delta Diablo Sanitation District	E	Sewer System Management Plan	2008	Wastewater and Recycled Water	Delta Diablo Sanitation District service area		not accessible online
Diablo Water District	E	Groundwater Management Plan for AB 3030	2007	Groundwater Management	Diablo Water District service area.		http://www.diablowater.org/documents/pdfs/DiabloWDGWMP5-23-07.pdf
Diablo Water District	E	Urban Water Management Plan	2016	Urban Water Management	Diablo Water District service area.	Yes (every 5 years)	http://diablowater.org/doc/194/
Dublin San Ramon Services District	E	Urban Water Management Plan	2016	Urban Water Management	Dublin San Ramon Services District service area	Yes (every 5 years)	https://www.dsrsd.com/home/showdocument?id=2890
Dublin San Ramon Services District	E	Water Master Plan Update	2016	Water Supply	Dublin San Ramon Services District service area		https://www.dsrsd.com/home/showdocument?id=2816
East Bay Municipal Utility District	E	Urban Water Management Plan	2016	Urban Water Management	East Bay Municipal Utility District service area	Yes (every 5 years)	https://www.ebmud.com/water/about-your-water/water-supply/urban-water-management-plan/
East Bay Municipal Utility District	E	Main Wastewater Treatment Plant Land Use Master Plan EIR	2011	Wastewater and Recycled Water	East Bay Municipal Utility District service area	No	
East Bay Municipal Utility District	E	Water Supply Management Program 2040	2012	Water Supply	East Bay Municipal Utility District service area		http://www.ebmud.com/sites/default/files/pdfs/wsmp-2040-revised-final-plan.pdf
Zone 7	E	Stream Management Master Plan	2006	Flood Protection and Stormwater Management	Zone 7 service area	Yes (update underway)	http://www.zone7water.com/final-smmp
Zone 7	E	Groundwater Management Plan for Livermore Amador Valley Groundwater Basin	2005	Groundwater Management	Zone 7 service area	Yes (as needed)	http://www.zone7water.com/images/pdf_docs/water_supply/gmp-covertablecontents.pdf
Zone 7	E	Salt/Nutrient Management Plan	2004	Salt and Salinity	Zone 7 service area	Yes (update underway)	http://www.zone7water.com/publications-reports/water-reportsplanning-documents/158-salt-management-plan-2004
Zone 7	E	Urban Water Management Plan	2016	Urban Water Management	Zone 7 service area	Yes (every 5 years)	https://www.zone7water.com/images/pdf_docs/water_supply/urban_water_mgmt_plan_2015.pdf

Appendix D: Local and Regional Water Resource Plan Inventory

Agency	IRWM Subregion	Title of Plan	Year	Water Management Activity Addressed in Plan	Jurisdiction or Area	Is Plan Updated Periodically (Y/N)? (Update Interval in Years)	Link
Zone 7	E	Water Supply Evaluation	2019	Water Supply/Urban Water Management	Zone 7 service area	Yes (as needed)	https://www.dropbox.com/s/fzhdf6olhcvnmyc/2019%20WSE%20Update.pdf?dl=0
Zone 7	E	Sustainable Water Supply Annual Review	2011	Water Supply/Urban Water Management	Zone 7 service area	Yes (annually)	http://www.zone7water.com/sustainable-water-supply-annual-review-invisible-menu-553?task=view
Zone 7	E	Eastern Alameda County Conservation Strategy	2010	Watershed Management and Habitat Restoration	Zone 7 service area	Yes, database updated as needed	http://ww.eastalco-conservation.org/
Zone 7	E	Lake Del Valle Reservoir Water Supply Storage Expansion Concept	2018	Water Supply	Zone 7 service area		https://www.zone7water.com/images/pdf_docs/water_supply/lake_del_valle_firo_report_1-31-18.pdf
Tri Valley Agencies	E	Joint Tri-Valley Potable Reuse Technical Feasibility Study	2018	Water Supply	Tri Valley area (Livermore, Dublin, Pleasanton)		https://www.dropbox.com/s/pxcyajryga5j61s/potable_reuse_feasibility_study_May-2018.pdf?dl=0
Bay Area Regional Water Recycling Program	E, S, W	Regional Recycled Water Master Plan	1999	Wastewater and Recycled Water	Bay Area Region		
Bay Area Water Supply and Conservation Agency	E, S, W	Bay Area Water Supply and Conservation Agency Long Term Water Supply Strategy Phase IIA Final Report	2012	Water Supply	Bay Area Water Supply and Conservation Agency service area		http://bawsca.org/docs/BAWSCA%20PH%20II%20A%20Final%20Report_2012_07_03%20Revised%20073012.pdf
South Bay Salt Pond Restoration Project	E, S, W	South Bay Salt Pond Restoration Final EIR/EIR	2007	Watershed Management and Habitat Restoration	Eden Landing, Alviso and Ravenswood salt pond complexes, south San Francisco Bay	No	http://www.southbayrestoration.org/EIR/
City of Benicia	N	Urban Water Management Plan	2016	Urban Water Management	City of Benicia	Yes (every 5 years)	https://www.ci.benicia.ca.us/vertical/sites/%7BF991A639-AAED-4E1A-9735-86EA195E2C8D%7D/uploads/Benicia_2015_UWMP_Final_7.20.16.pdf
City of Fairfield	N	Urban Water Management Plan	2016	Urban Water Management	City of Fairfield	Yes (every 5 years)	https://fairfield.ca.gov/civicax/filebank/blobdload.aspx?blobid=13707
City of Napa	N	Urban Water Management Plan	2016	Urban Water Management	City of Napa	Yes (every 5 years)	https://www.cityofnapa.org/DocumentCenter/View/1376/Urban-Water-Management-Program-2015-Update-PDF?bidId=
City of Petaluma	N	Urban Water Management Plan	2016	Urban Water Management	City of Petaluma	Yes (every 5 years)	https://cityofpetaluma.net/wrcd/pdf/temp/2015UWMPFinal.pdf
City of Sonoma	N	Urban Water Management Plan	2016	Urban Water Management	City of Sonoma	Yes (every 5 years)	https://www.sonomacity.org/documents/2015-urban-water-management-plan/

Appendix D: Local and Regional Water Resource Plan Inventory

Agency	IRWM Subregion	Title of Plan	Year	Water Management Activity Addressed in Plan	Jurisdiction or Area	Is Plan Updated Periodically (Y/N)? (Update Interval in Years)	Link
City of Vallejo	N	Urban Water Management Plan	2016	Urban Water Management	City of Vallejo	Yes (every 5 years)	http://www.cityofvallejo.net/common/pages/DisplayFile.aspx?itemId=5570055
Fairfield-Suisun Sewer District	N	Urban Water Management Plan	2010	Urban Water Management	Fairfield-Suisun Sewer District service area	Yes (every 5 years)	ESA library
Marin County Flood Control and Water Conservation District	N	Stormwater Pollution Prevention Program Action Plan	2010	Water Quality	Marin County Flood Control and Water Conservation District service area		http://www.mcstoppp.org/acrobat/AP2010_20050520%20.pdf
Marin County Parks	N	Marin County Parks Road Assessment		Watershed Management and Habitat Restoration	Marin County		
Marin County Parks	N	Marin County Parks Road and Trail Management Plan		Watershed Management and Habitat Restoration	Marin County		http://www.marincounty.org/Depts/PK/Our-Work/OS-Main-Projects/RTMP
Marin County Stormwater Pollution Prevention Program	N	Action Plan Fiscal Years 2005-2006 through 2009-2010	2012	Flood Protection and Stormwater Management	Marin County	Yes (annually)	http://www.mcstoppp.org/acrobat/AP2010_20050520%20.pdf
Marin Municipal Water District	N	Urban Water Management Plan	2016	Water Supply	Marin Municipal Water District service area	Yes (every 5 years)	http://www.marinwater.org/DocumentCenter/View/4016/MMWD-2015-UWMP-Final-Report?bidId=
Marin Municipal Water District	N	Vegetation Management Plan	2012	Watershed Management and Habitat Restoration	Marin Municipal Water District service area		
Marin Municipal Water District	N	Mt. Tamalpais Watershed Road and Trail Management Plan and EIR		Watershed Management and Habitat Restoration	Marin Municipal Water District service area		
Marin Municipal Water District	N	Lagunitas Creek Stewardship Plan	2011	Watershed Management and Habitat Restoration	Marin Municipal Water District service area		http://www.marinwater.org/documents/Lagunitas_Creek_Stewardship_Plan_MMWD_Final_June_2011.pdf
Marin Municipal Water District	N	Lagunitas Creek Unpaved Roads Sediment Source Site Assessment	2011	Watershed Management and Habitat Restoration	Marin Municipal Water District service area		http://marinwater.org/DocumentCenter/View/182/Lagunitas-Creek-Review-and-Evaluation-June-2011?bidId=
Marin Municipal Water District	N	Water Resources Plan 2040	2016	Urban Water Management	Marin Municipal Water District service area		www.marinwater.org/DocumentCenter/View/5095
Napa County Resource Conservation District	N	Napa River Watershed Owners Manual: An Integrated Resource Management Plan	no date	Water Supply	Napa County Resource Conservation District service area	No	http://www.napawatersheds.org/docManager/
Napa County Resource Conservation District	N	2005-06 Strategic Plan	2005	Watershed Management and Habitat Restoration	Napa County Resource Conservation District service area		http://www.napawatersheds.org/files/managed/Document/3900/FinalWICCStratPlan05-06.pdf

Appendix D: Local and Regional Water Resource Plan Inventory

Agency	IRWM Subregion	Title of Plan	Year	Water Management Activity Addressed in Plan	Jurisdiction or Area	Is Plan Updated Periodically (Y/N)? (Update Interval in Years)	Link
Napa County Resource Conservation District	N	Carneros Creek Watershed Management Plan	2005	Watershed Management and Habitat Restoration	Napa County Resource Conservation District service area		http://www.napawatersheds.org/docs.php?ogid=10423
Napa Sanitation District	N	Wastewater Treatment Plan Master Plan	2011	Wastewater and Recycled Water	Napa Sanitation District service area	No	http://www.napasanitationdistrict.com/treatment/wtpmp.html
North Bay Water Reuse Authority	N	North Bay Water Reuse Program	2010	Wastewater and Recycled Water	North Bay Water Reuse Authority service area	No	http://www.nbwra.org/docs/index.html
North Bay Watershed Association	N	North Bay Watershed Stewardship Plan	2003	Watershed Management and Habitat Restoration	North Bay Watershed Association membership area	No	http://www.nbwatershed.org/SWP/ph1/Ph1_ExecSummary.pdf
North Marin Water District	N	Urban Water Management Plan	2016	Urban Water Management	North Marin Water District service area	Yes (every 5 years)	https://www.nmwd.com/pdf/FINAL%20North%20Marin%20UWMP%20Master%202015.pdf
Novato Sanitary District	N	Sewer System Management Plan	2010	Wastewater and Recycled Water	Novato Sanitary District service area	No	http://www.novatosan.com/assets/files/documents/Final_SSMP_2010_revJune2011.pdf
Solano County Water Agency	N	Urban Water Management Plan	2016	Urban Water Management	Solano County Water Agency	Yes (every 5 years)	http://www.scwa2.com/home/showdocument?id=2798
Sonoma County Water Agency	N	Sonoma Valley Groundwater Management Plan	2007	Groundwater Management	Sonoma County Water Agency service area	No	http://sonomavalleygroundwater.org/wp-content/uploads/Sonoma-Valley-Groundwater-Management-Plan-2007.pdf
Sonoma County Water Agency	N	Urban Water Management Plan	2016	Urban Water Management	Sonoma County Water Agency service area	Yes (every 5 years)	https://evogov.s3.amazonaws.com/media/185/media/164720.PDF
Sonoma County Water Agency	N	Sewer System Management Plans (All Service Areas)	2006	Wastewater and Recycled Water	Sonoma County Water Agency service area	No	http://www.scwa.ca.gov/sewer-system-management-plans/
Sonoma County Water Agency	N	Water Supply Strategies Action Plan	2013	Water Supply, Groundwater Management	Sonoma County Water Agency service area		https://evogov.s3.amazonaws.com/185/media/164687.pdf
Sonoma County Water Agency	N	Sonoma County Stream Maintenance Program Manual and EIR	2011	Watershed Management and Habitat Restoration	Sonoma County Water Agency service area		http: www.scwa.ca.gov/lower.php?urs=environmenal-impact reportss#smp
Suisun Solano Water Authority	N	Urban Water Management Plan	2016	Urban Water Management	Suisun Solano Water Authority service area	Yes (every 5 years)	https://www.sidwater.org/DocumentCenter/View/1151/SSWA_2015-UWMP-FINAL_8-15-16?bidId=
The Marin County Community Development Agency, Planning Division	N	Watershed Management Plan	2004	Watershed Management and Habitat Restoration	Marin County	No	http://www.co.marin.ca.us/depts/CD/main/comdev/Watershed/WMP_Pt1.pdf

Appendix D: Local and Regional Water Resource Plan Inventory

Agency	IRWM Subregion	Title of Plan	Year	Water Management Activity Addressed in Plan	Jurisdiction or Area	Is Plan Updated Periodically (Y/N)? (Update Interval in Years)	Link
Tomales Watershed Council	N	Tomales Bay Integrated Coastal Watershed Management Plan	2007	Watershed Management and Habitat Restoration	Tomales Bay watershed		http://www.tomalesbaywatershed.org/informationreports.html
Valley of the Moon Water District	N	Urban Water Management Plan	2016	Urban Water Management	Valley of the Moon Water District service area	Yes (every 5 years)	https://docs.wixstatic.com/ugd/f7204b_0b944a237b264fb294630cc4b82619ba.pdf
Fairfield-Suisun Sewer District	N	Sewer System Management Plan	no date	Wastewater and Recycled Water	Fairfield-Suisun Sewer District service area		not accessible online
City of Milpitas	S	Urban Water Management Plan	2016	Urban Water Management	City of Milpitas	Yes (every 5 years)	http://www.ci.milpitas.ca.gov/wp-content/uploads/2015/07/Adopted-2015-Milpitas-UWMP-Revised-6-27-16.pdf
City of Morgan Hill	S	Urban Water Management Plan	2016	Urban Water Management	City of Morgan Hill	Yes (every 5 years)	https://www.morgan-hill.ca.gov/DocumentCenter/View/22998/MorganHill_2015UWMP_FinalWithErrata_051018
City of Mountain View	S	Urban Water Management Plan	2016	Urban Water Management	City of Mountain View	Yes (every 5 years)	https://www.mountainview.gov/civicax/filebank/blobdload.aspx?BlobID=19444
City of San Jose	S	Urban Water Management Plan	2016	Urban Water Management	City of San Jose	Yes (every 5 years)	https://www.sanjoseca.gov/DocumentCenter/View/57483
City of San Jose	S	San Jose/Santa Clara Water Pollution Control Plant Master Plan	2011	Wastewater and Recycled Water, Flood Protection, Habitat Restoration	San Jose/Santa Clara Water Pollution Control Plant lands	No	http://www.rebuildtheplant.org/go/site/1823/
City of Santa Clara	S	Urban Water Management Plan	2016	Urban Water Management	City of Santa Clara	Yes (every 5 years)	http://santaclaraca.gov/home/showdocument?id=48088
Santa Clara Basin WatershedManagement Initiative	S	Watershed Action Plan	2003	Watershed Management and Habitat Restoration	Santa Clara Basin Watershed		http://cf.valleywater.org/_wmi/Participates_login/Participates/WAP/draft/Actiondraft0803.cfm
Santa Clara Valley Urban Run-off Program	S	Santa Clara Valley Urban Run-off Pollution Prevention Program	2004	Stormwater and Groundwater Management	Santa Clara Valley Water District service area		http://www.scvurppp-w2k.com/urmp_2004/2004_URMP_Final.pdf
Santa Clara Valley Water District	S	One Water Plan		Flood Protection and Stormwater Management; Watershed Management and Habitat Restoration; Water Supply	Santa Clara County		https://onewaterplan.wordpress.com/
Santa Clara Valley Water District	S	Santa Clara Valley Water District Groundwater Management Plan	2012	Groundwater Management	Santa Clara Valley Water District service area		http://www.valleywater.org/Services/Groundwater.aspx

Appendix D: Local and Regional Water Resource Plan Inventory

Agency	IRWM Subregion	Title of Plan	Year	Water Management Activity Addressed in Plan	Jurisdiction or Area	Is Plan Updated Periodically (Y/N)? (Update Interval in Years)	Link
Santa Clara Valley Water District	S	Urban Water Management Plan	2016	Urban Water Management	Santa Clara County	Yes (every 5 years)	https://www.valleywater.org/sites/default/files/SCVWD%202015%20UWMP-Report%20Only.pdf
Santa Clara Valley Water District	S	Water Supply and Infrastructure Master Plan	2012	Water Supply	Santa Clara County	Yes (every 5 years)	http://www.valleywater.org/Services/WaterSupplyPlanning.aspx
Santa Clara Valley Water District	S	Water Supply Master Plan	In Process	Water Supply	Santa Clara Valley Water District service area		https://www.valleywater.org/sites/default/files/Draft%20WSMP%202040%20Complete_v2.pdf
South Bay Water Recycling and Santa Clara Valley Water District	S	South Bay Water Recycling Strategic and Master Plan	2014	Wastewater and Recycled Water	Santa Clara County		https://www.valleywater.org/sites/default/files/335%20P3%20Related%20Reports%20SBWR%20Stratigic%20and%20Master%20Plan%20-%20Report%20%28Vol.1%29%20%281%29.pdf
City of Palo Alto	S	Urban Water Management Plan	2016	Urban Water Management	City of Palo Alto	Yes (every 5 years)	https://www.cityofpaloalto.org/civicax/filebank/documents/51985
Great Oaks Water Company	S	Urban Water Management Plan	2016	Urban Water Management	Southern San Jose	Yes (every 5 years)	https://www.greatoakswater.com/OtherPDFs/2015UrbanWaterManagementPlan.pdf
City of Sunnyvale	S	Urban Water Management Plan	2016	Urban Water Management	City of Sunnyvale	Yes (every 5 years)	https://sunnyvaleca.legistar.com/LegislationDetail.aspx?ID=2761621&GUID=A221A3CC-14F2-49A9-B9DE-54ECC6359DC9&Options=&Search=
California Water Service Company	S	Urban Water Management Plan	2011	Urban Water Management	The majority of the incorporated city of Los Altos, fringe sections of the cities of Cupertino, Los Altos Hills, Mountain View, Sunnyvale and adjacent unincorporated areas of Santa Clara County.	Yes (every 5 years)	https://www.calwater.com/docs/uwmp2015/las/2015_Urban_Water_Management_Plan_Final_(LAS).pdf
San Jose Water Company	S	Urban Water Management Plan	2011	Urban Water Management	Most of San Jose, most of Cupertino, Campbell, Monte Sereno, Saratoga, Los Gatos, and parts of unincorporated Santa Clara County	Yes (every 5 years)	http://www.water.ca.gov/urbanwatermanagement/2010uwmps/San%20Jose%20Water%20Company/SJWC'S%202010%20UWMP%20with%20Appendicies.pdf

Appendix D: Local and Regional Water Resource Plan Inventory

Agency	IRWM Subregion	Title of Plan	Year	Water Management Activity Addressed in Plan	Jurisdiction or Area	Is Plan Updated Periodically (Y/N)? (Update Interval in Years)	Link
Santa Clara Valley Water District	S	Santa Clara Subbasin Salt and Nutrient Management Plan	2014	Stormwater and Groundwater Management; Wastewater and Recycled Water	Northern Santa Clara County		
Santa Clara Valley Water District	S	Infrastructure Reliability Plan	2005	Water Supply	Santa Clara County	Yes (in process)	
Santa Clara Valley Water District	S	Three Creeks Habitat Conservation Plan	2015	Watershed Management and Habitat Restoration	Coyote Creek, Guadalupe River, and Stevens Creek Watersheds in Santa Clara County	No	
City of Gilroy, City of Morgan Hill, City of San Jose, Santa Clara County, Santa Clara Valley Transportation Authority, Santa Clara Valley Water District	S	Valley Habitat Plan	2012	Watershed Management and Habitat Restoration	Most of Santa Clara County		http://scv-habitatplan.org/www/site/alias__default/1/home.aspx
City of Mountain View	S	Recycled Water Master Plan	In Process	Wastewater and Recycled Water	City of Mountain View		
San Jose Water Company	S	Recycled Water Master Plan	2008	Wastewater and Recycled Water			
City of Sunnyvale	S	Recycled Water Master Plan		Wastewater and Recycled Water	City of Sunnyvale		
City of Burlingame	W	Urban Water Management Plan	2016	Urban Water Management	City of Burlingame	Yes (every 5 years)	https://www.burlingame.org/document_center/Water/2015%20Urban%20Water%20Management%20Plan.pdf
City of Daly City	W	Urban Water Management Plan	2016	Urban Water Management	City of Daly City	Yes (every 5 years)	http://www.dalycity.org/Assets/Departments/Water+and+Wastewater/pdf/City+of+Daly+City+2015+UWMP_Public+Review+Draft_Full+Report.pdf
City of East Palo Alto	W	Urban Water Management Plan	2016	Urban Water Management	City of East Palo Alto	Yes (every 5 years)	https://www.ci.east-palo-alto.ca.us/DocumentCenter/View/2714
City of Menlo Park	W	Urban Water Management Plan	2016	Urban Water Management	City of Menlo Park	Yes (every 5 years)	https://www.menlopark.org/DocumentCenter/View/10111/2015-Urban-Water-Managment-Plan?bidId=
City of Millbrae	W	Urban Water Management Plan	2016	Urban Water Management	City of Millbrae	Yes (every 5 years)	https://www.ci.millbrae.ca.us/home/showdocument?id=7918
City of Redwood City	W	Urban Water Management Plan	2016	Urban Water Management	City of Redwood City	Yes (every 5 years)	http://www.redwoodcity.org/home/showdocument?id=8091
City of San Bruno	W	Urban Water Management Plan	2016	Urban Water Management	City of San Bruno	Yes (every 5 years)	https://www.sanbruno.ca.gov/civicax/filebank/blobdload.aspx?blobid=27012

Appendix D: Local and Regional Water Resource Plan Inventory

Agency	IRWM Subregion	Title of Plan	Year	Water Management Activity Addressed in Plan	Jurisdiction or Area	Is Plan Updated Periodically (Y/N)? (Update Interval in Years)	Link
Estero Municipal Improvement District	W	Urban Water Management Plan	2011	Urban Water Management	Estero Municipal Improvement District service area	Yes (every 5 years)	http://www.water.ca.gov/urbanwatermanagement/2010uwmps/Estero%20Municipal-Foster%20City/
Mid-Peninsula Water District	W	Urban Water Management Plan	2016	Urban Water Management	Mid-Peninsula Water District service area	Yes (every 5 years)	https://storage.googleapis.com/midpeninsulawater-org/uploads/MPWD_2015%20UWMP_Final.pdf
National Heritage Institute	W	San Gregorio Creek Watershed Management Plan	2012	Watershed Management and Habitat Restoration	San Gregorio Creek Watershed	No	
North Coast County Water District	W	Urban Water Management Plan	2016	Urban Water Management	North Coast County Water District service area	Yes (every 5 years)	https://www.nccwd.com/images/PDFs/North_Coast_County_Water_District_2015_UWMP_June_15_2016.pdf
San Francisco Public Utilities Commission	W	Urban Water Management Plan	2016	Urban Water Management	City and County of San Francisco	Yes (every 5 years)	https://sfwater.org/modules/showdocument.aspx?documentid=9300
San Francisco Public Utilities Commission	W	Sewer System Improvement Program Report	2010	Wastewater, watershed management	City and County of San Francisco		http://sfwater.org/index.aspx?page=117
San Francisco Public Utilities Commission	W	Sources and Supply Planning	2012	Water Supply	City and County of San Francisco		www.sfwater.org/index.aspx?page=75
San Mateo County	W	Sewer System Management Plan	2009	Wastewater and Recycled Water	San Mateo County		http://www.co.sanmateo.ca.us/publicworks/Divisions/Flood%20Control,%20Lighting,%20Sewer%20and%20Water/Sewer%20Services/San%20Mateo%20Co%20SSMP_1.pdf
San Mateo County Resource Conservation District	W	Pilarcitos Integrated Watershed Management Plan	2008	Watershed Management and Habitat Restoration	San Mateo County	No	www.sanmateorcd.org/PilarcitosIntWtrshdMgmPlan_TxtFigs.pdf
Town of Hillsborough	W	Urban Water Management Plan	2016	Urban Water Management	Town of Hillsborough	Yes (every 5 years)	https://www.hillsborough.net/DocumentCenter/View/2988/Final-2015-UWMP-with-Attachments?bidId=
California Department of Fish and Game		Recovery Strategy for California Coho Salmon		Watershed Management and Habitat Restoration	California		
National Marine Fisheries Service		Recovery Plan for Central California Coastal Coho Salmon		Watershed Management and Habitat Restoration	California		

Appendix E-1

BAIRWMP
Master Stakeholder List and Sample Messages Sent to List

(note: email addresses have been removed from stakeholder list. For entries that only have an organization, only the email address is known.)

First Name	Last Name	Organization
Jeff	Aalfs	Town of Portola Valley
Margaret	Abe-Koga	City of Mountain View
Janet	Abelson	City of El Cerrito
Myrna	Abramowicz	Napa County Regional Park and Open Space District
Kristi	Abrams	City of Gilroy
Michael	Abramson	Napa Sanitation District
Ruben	Abrica	City of East Palo Alto
Derek	Acomb	California Dept of Fish and Wildlife
Teresa	Acuna	Califiornia Special Districts Association
Marissa	Adams	Jones & Stokes
Susan	Adams	County of Marin
Susan	Adams	County of Marin
Mark	Addiego	City of South San Francisco
Gary S.	Agopian	City of Antioch
Alicia C.	Aguirre	City of Redwood City
Amy O.	Ahanotu	City of Rohnert Park
Chris	Albertson	
Pat	Alexander	Napa Valley Museum
Pete	Alexander	East Bay Regional Park District
Susan	Alfelp	Napa County Park and Open Space District
Allan	Alifano	City of Half Moon Bay
Emily	Allen	The Bay Institute
Emily	Allen	PRBO/STRAW
James	Allen	City of Palo Alto
Katy	Allen	City of San Jose
Steven	Allen	Town of Windsor
Dean	Allison	City of Pinole
Alex	Ameri	City of Hayward
Candace	Andersen	Town of Danville
Craig	Anderson	LandPaths
Dave	Anderson	City of Saratoga
John	Anderson	Hedgerow Farms
Kellie	Anderson	
Max	Anderson	City of Berkeley
Mike	Anderson	City of Lafayette
Pat	Anderson	City of Oakley
Scott	Anderson	Town of Tiburon
Tim	Anderson	Sonoma County Water Agency
Brandt	Andersson	City of Lafayette
Susan	Andrade-Wax	City of Pleasanton
Greg	Andrew	Marin Municipal Water District
Betty	Andrews	ESA
Carl	Anduri	City of Lafayette
Rick	Angrisani	City of Clayton
Rick	Angrisani	City of Clayton
Marshall	Anstandig	City of Monte Sereno
Ana M.	Apodaca	City of Newark
Alyson	Aquino	Natural Resources Conservation Service
Eddie	Arango	Corix
Peter	Arellano	City of Gilroy
Kurt	Arends	Zone 7 Water Agency
Greg	Armendariz	City of Milpitas
Jennifer	Armer	City of Rio Vista
Newell	Arnerich	Town of Danville

First Name	Last Name	Organization
Carol	Arnold	Contra Costa Resource Conservation District
Judy	Arnold	County of Marin
Jesse	Arreguin	City of Berkeley
Jac	Asher	City of Emeryville
Darcy	Aston	Napa Sanitation District
Ruth	Atkin	City of Emeryville
Kwablah	Attiogbe	Alameda County Public Works
Mitch	Avalon	Contra Costa County Flood Control and Water Conservation District
John	Avalos	City and County of San Francisco
Steve	Babb	City of Healdsburg
Rachel	Babcock	
Sandy	Baily	Town of Los Gatos
Ian	Bain	City of Redwood City
Mike	Bakaldin	City of San Leandro
Mike	Bakaldin	City of San Leandro
Jason	Baker	City of Campbell
Edward	Ballman	Balance Hydrologics
Michael	Ban	Marin Municipal Water District
Subrata	Bandy	HDR
Curtis	Banks	City of Foster City
Tim	Banuelos	City of Pinole
Sheryl	Barbic	The Bay Institute
Janet	Barbieri	Jones & Stokes
Steve	Barbose	Vom.com
Siavash	Barmand	City of Belvedere
Jill	Barnes	City of Mill Valley
Valerie	Barone	City of Concord
Morris	Barr	City of Dixon
Steve	Barr	City of Brentwood
Erika	Barraza	Carollo Engineers
Teresa	Barrett	
David	Barron	Butters Canyon Conservancy
David	Barth	California Depatment of Water Resources
Scott	Bartley	City of Santa Rosa
Stephanie	Bastianon	Friends of the Petaluma River
Phil	Batchelor	City of Vallejo
Helen	Bates	
Milenka	Bates	City of Sonoma
Nathaniel	Bates	City of Richmond
Tom	Bates	City of Berkeley
Rajeev	Batra	City of Santa Clara
Rajeev	Batra, P. E.	City of Santa Clara
Robert	Bauman	City of Hayward
Victoria	Baxter	City of San Jose
Cathy	Baylock	City of Burlingame
Chris	Bazar	County of Alameda
John	Beall	Coyote Guadalupe RDC
Michele	Beasly	Greenbelt Alliance
Robert	Beaumont	County of Marin
Erin	Beavers	City of Fairfield
Gordon	Becker	Center for Ecosystem Management and Restoration (CEMAR)
John	Becker	City of Newark

First Name	Last Name	Organization
Jovanka	Beckles	City of Richmond
Christie	Beeman	ESA PWA
Gina	Belforte	City of Rohnert Park
Doug	Bell	City of Burlingame
Robert B.	Bell	City of Redwood City
Rebecca	Benassini	City of El Cerrito
Ron	Bendorff	City of Healdsburg
Diana	Benner	The Watershed Nursery
Belia R.	Bennett	City of American Canyon
Joan	Bennett	City of American Canyon
Michelle	Benvenuto	Winegrowers of Napa County
Don	Berger	Central Contra Costa Sanitary District
Jim	Bergman	Town of Windsor
Katie	Bergmann	Natural Resources Conservation Service
Allan	Berkwitz	Environmental Volunteers
Andrew	Berman	City of Mill Valley
Yader	Bermudez	City of Richmond
Daniel	Bernie	Town of Moraga
Kevin	Berryhill	Napa County Public Works
Pam	Bertani	City of Fairfield
Martha	Berthelsen	The Watershed Project
Toni	Bertolero	GHD
Dane	Besneatte	City of Dixon
Jack	Betoune	*Napa County Stormwater Pollution Prevention Program*
Jack	Betourne	Betourne Environmental Consulting
Robert	Beyer	City of Fremont
Dipti	Bhatnagar	Environmental Justice Coalition for Water
Rhodora	Biagtan	Dublin San Ramon Services District
Jill	Bicknell	Santa Clara Valley Urban Runoff Pollution Prevention Program
Don	Biddle	City of Dublin
Betsy	Bikle	Wellesley
Mandi	Billingo	Kids for the Bay
Victor	Bjelajac	California Department of Parks and Recreation
Kate	Black	City of Piedmont
Jim	Blanke	RMC Water and Environment
Terry	Blount	City of Martinez
Natalya	Blumenfeld	Golden Gate National Parks Conservancy
Jill	Bluso Demers	San Francisco Bay Bird Observatory
Phil	Bobel	City of Palo Alto
Astrid	Bock-Foster	Napa Sustainable Winegrowing Group
David	Boesch	County of San Mateo
Rob	Bonta	City of Alameda
Kevin	Booker	Sonoma County Water Agency
Courtland (Corky)	Booze	City of Richmond
Steve	Borchard	Rios Farming Company
Timm	Borden	City of Cupertino
Brian	Bordona	Napa County CDPD
Ann	Borgonovo	ESA/PWA
Susan	Boswell	Watershed Information Center and Conservancy of Napa County; Sustainable Napa County
Mark	Boucher	Contra Costa County Flood Control and Water Conservation District
Gerard	Boulanger	City of Hercules

First Name	Last Name	Organization
Mike	Boulland	Friends of Los Alamitos Creek Watershed (FOLAW)
Constance	Boulware	City of Rio Vista
Josephine	Bower	San Francisco International Airport
Dennis	Bowker	Private Consultant
Pam	Boyle	
Dion	Bracco	City of Gilroy
Dave	Bracken	Town of Corte Madera
David	Bracken	Town of Corte Madera
Jerry	Bradshaw	City of El Cerrito
Josh	Bradt	Urban Creeks Council
Suzanne	Bragdon	City of Suisun City
Larry	Bragman	Town of Fairfax
Susie	Brain	Friends of Stevens Creek Trail
David	Braunstein	City of Belmont
Shawna	Brekke-Read	Town of Moraga
David	Briggs	Lake Berryessa Watershed Partnership
Kurt	Brinkman	City of Emeryville
Mike	Britten	Carollo Engineers
Del	Britton	City of St. Helena
Gary	Broad	City of St. Helena
Robert	Brockman	City of Brentwood
Charlie	Bronitsky	City of Foster City
Desley	Brooks	City of Oakland
John	Brosnan	Sonoma Land Trust
Amy	Brown	City of Campbell
John C.	Brown	City of Petaluma
Ken	Brown	Bear Flag Social Club
Marti	Brown	City of Vallejo
Valerie	Brown	County of Sonoma
Michael	Brownrigg	City of Burlingame
Jane	Brunner	City of Oakland
Charles	Bryant	City of Emeryville
Joel	Bryant	City of Brentwood
Kevin	Bryant	Town of Woodside
Ronit	Bryant	City of Mountain View
Julia	Bueren	Contra Costa County
Howard	Bunce	County of Marin
Bob	Bundy	Corte Madera Flood Board
Brad	Burkholder	California Dept of Fish and Wildlife
David	Burow	Town of Woodside
Patrick	Burt	City of Palo Alto
Richard	Burtt	Town of Windsor
Lisa	Bush	
Gerald	Butler	City of Belvedere
Shannon	Butler	Pacific Watershed Associates
Thomas K.	Butt	City of Richmond
Brenda	Buxton	California State Coastal Conservancy
Nicole	Byrd	Solano Land Trust
Ted	Cabral	
Carl	Cahill	Town of Los Altos Hills
Joseph A.	Calabrigo	Town of Danville
Keith	Caldwell	County of Napa
Josept T.	Callinan	City of Rohnert Park
Tom	Campbell	City of Benicia

First Name	Last Name	Organization
David	Campos	City and County of San Francisco
Xavier	Campos	City of San Jose
Chris	Canning	City of Calistoga
Stacey Dolan	Capitani	Napa Valley Vintners
Laurie	Capitelli	City of Berkeley
Manny	Cappello	City of Saratoga
Todd	Capurso	Town of Los Gatos
Janice	Carey	City of Orinda
Michael	Carlin	San Francisco Public Utilities Commission
Ed	Carlson	
Jerry	Carlson	Town of Atherton
Mike	Carlson	Contra Costa County Flood Control and Water Conservation District
Stephanie	Carlson	University of California Berkeley
Bill	Carmen	
Larry	Carr	City of Morgan Hill
Efren	Carrillo	County of Sonoma
Keith	Carson	County of Alameda
Maureen	Carson	City of Vacaville
Emmett D.	Carson, Ph.D.	Silicon Valley Community Foundation
Emmett D.	Carson, Ph.D.	Silicon Valley Community Foundation
Eric	Cartwright	Alameda County Water District
Bob	Caruso	Always Angels
David	Casas	City of Los Altos
Will	Casey	City of Pittsburg
Stephen H.	Cassidy	City of San Leandro
L	Castilla	New Leaf
June	Catalano	City of Pleasant Hill
Kristen	Cayce	San Francisco Estuary Institute
Jarnail	Chahal	Zone 7 Water Agency
Tom	Chambers	City of Healdsburg
Wilma	Chan	County of Alameda
Ann	Chaney	City of Albany
Barry	Chang	City of Cupertino
Michael	Chang	Asian Pacific American Leadership Institute
Andre	Chapman	Unity Care Group
Steve	Chappel	Suisun Resource Conservation District
Erin	Chappell	Department of Water Resources
Laura	Chariton	
Daniel	Chase	WRA, Inc.
Kathleen	Chasey	Martha Walker Garden California Native Habitat Garden
Steve	Chatham	Prunuske Chatham Inc. Environmental Consulting
Aparna	Chatterjee	City of Hayward
Larry	Cheeves	City of Union City
Jen	Chen	City of Hillsborough
Judy	Chen	Chinese American Political Association
Ann	Cheng	City of El Cerrito
Mintze	Cheng	City of Union City
John	Cherbone	City of Saratoga
Ken	Chew	Town of Moraga
John	Chiang	City of Piedmont
Lewis	Chilton	Town of Yountville
David	Chiu	City and County of San Francisco
Richard	Chiu	Town of Los Altos Hills

First Name	Last Name	Organization
Richard	Chiu, Jr., P.E.	Town of Los Altos HIlls
Paul	Choisser	Friends of Mount Diablo Creek
Chris	Choo	County of Marin, Department of Public Works
Mark	Chow	San Mateo County
Carmen	Chu	City and County of San Francisco
Kansen	Chu	City of San Jose
Lawrence	Chu	City of Larkspur
Rich	Cimino	Audubon Society
Peggy	Claassen	City of Newark
Susannah	Clark	County of Marin
Bill	Clarkson	City of San Ramon
Jennifer	Clary	
Tracy	Clay	County of Marin
Meredith	Clement	Kennedy/Jenks Consultants
Richard	Cline	City of Menlo Park
Brian	Cluer	National Marine Fisheries Service
Alexandra	Cock	Town of Corte Madera
Suzanne	Coffee	Selby Creek Watershed Partnership
Cindy	Coffey	City of American Canyon
Andrew	Cohen	City of Menlo Park
Ellie	Cohen	PRBO Conservation Science
Malia	Cohen	City and County of San Francisco
Walter	Cohen	City of Oakland
Marge	Colapietro	City of Millbrae
John	Coleman	Bay Planning Coalition
Kay	Coleman	Town of San Anselmo
Laurel	Collins	
Richard	Collins	Town of Tiburon
Ron	Collins	City of San Carlos
Andrew	Collison	ESA
Diana	Colvin	Town of Colma
Neal	Conatser	County of Marin
Carla	Condon	Town of Corte Madera
Sean	Condry	Town of San Anselmo
Patrick	Congdon	Santa Clara County Open Space Authority
Craig	Conner	Headquarters U.S. Army Corps of Engineers
Damon	Connolly	City of San Rafael
Mike	Connor	San Francisco Estuary Institute
Pete	Constant	City of San Jose
Rich	Constantine	City of Morgan Hill
Anthony	Constantouros	Town of Hillsborough
Clarke	Conway	City of Brisbane
Valorie	Cook Carpenter	City of Los Altos
Cheryl	Cook-Kallio	City of Pleasanton
Brent	Cooper	City of American Canyon
Caitlin	Cornwall	Sonoma Ecology Center
Leslie	Corp	
Birgitta E.	Corsello	County of Solano
David D.	Cortese	County of Santa Clara
Gene	Cortright	City of Fairfield
Pat	Costello	City of Napa Water Division
Mark	Cowin	Department of Water Resources
Bob	Cox	City of Cloverdale
Burton	Craig	City of Monte Sereno

First Name	Last Name	Organization
Dave	Craig	City of San Anselmo
Jim	Craig	City of Sunnyvale
Brian	Crawford	County of Marin
Anne	Crealock	Sonoma County Water Agency
Pamela C.	Creedon	Central Valley RWQCB
Jeffrey R.	Cristina	City of Campbell
Thomas H.	Cromwell	City of Belvedere
Sharon	Crull	City of St. Helena
Arturo	Cruz	City of San Pablo
Paul	Curfman	ESA
Paul	Curfman	
Jack	Curley	County of Marin
Peggy	Curran	Town of Tiburon
Richard	Currie	Union Sanitary District
Bene	Da Silva	County of Marin
Cynthia	D'Agosta	Committee for Green Foothills
Linda	Dahl	County of Marin
Tom	Dalziel	
Steve	Danehy	City of Mill Valley
Christine	Daniel	City of Berkeley
Brad	Daniels	Trout Unlimited
Kate	Dargan	State Fire Marshall, Retired
Doug	Darling	
Maeve	Daugharty	Winzler and Kelly
Fran	David	City of Hayward
Debbie	Davis	Environmental Justice Coalition for Water
Debbie	Davis	
Hugh	Davis	County of Marin
James (Jim)	Davis	City of Antioch
Nora	Davis	City of Emeryville
Osby	Davis	City of Vallejo
Ronald	Davis	City of East Palo Alto
Sheila	Davis	Silicon Valley Toxics Coalition
Jane	Day	City of Suisun City
Ignacio	De La Fuente	City of Oakland
Hector	De La Rosa	City of Rio Vista
Jerry	Deal	City of Burlingame
Emily	Dean	
Diane	Decicio	City of San Rafael
Chris	DeGabriele	North Marin Water District
Chris	DeGroot	City of Santa Clara
Doug	deHaan	City of Alameda
Peter	DeJarnatt	City of Pacifica
Joanne F.	del Rosario	Town of Colma
Lara	DeLaney	City of Martinez
John	Delgado	City of Hercules
Theresa	Della Santa	Town of Atherton
John	Dell'Osso	City of Cotati
Sonya	DeLuca	Grape Growers
Sonya	DeLuca	Napa Valley Grape Growers
Phillip	Demery	County of Sonoma
Priscillia	deMuizon	
Melanie	Denninger	California Coastal Conservancy
Scott	Derdenger	City of Belvedere

First Name	Last Name	Organization
Sam	Derting	City of Suisun City
Maryann	Derwin	Town of Portola Valley
Greg	Desmond	City of St. Helena
Paul	Detjens	Contra Costa County Flood Control and Water Conservation District
Myrna	deVera	City of Hercules
Carlos	Diaz	Winzler and Kelly
Fred	Diaz	City of Fremont
Sue	Digre	City of Pacifica
Diane	Dillon	Napa County
Robert	Dillon	City of Gilroy
Deanne	DiPietro	Sonoma Ecology Center
Rod	Diridon, Sr.	Santa Clara County League of Conservation Voters
Jim	Dobbie	Town of Atherton
Bill	Dodd	County of Napa
Tim	Dodson	California Dept of Fish and Wildlife
Brian	Dolan	City of Pleasanton
Brad	Donahue	Town of Colma
Sandra	Donnell	City of Belvedere
Morgan	Doran	University of California Agricultural Extension
Marita	Dorenbecher	Town of Yountville
John	Doughty	City of East Palo Alto
Jim	Downey	
Lowell	Downey	ICARE
Gary	Downing	Town of Corte Madera
HR	Downs	Owl Foundation
David	Dowswell	City of Dixon
Frank	Doyle	Town of Tiburon
Michael (Mike)	Doyle	Town of Danville
Robert E.	Doyle	East Bay Regional Parks District
Will	Drayton	Treasury Wine Estates
Will	Drayton	
Edward C. (Ted)	Driscoll	Town of Portola Valley
Phong	Du	City of Redwood City
Sara	Duckler	Santa Clara Valley Water District
John	Dunbar	Town of Yountville
Emily	Duncan	City of Union City
Elizabeth	Dunn	City of Novato
Michael	Dunsford	City of Calistoga
Steve	Duran	City of Richmond
Steven	Duran	City of Hercules
David	Durant	City of Pleasant Hill
Scott	Dusterhoff	Stillwater Sciences
Patti	Dustman	Alameda County Water District
Dominic	Dutra	City of Fremont
Anona	Dutton	Bay Area Water Supply and Conservation Agency
Beth	Dyer	Santa Clara Valley Water District
Lynn	E. Johnson, Phd, Pe	National Marine Fisheries Service
Teresa	Eade	Alameda County Waste Management Authority/StopWaste.org
Suzanne	Easton	Blue Ridge Berryessa Natural Area
Dean	Eckerson	Delta Diablo Sanitary District
Kathleen	Edson	Napa County Resource Conservation District

First Name	Last Name	Organization
Bill	Ekern	City of Redwood City
Jon	Elam	
Paul R.	Eldredge	City of Brentwood
Wendy	Eliot	Sonoma Land Trust
Sandy	Elles	Napa County Farm Bureau
Claire	Elliot	Acterra - Stewardship Program
Deborah	Elliott	Napa County
Bud	Ellis	City of Napa Public Works Department
Lorrin	Ellis	City of Union City
Ellen	Ellsworth	City of Novato
Sean	Elsbernd	City and County of San Francisco
Richard	Emig	City of Sebastopol
William F.	Emlen	County of Solano
Kristin	Ep	
Belinda B.	Espinosa	City of Pinole
Sid	Espinosa	City of Palo Alto
Tonya	Espinoza	City of Napa Water Division
Jose	Esteves	City of Milpitas
Eric	Ettlinger	Marin Municipal Water District
Linus	Eukel	Muir Heritage Land Trust
A. Peter	Evans	City of East Palo Alto
Amy	Evans	Alameda County Resource Conservation District
Salvatore	Evola	City of Pittsburg
Matt	Fabry	City of Brisbane
Aaron	Fairbrook	Turtle Island Restoration Network
Rina	Faletti	Univerisity of Texas
Steven B.	Falk	City of Lafayette
Anthony	Falzone	NewFields
Erin	Farnand	City of Napa Public Works Department
Erin	Farnand	City of Napa Public Works Department
Mark	Farrell	City and County of San Francisco
Terri	Fashing	BASMAA
Terri	Fashing	County of Marin
Abby	Fateman	Contra Costa County Habitat Conservancy
Stephanie	Faulkner	Institute for Conservation Advocacy, Research and Education
Carol	Federighi	City of Lafayette
Coralin	Feierbach	City of Belmont
Bill	Feil	Friends of Pleasant Hills Creeks
Arthur	Feinstein	Citizens Committee to Complete the Refuge
Leslie	Fergson	State Water Resources Control Board
Veronica A.	Ferguson	County of Sonoma
Kelly	Fergusson	City of Menlo Park
John	Ferons	City of St. Helena
Frederick	Ferrer	Health Trust
Nelson	Fialho	City of Pleasanton
Debra	Figone	City of San Jose
Frank	Figone	Marin Municipal Water District
Jarrett	Fishpaw	City of Los Altos
Helen	Fisicaro	Town of Colma
John	Fitzgerald	
R Warren	Flint	Five E's Unlimited
Steve	Flint	City of Half Moon Bay
Darren	Fong	National Park Service

First Name	Last Name	Organization
Carolyn	Ford	City of Sausalito
Claudette	Ford	City of Berkeley
Will	Forney	Jones & Stokes
Paul	Forsberg	California Dept of Fish and Wildlife
Jim	Forsythe	City of San Rafael
Rosanne	Foust	City of Redwood City
Amy	Fowler	Santa Clara Valley Water District
Rick	Fraites	County of Marin
Charissa	Frank	Swinerton Incorporated
Michael	Frank	City of Napa
Michael	Frank	City of Novato
Paul	Frank	NewFields
Jim	Fraser	Town of Tiburon
Marina	Fraser	City of Half Moon Bay
John	Frawley	The Bay Institute of San Francisco
Jim	Frazier	City of Oakley
Alice	Fredericks	Town of Tiburon
Robin	Freeman	Peralta Community College
Matt	Freiberg	
Matthew	Freiberg	The Watershed Project
Sandra	Freitas	Santa Clara Basin WMI
Maureen	Freschet	City of San Mateo
Nick	Frey	
Pam	Frisella	City of Foster City
Roger	Fry	
Debora	Fudge	Town of Windsor
Margaret	Fujioka	City of Piedmont
Brian	Fulfrost	San Francisco Bay Bird Observatory
Michael	Fuller	City of Mountain View
Michael A.	Fuller	City of Mountain View
Stephen	Fuller-Rowell	
Diane	Furst	Town of Corte Madera
Greg	Fuz	City of Pleasant Hill
Karen	Gaan	
Pat	Gacoscos	City of Union City
Karen	Gaffney	County of Sonoma
Kevin	Gailey	Town of Danville
Tina	Gallegos	City of San Pablo
Laurie	Gallian	
Charlene	Gallina	City of Calistoga
Tom	Gandesbery	California Coastal Conservancy
Richard	Garbarino	City of South San Francisco
Herman	Garcia	Coastal Habitat Education & Environmental Restoration
Leon	Garcia	City of American Canyon
Genoveva	Garcia Calloway	City of San Pablo
Patricia	Gardner	Silicon Valley Council of Nonprofits
Shari	Gardner	Friends of the Napa River
Elizabeth	Gargay	GHD
Frances	Garland	Contra Costa Water District
Susan	Garner	City of Monte Sereno
Stewart	Gary	City of Livermore
Victor	Garza	La Raza Roundtable
Dr. Lori	Gaskin	West Valley College
Don	Gasser	Napa Communities Firewise Foundation

First Name	Last Name	Organization
Jeffrey	Gee	City of Redwood City
Debbie	Gehret	City of Pacifica
Howard	Geller	City of Clayton
Andy	Gere	San Jose Water Company
Matt	Gerhart	California Coastal Conservancy
Vince	Geronimo	AECOM
Lorrie	Gervin	City of Sunnyvale
Ben	Gettleman	Kearns & West, Inc.
Geoff	Geupel	PRBO Conservation Science
Sami	Ghossain	Union Sanitary District
Leia	Giambastiani	PRBO Conservation Science
Patricia S.	Gilardi	City of Cotati
Paul	Gilbert-Snyder	East Bay Municipal Utility District
Crisand	Giles	Building Industry of the Bay Area
Jeri	Gill	Sustainable Napa County
Peter	Gilli	City of Mountain View
Marie	Gilmore	City of Alameda
Kelly	Gin	Natural Resources Conservation Service
Jack	Gingles	City of Calistoga
John	Gioia	County of Contra Costa
Debbie	Giordano	City of Milpitas
Hillary	Gitelman	County of Napa
David	Gittleson	City of Morgan Hill
Mayor David	Glass	
Steve	Glazer	City of Orinda
Federal D.	Glover	County of Contra Costa
Fred	Glover Blackwell	City of Oakland
Robin	Goble	Town of Windsor
Brenda	Goeden	Bay Conservation and Development Commission
Glenn	Goepfert	City of Cupertino
Dev	Goetschius	Housing Land Trust of Sonoma County
Steve	Goldbeck	SF Bay Conservation & Development Commission
Jonathon	Goldman	City of Sausalito
Jonathon	Goldman	City of St. Helena
Stephanie	Gomes	City of Vallejo
Armando	Gomez	City of Milpitas
Gabriel A.	Gonzalez	City of Rohnert Park
Ignacio	Gonzalez	County of Santa Clara
Javier	Gonzalez	Silicon Valley Latino Democratic Forum
Juliana	Gonzalez	The Watershed Project
Pedro	Gonzalez	City of South San Francisco
Raquel (Rae)	Gonzalez	Town of Colma
David	Goodison	City of Sonoma
Barry	Gordon	City of Walnut Creek
Deborah C.	Gordon	Town of Woodside
Malila	Gordon	Bioengineering Institute
Susan	Gorin	City of Santa Rosa
Robert G.	Gottschalk	City of Millbrae
Zeke	Grader	Institute for Fisheries Resources
Sue	Graham	League of Women Voters
Robert	Grassilli	City of San Carlos
Matt	Graul	East Bay Regional Park District
David	Graves	Saintsbury Vineyard and Winery
Jeremy	Graves	City of Sausalito

First Name	Last Name	Organization
Allen	Grayson	Lawrence Livermore National Laboratory
Mark	Green	City of Union City
Phil	Green	City of Pinole
Ford	Greene	Town of San Anselmo
Russ	Greenfield	
Darren	Greenwood	City of Livermore
Michael J.	Gregory	City of San Leandro
Bailey	Grewal	City of Brentwood
Bailey	Grewal	City of Brentwood
Jack	Griffin	City of Sebastopol
Thomasin	Grim	Marin Municipal Water Distric
Terrence	Grindall	City of Newark
Matt	Grocott	City of San Carlos
Carole	Groom	County of San Mateo
Jan	Gross	Heritage Landscapes
Kara	Gross	Joint Venture Silicon Valley Network
Robin	Grossinger	San Francisco Estuary Institute
Geoffrey L.	Grote	City of Piedmont
Brandt	Grotte	City of San Mateo
Phoebe	Grow	RMC Water and Environment
John	Guardino	Southern Sonoma County Resource Conservation District
Pat	Guasco	City of Sausalito
Sandy	Guldman	
Andy	Gunther	Center for Ecosystem Management and Restoration (CEMAR)
Jim	Gustafson	City of Los Altos
Kent	Gylfe	Sonoma County Water Agency
Laurie	H. Suda	United States Army Corps of Engineers
Linda	H.Hu	East Bay Municipal Utility District
Dana	Haasz	Kennedy/Jenks Consultants
Scott	Haggerty	County of Alameda
Tom	Haglund	City of Gilroy
Brad	Hall	
Richard	Hall	Town of Yountville
Richard	Hall	Yountville Town Council
Barbara	Halliday	City of Hayward
Whit	Halvorsen	The Bay Institute of San Francisco
Keith	Halvorson	City of Pittsburg
Leslee	Hamilton	Friends of Guadalupe River Park and Gardens
Lauren	Hammack	Prunuske Chatham Inc. Environmental Consulting
Matt	Hammer	People Acting in Community Together (PACT)
Doug	Hanford	Hanford ARC
Scott	Hanin	City of El Cerrito
Erin	Hannigan	City of Vallejo
Eric	Hansen	South Bay Water Recycling
Jeri	Hansen-Gill	Sustainable Napa County
Marilyn	Harang	City of Redwood City
Bree	Hardcastle	California Department of Parks and Recreation
James C.	Hardy	City of Foster City
Steve	Hardy	City of Vacaville
Wade	Harper	City of Antioch
Howard	Harpham	Town of Moraga
Mike	Harris	
Cheryl	Harris	Napa Solano Audubon

First Name	Last Name	Organization
Dilenna	Harris	City of Vacaville
Kelly	Harris	Bioengineering Institute
Richard	Harris	East Bay Municipal Utility District
Bill	Harrison	City of Fremont
Kevin	Hart	City of Dublin
Marshall	Hart	City of Napa Water Division
Roger	Hartwell	
Pam	Hartwell-Herrero	Town of Fairfax
Susan	Harvey	City of Cotati
Ben	Harwood	Golden Gate National Parks Conservancy
Daphne	Hatch	National Park Service
Erik	Hawk	
Susan	Haydon	Southern Sonoma County Resource Conservation District
Gretchen	Hayes	Napa River Rutherford Reach Restoration Project
Kathy	Hayes	
Mike	Healy	
Barry	Hecht	Balance Hydrologics
Kara	Heckert	Sotoyome Resource Conservation District
Trathen	Heckona	Daily Acts
Erica	Heimberg	Turtle Island Restoration Network
Kirk	Heinrichs	City of Campbell
Daniel C.	Helix	City of Concord
Barbara	Heller	City of San Rafael
Paul	Helliker	Marin Municipal Water District
Bob	Hemati	Town of Ross
Diane	Henderson	Town of San Anselmo
Olden	Henson	City of Hayward
Iris	Herrera	Califiornia Special Districts Association
Rose	Herrera	City of San Jose
George R.	Hicks	City of Fairfield
Kasie	Hildenbrand	City of Dublin
Daniel	Hillmer	City of Larkspur
Adele	Ho	City of San Pablo
Tan	Hoang	
Rainer	Hoenicke	San Francisco Estuary Institute
John	Hoffnagle	Land Trust of Napa County
Dana	Hoggatt	City of Pittsburg
Barry	Hogue	Town of Corte Madera
Barry	Hogue	Town of Corte Madera
Dwight	Holford	Upper Putah Creek Stewardship
Elise	Holland	County of Marin
Karen	Holman	City of Palo Alto
Marc	Holmes	
Nadia V.	Holober	City of Millbrae
Clayton	Holstine	City of Brisbane
Hanson	Hom	City of Sunnyvale
Parastou	Hooshialsadat	Winzler and Kelly
Dale	Hopkins	Regional Water Quality Control Board
Kathy	Hopkins	Fairfield-Suisun Sewer District
Doug	Horner	City of Livermore
Don	Horsley	County of San Mateo
Joseph	Horwedel	City of San Jose
Gregg	Hosfeldt	City of Mountain View
Saeid	Hosseini	Santa Clara Valley Water District

First Name	Last Name	Organization
Jennifer	Hosterman	City of Pleasanton
Vivian	Housen	
Rod	Houser	Kennedy/Jenks Consultants
David	Houts	Zone 7 Water Agency
Angela	Howard	Town of Portola Valley
Joey	Howard	
Dan	Hubacher	
Dave	Hudson	City of San Ramon
Michael J.	Hudson	City of Suisun City
Terry	Huff	Alameda County Resource Conservation District
Mark	Hughes	City of Benicia
Erika	Hughes Reis	Marin Resource Conservation District
Gary	Huisingh	City of Dublin
Gary	Huisingh	City of Dublin
Joan	Hultberg	Sonoma County Water Agency
Beth	Huning	San Francisco Bay Joint Venture
Curtis	Hunt	City of Vacaville
Jill	Hunter	City of Saratoga
Linda	Hunter	The Watershed Project
Linda	Hunter	The Watershed Project
R. Scot	Hunter	Town of Ross
Eliot	Hurwitz	Napa County Transportation and Planning Agency
Larry	Husted	City of Napa Public Works Department
Amy	Hutzel	California Coastal Conservancy
Matthew	Hymel	County of Marin
Ken	Ibarra	City of San Bruno
Jim	Inglis	Stanford University
Jay	Ingram	Town of Moraga
John	Inks	City of Mountain View
Juliana	Inman	City of Napa
Jeff	Ira	City of Redwood City
Joseph	J. Dillon	National Marine Fisheries Service
Jennifer	J. Walker	Watearth, Inc.
Connie	Jackson	City of San Bruno
Janeen	Jackson	Greenbelt Alliance
Rose	Jacobs Gibson	County of San Mateo
Craig	Jacobsen	
Jim	Jakel	City of Antioch
Beverly	James	Novato Sanitary District
Dave	Jaramillo	California Conservation Corps
Jay	Jaspers	Sonoma County Water Agency
Paul	Jensen	City of San Rafael
Tim	Jensen	Contra Costa County Flood Control and Water Conservation District
Mick	Jessop	City of Suisun City
Ben	Johnson	City of Pittsburg
Beverly J.	Johnson	City of Alameda
Corbin	Johnson	County of Sonoma
Doug	Johnson	California Invasive Plant Council
Ralph	Johnson	Alameda Flood Control and Water Conservation District
Margaret	Johnston	Tomales Bay Watershed Council
Carolyn	Jones	Natural Resources Conservation Service
Pam	Jones	Kearns & West, Inc.

First Name	Last Name	Organization
Susan	Jones	City of Healdsburg
Tim	Jones	US EPA, Headquarters
William C.	Jones	City of El Cerrito
Mark	Joseph	City of American Canyon
Shicha	K Chander	California Department of Water Resources
Jennifer	Kaiser	Vallejo Sanitation & Flood Control District
Brian	Kalinowski	City of Antioch
Ash	Kalra	City of San Jose
Matt	Kamkar	San Jose Silicon Valley Chamber of Commerce
Rachel	Kamman	Kamman Hydrology & Engineering, Inc.
Jon	Kanagy	Nord Vineyard Services
Rebecca	Kaplan	City of Oakland
Sandeep	Karkal	Novato Sanitary District
Mike	Kashiwagi	Town of Atherton
Daniel	Kasperson	City of Suisun City
R. Michael	Kasperzak	City of Mountain View
Anne	Kasten	Town of Woodside
Thom	Kato	Lawrence Livermore National Laboratory
Maurice	Kaufman	City of Emeryville
Guy	Kay	Napa County Regional Park and Open Space District
Sandra	Kaya	Livermore area Recreation and Park District
Gabe	Kearney	
Garrett	Keating	City of Piedmont
Daniel E.	Keen	City of Concord
Bill	Keene	County of Sonoma
James	Keene	City of Palo Alto
William	Keene	Sonoma County Water Agency
Janet	Keeter	City of Orinda
Megan	Keever	Stillwater Sciences
Paula	Kehoe	San Francisco Public Utilities Commission
Ann	Keighran	City of Burlingame
Jill	Keimach	Town of Moraga
Kirsten	Keith	City of Menlo Park
David	Keller	
Judy	Kelly	San Francisco Estuary Partnership
Ken	Kelly	United Neighborhoods of Santa Clara County
Linda	Kelly	City of Sonoma
Michael	Kelly	City of Sausalito
Naomi	Kelly	City and County of San Francisco
Barbara	Kelsey	Sierra Club Loma Prieta Chapter
Thomas R.	Kendall, PE	U.S. Army Corps of Engineers, SF District, Chief, Planning Branch
Janet	Kennedy	City of Martinez
Paul	Kermoyan	City of Campbell
Patricia	Kernighan	City of Oakland
Brannon	Ketcham	National Park Service
Sapna	Khandwala	Stillwater Sciences
Art	Kiesel	City of Foster City
Brad	Kilger	City of Benicia
Jane	Kim	City and County of San Francisco
Jay	Kim	City of Palo Alto
Mary	Kimball	Center for Land Based Learning
Sally	Kimsey	Putah Creek Watershed Group
Sally	Kimsey	

First Name	Last Name	Organization
Mary Ann	King	Trout Unlimited
Neysa	King	Tomales Bay Watershed Council
Stephen	Kinsey	County of Marin
Susan	Kirks	
Mike	Kirn	City of Healdsburg
Andy	Klein	City of San Carlos
Janet	Klein	Marin Municipal Water District
Larry	Klein	City of Palo Alto
Shani	Kleinhaus	Santa Clara Valley Audubon Society
David	Kleinschmidt	City of Vallejo
Shane	Klingbeil	
John	Klochak	U.S. Fish and Wildlife Service
Ernest	Klock	County of Marin
Mitchell	Klug	Napa County RCD/WICC
David	Knapp	City of Cupertino
Liz	Kniss	County of Santa Clara
Charlie	Knox	City of Benicia
Jonathan	Koehler	Napa County Resource Conservation District
Leslie	Koenig	Alameda County Resource Conservation District
Fred	Kogler	City of Rio Vista
Carl	Kohnert	Friends of Sausal Creek
Steve	Kokotas	MIG, Inc.
Larry P.	Kolb	Friends of the San Francisco Estuary
Stan	Kolodzie	Dublin San Ramon Services District
Stan	Koludzie	DSRSD
Steve	Konakis	California Native Plant Society - Napa Chapter
Richard	Konda	Asian Law Alliance
Barbara	Kondylis	County of Solano, Supervisor
Barbara R.	Kondylis	County of Solano
Jaime	Kooser	SF NERR, SFSU / Romberg Tiburon Center
John	Kopchik	Contra Costa County
John	Kopchik	Contra Costa County Habitat Conservancy
Max	Korten	Conervation Corps North Bay
Michael F.	Kotowski	City of Campbell
Rick	Kowalczyk	City of Half Moon Bay
Kevin	Kramer	Town of Corte Madera
Gary	Kraus	City of Calistoga
Jack	Krebs	City of Rio Vista
Jennifer	Krebs	San Francisco Estuary Project
Bernhard	Krevet	Friends of the Napa River
Bernhard	Krevet	Friends of the Napa River
James	Krider	City of Napa
Christine M.	Krolik	Town of Hillsborough
Jeff	Kroot	Town of San Anselmo
Andrea	Krout	County of Sonoma
Laura C.	Kuhn	City of Vacaville
Kallie	Kull	County of Marin
Krishna	Kumar	
Carol	Kunze	Berryessa Trails and Conservation
Carol	Kunze	Berryessa Trails and Conservation
Alan	Kurotori	City of Santa Clara
Catherine	Kutsuris	Contra Costa County
Florence	La Riviere	Citizens Committee to Complete the Refuge
Melody	Labella	Central Contra Costa Sanitary District

First Name	Last Name	Organization
Peter	LaCivita	United States Army Corps of Engineers
Jon	LaHaye	Marin Municipal Water District
Thomas	Lai	County of Marin
Steve	Lake	Town of Danville
Mark	Landman	City of Cotati
Brooke	Langston	BRBNA Conservation Partnership/ Audubon CA Landowner Stewardship Program
Stephanie	Lapine	Kamman Hydrology & Engineering, Inc.
Margaret	Laporte	Stanford University
Michael	Lappert	Town of Corte Madera
Mondy	Lariz	Santa Clara County Creeks Coalition
Mondy	Lariz	Stevens & Permanente Creeks Watershed
M	Larizadeh	City of Novato
Jack	LaRochelle	City of Napa
Rich	Larsen	Town of Los Altos Hills
Greg	Larson	Town of Los Gatos
Sue	Lattanzio	
Michael	Laughlin	Town of Colma
Michael	Lauher	Environmental Education Coalition of Napa County
Jane	Lavelle	Water Enterprise, San Francisco Public Utilities Commission
Kristina	Lawson	City of Walnut Creek
Becca	Lawton	Sonoma Ecology Center
Cathy	Lazarus	City of Mountain View
Steve	Lederer	Napa County Department of Environmental Management
Brad	Ledesma	Zone 7 Water Agency
Chris	Lee	Sonoma County Water Agency
Edwin	Lee	City and County of San Francisco
Hannah	Lee	County of Marin
Wayne J.	Lee	City of Millbrae
Daisy	Lee	Napa County Flood Control and Water Conservation District
Suzanne	Lee Chan	City of Fremont
Lou	Leet	City of American Canyon
Ron	Lefler	City of Lafayette
Michael	Lennox	University of California Davis
Cliff	Lentz	City of Brisbane
Steve	Leonardis	Town of Los Gatos
Jonathan	Leone	City of Sausalito
Peter	Leroe-Munoz	City of Gilroy
Roger	Leventhal	County of Marin
Ellen	Levin	SFPUC
Marc	Levine	City of San Rafael
Michele	Lew	Asian Americans for Community Involvement
David	Lewis	Save the Bay
David	Lewis	University of California Davis
Elizabeth	Lewis	Town of Atherton
Liz	Lewis	County of Marin
Liliana	Li	Vision New America
Marilyn	Librers	City of Morgan Hill
Sam	Liccardo	City of San Jose
Warren	Lieberman	City of Belmont
Jack	Liebster	County of Marin
David	Lim	City of San Mateo

First Name	Last Name	Organization
Khee	Lim	City of Millbrae
Karin	Lin	NPS RTCA
Jim	Lincoln	Napa County Farm Bureau/Putah Creek Watershed Group
Jim	Lindley	City of Dixon
Bill	Lindsay	City of Richmond
James	Lindsay	City of Milpitas
James	Lindsay	City of Saratoga
Helen	Ling	City of Livermore
Garry	Lion	City of Mill Valley
Katherine	Lira	Nielsen Merksamer Parrinello Gross & Leoni LLP
Ally	Little	Assm. Nancy Skinner
Leslie	Little	City of Morgan Hill
Jim	Livingstone	City of San Ramon
John	Livingstone	City of Saratoga
Emily	Lo	City of Saratoga
Mark	Lockaby	Town of Fairfax
Nadia	Lockyer	County of Alameda
Susan	Loftus	City of San Mateo
Dan	Logan	National Marine Fisheries Service
Brian	Long	City of Napa Public Works Department
Debbie	Long	City of Pinole
Pete	Longmire	City of Pittsburg
Albert	Lopez	County of Alameda
Lori	Lopin	Town of San Anselmo
Mary	Lou	Kennedy/Jenks Consultants
Andria	Loutsch	CDM Smith
Michael	Love	Michael Love and Associates, Inc.
Brian	Loventhal	City of Monte Sereno
Evan	Low	City of Campbell
Diane	Lowart	City of Dublin
Jeremy	Lowe	ESA/PWA
Patrick	Lowe	Watershed Information Center and Conservancy of Napa County
Eric	Lucan	City of Novato
Darcie	Luce	California Land Stewardship Institute
Mark	Luce	County of Napa
Gary	Luebbers	City of Sunnyvale
Pamela	Lung	City of Livermore
Greg	Lyman	City of El Cerrito
Robert	Lynch	
Mike	Maacks	City of Cloverdale
Rob	Maccario	Town of Ross
Pierce	Macdonald	City of Belvedere
Sue	Mace	
Michael	Machado	Delta Protection Commission
Laura	Macias	City of Mountain View
Ilene	Macintire	Alameda County Flood Control
Jake	Mackenzie	City of Rohnert Park
Nancy	Mackle	City of San Rafael
Nancy	Mackle	City of San Rafael
Jeremy	Madsen	Greenbelt Alliance
Carol	Mahoney	Zone 7 Water Agency
Orrin	Mahoney	City of Cupertino

First Name	Last Name	Organization
Homer	Maiel	Town of Atherton
Linda	Maio	City of Berkeley
Vivien	Maisonneuve	California Department of Water Resources
Karen	Majors	City of Martinez
Chris	Malan	ICARE
Chris	Malan	Institute for Conservation Advocacy, Research and Education
Josh	Malan	Institute for Conservation Advocacy, Research and Education
Joshua	Malan	ICARE
Joan	Malloy	City of Union City
Lana	Malloy	City of Monte Sereno
Jeff	Maltbie	City of San Carlos
Frank	Mandola	City of South San Francisco
Jon	Mann	HDR
David	Mansfield	
Nader	Mansourian	City of San Rafael
Eric	Mar	City and County of San Francisco
John	Marchand	City of Livermore
Laurel	Marcus	California Land Stewardship Institute
Laurel	Marcus	California Land Stewardship Institute
Dan	Marks	City of Berkeley
Darlene	Marler	Pope Valley Watershed Council
Brad	Marsh	City of Larkspur
Shawn E.	Marshall	City of Mill Valley
Patricia E.	Martel	City of Daly City
Bob	Martin	
Christopher	Martin	Town of Ross
Mischon	Martin	County of Marin
Laura	Martinez	City of East Palo Alto
Jessica	Martini-Lamb	Sonoma County Water Agency
Mitch	Mashburn	City of Vacaville
Abbas	Masjedi	City of Pleasanton
Peter	Mason	Town of Woodside
Karen	Massey	City of Cloverdale
Len	Materman	San Francisquito Creek JPA
Karyl	Matsumoto	City of South San Francisco
Jack	Matthews	City of San Mateo
Carol	Mattson	California Native Plant Society
Michael	May	San Francisco Estuary Institute
John	McArthur	City of Rohnert Park
Robert (Bob)	McBain	City of Piedmont
Scott	McBain	
Casey	McCann	City of Brentwood
Casey	McCann	City of Brentwood
James	McCann	City of Mill Valley
James C.	McCann	City of Mill Valley
Julie	McClure	City of Mill Valley
Robert H.	McConnell	City of Vallejo
Lex	McCorvey	County of Sonoma Farm Bureau
Paul	McCreary	City of Dublin
Andrew	McCullough	City of San Rafael
Lori	McDonald	Larkspur City Hall
Lisa	McEvilly	Kliman Sales

First Name	Last Name	Organization
Cindy	McGovern	City of Pleasanton
Kevin	McGowan	City of San Rafael
Mike	McGraw	Bureau of Reclamation
John	McGuire	City of Hercules
Mike	McGuire	County of Sonoma
Susan	Mcguire	Las Gallinas Valley Sanitary District
Pete	McHugh	City of Milpitas
Tom	McInerney	Town of San Anselmo
Alex	McIntyre	City of Menlo Park
Dan	McIntyre	City of Livermore
Drew	McIntyre	North Marin Water District
Kathy	McKeithen	Town of Atherton
Chris	McLam	Institute for Conservation Advocacy, Research and Education
Eileen	McLaughlin	Wildlife Stewards
Gayle	McLaughlin	City of Richmond
Clysta	McLemore	Ulistac Outreach Center/ Natural Area
Jamie	McLeod	City of Santa Clara
Richard	McMurtry	Environmental Coalition for Living Streams
Karen	McNamara	City of San Ramon
Leonard R.	McNeil	City of San Pablo
Tom	McNicholas	
Diane	McNutt	Town of Los Gatos
Tom	Means	City of Mountain View
Rico E.	Medina	City of San Bruno
Joe	Medrano	City of Clayton
Julian	Meisler	Sonoma Land Trust
David	Melilli	City of Rio Vista
Gerardo	Mendez	City of Napa Public Works Department
Karen	Mendonca	Town of Moraga
Michael	Menesini	City of Martinez
Ariel	Mercado	City of Hercules
Jill	Mercurio	Town of Moraga
Ann	Merideth	City of Lafayette
Michael	Metcalf	Town of Moraga
Sandra	Meyer	City of Walnut Creek
Lisa	Micheli	Pepper Wood Preserve
John C.	Michels	Caltrans
Alrieq	Middlebrook	California Native Garden Foundation
Mike	Mielke	Silicon Valley Leadership Group
Nathan	Miley	County of Alameda
Brian	Millar	City of Daly City
Howard	Miller	City of Saratoga
Jeff	Miller	Alameda Creek Alliance
Phil	Miller	County of Napa
Ray	Miller	City of Brisbane
Roger	Miller	Federation of Fly Fishers - Nothern California Council
Kathy	Millison	City of Santa Rosa
Rick	Misuraca	City of Mill Valley
Pat	Mitchell	Silicon Valley Faces
Richard	Mitchell	City of Richmond
Karen	Mitchoff	County of Contra Costa
Glenn	Moeller	California Department of Water Resources
Marjorie	Mohler	Town of Yountville

First Name	Last Name	Organization
Bryan	Montgomery	City of Oakley
Anne	Moore	City of Larkspur
Darryl	Moore	City of Berkeley
Doug	Moore	
Gerald	Moore	
Jeffery	Moore	Silicon Valley NAACP
Jim	Moore	Town of Fairfax
Mike	Moore	City of Mill Valley
Steve	Moore	Nute Engineers
Jean	Mordo	Town of Los Altos Hills
Rod	Moresco	City of Vacaville
Morgan	Morgan	Lamoreaux Vineyards/Oak Knoll Ranch
Mike	Morris	Domaine Chandon
Paul V.	Morris	City of San Pablo
Ann	Morrison	City of Larkspur
Carl	Morrison	Morrison & Associates, Inc.
Gus	Morrison	City of Fremont
Marilyn	Mosher	City of Hayward
Rick	Moshier	City of Santa Rosa
Peter	Mott	City of Napa
Leslie	Moulton	ESA
Stephanie	Moulton-Peters	City of Mill Valley
Catherine	Moy	City of Fairfield
Christopher	Moylan	City of Sunnyvale
John	Mraz	City of Fairfield
Bert	Mulchaey	East Bay Municipal Utility District
Cicely	Muldoon	National Park Service
J. Matthew	Mullan	Town of Windsor
John	Muller	City of Half Moon Bay
Kevin	Mullin	City of South San Francisco
Trish	Mulvey	CLEAN South Bay
Thomas	Mumley	SF Bay Water Board
Pete	Munoa	Cal Fire
Pete	Munoa	Cal Fire
Susan S.	Muranishi	County of Alameda
Peter	Murray	City of Pinole
Mike	Myers	Larkspur City Hall
Matthew	Naclerio	City of Alameda
Nancy J.	Nadel	City of Oakland
Barry M.	Nagel	City of South San Francisco
Terry	Nagel	City of Burlingame
Chester	Nakahara	City of Piedmont
Reza	Namvar	RMC Water and Environment
James	Nantell	City of Burlingame
	Napa Chamber of Commerce	Napa Chamber of Commerce Green and Sustainable Practices Committee
Mike	Napolitano	San Francisco Bay Regional Water Quality Control Board
Gary	Napper	City of Clayton
Roger	Narsim	Santa Clara Valley Water District
Mansour	Nasser	City of Sunnyvale
Anu	Natarajan	City of Fremont
Jim	Navarro	City of Union City
Charles	Neal	Peralta Colleges District
Bob	Neale	Sonoma Land Trust

First Name	Last Name	Organization
Mary	Nejedly Piepho	County of Contra Costa
Playalina	Nelson	Sotoyome Resource Conservation District
Ann	Nevero	City of St. Helena
Jon	Newby	City of San Jose
Mark	Newhouser	Sonoma Ecology Center
Anne	Ng	Silicon Valley Bicycle Coalition
Madison P.	Nguyen	City of San Jose
Nick	Nguyen	Town of Tiburon
Joyce	Nichols	Carolyn Parr Nature Center
Marilyn	Nickel	City of Milpitas
Richard	Niemann	Friends of the Napa River
Richard	Niemann	Friends of the Napa River
Thomas	Niesar	Alameda County Water District
Mary Ann	Nihart	City of Pacifica
Ron	Noble	
Ken	Nordhoff	City of Walnut Creek
Janith	Norman	City of Rio Vista
Tony	Norris	Napa County Regional Park and Open Space District
Karin	North	City of Palo Alto
Mohammed	Nuru	City and County of San Francisco
Ed	Nute	Nute Engineers
Jason	Nutt	City of Novato
Jason	Nutt	City of Novato
Damien	O'Bid	City of Cotati
Irene	O'Connell	City of San Bruno
Terry	O'Connell	City of Brisbane
Matt	O'Conner	O’Connor Environmental, Inc.
Matt	O'Connor	Town of Hillsborough
Emmett	O'Donnell	Town of Tiburon
Rolf	Ohlemutz	Vallejo Sanitation & Flood Control District
Peter	Ohtaki	City of Menlo Park
Lorraine	Okabe	League of California Cities
Steve	Okamoto	City of Foster City
Patrick	O'Keeffe	City of Emeryville
Christina	Olague	City and County of San Francisco
Mark	Olbert	City of San Carlos
Ernesto	Olivares	City of Santa Rosa
Pierluigi	Oliverio	City of San Jose
Phil	O'Loane	City of San Ramon
Peggy	Olofson	San Francisco Estuary Invasive Spartina Project
Daniel	Olstein	The Nature Conservancy
Suzanne	Olyarnik	University of California Davis
Stephen	Omdorf	Wildlife Conservation Commission
Ryan	O'Neil	Town of Fairfax
Janet	Orchard	City of Cotati
Ned	Orett	
Bruce	Orr	Stillwater Sciences
Dean	Orr	City of Orinda
Nate	Ortiz	California Conservation Corps
Afshin	Oskoui	City of Belmont
Jake	Ours	City of Santa Rosa
Ron	Packard	City of Los Altos
Chuck	Page	City of Saratoga
Joe	Palla	City of Cloverdale

First Name	Last Name	Organization
Bob	Pallas	Connolly Ranch
Michael	Palmer	Town of Corte Madera
Marc	Pandone	WICC Board of Directors
Gina	Papan	City of Millbrae
Nancy	Parent	City of Pittsburg
Vicki	Parker	City of Cotati
Peter	Parkins	County of Sonoma
Mike	Parness	City of Napa
John	Parodi	PRBO Conservation Science
Dean	Parson	County of Sonoma
Naomi	Patridge	City of Half Moon Bay
Elizabeth	Patterson	City of Benicia
Joni	Pattillo	City of Dublin
Mary	Pearsall	
Walter	Pease	City of Pittsburg
Joe	Pecharich	National Marine Fisheries Service
Debbie	Pedro, AICP	Town of Los Altos HIlls
Marvin	Peixoto	City of Hayward
Onita	Pelligrini	City of Petaluma
Rodrigo	Pena	San Jose Conservation Corp
Michael	Perani	
Herb	Perez	City of Foster City
Scott	Perkins	City of San Ramon
Michel	Perret	Michel Perret Vineyard
MIchael	Perrone	CA Dept.of Water Resources, Div of Environ Services
Leslie	Perry	Regional Water Quality Control Board
Jeff	Peters	Questa Engineering
Paula	Peterson	
Robert	Peterson	Napa County
Marjie	Pettus	City of Healdsburg
Linda	Pfeifer	City of Sausalito
Kathleen	Phalen	City of Milpitas
Gary O.	Phillips	City of San Rafael
Barbara	Pierce	City of Redwood City
Julie	Pierce	City of Clayton
Jim	Pierson	City of Fremont
Patrick	Pike	Napa County Public Works
Dave	Pine	County of San Mateo
Al	Pinheiro	City of Gilroy
Joe	Pirzynski	Town of Los Gatos
Ina	Pisani	National Marine Fisheries Service/Ocean Associates, Inc.
Michele	Pla	
Gary	Plass	City of Healdsburg
Althea	Polanski	City of Milpitas
Adam	Politzer	City of Sausalito
Carrie	Pollard	Sonoma County Water Agency
Kathy	Pons	
James	Ponton	San Francisco Bay Regional Water Quality Control Board
Jim	Ponton	Regional Water Quality Control Board
Randy	Pope	City of Oakley
Chris	Potter	CA Resources Agency
Bob	Power	Santa Clara Valley Audubon Society
Myke	Praul	Town of Yountville
Andy	Preston	City of San Rafael

First Name	Last Name	Organization
Gail A.	Price	City of Palo Alto
Harry T.	Price	City of Fairfield
Nico	Procos	City of Palo Alto
Jim	Prola	City of San Leandro
Jeffery	Provenzano	City of San Jose
Liza	Prunuske	Prunuske Chatham Inc. Environmental Consulting
Gina	Purin	County of Marin
Nancy	Pyle	City of San Jose
Ralph	Qualls	City of Cupertino
Jean	Quan	City of Oakland
Caroline	Quinn	Delta Diablo Sanitary District
Sean	Quinn	City of Fairfield
Michelle	Quinney	City of Campbell
Bill	Quirk	City of Hayward
Jeff	Quiter	Hedgerow Farms
David	Rabbitt	County of Sonoma
Dan	Rademacher	The Bay Nature Institute
John	Radford	Town of Los Altos Hills
Marcia L.	Raines	City of Millbrae
James	Raives	County of Marin
Kish	Rajan	City of Walnut Creek
Jeri	Ram	City of Dublin
Jeri	Ram	City of Dublin
Brent	Randol	Napa County Wildlife Conservation Commission
Elke	Rank	Zone 7 Water Agency
Matt	Raschke	City of Palo Alto
Jeff	Rasmussen	East Bay Regional Park District
Yvonne	Rasmussen	University of California Master Gardners
Jane	Ratchyre	City of Palo Alto
Robert	Ravasio	Town of Corte Madera
Michael J.	Reagan	County of Solano
Chuck	Reed	City of San Jose
John	Reed	Town of Fairfax
Ursula	Reed	City of San Leandro
Nina D.	Regor	City of Cloverdale
David	Reid	Friends of Five Creeks
Larry E.	Reid	City of Oakland
Robert R.	Reid	West Valley Sanitation District
James	Reilly	Stetson Engineers
Anthony	Rendon	California League of Conservation Voters
Tiffany	Renee	
Dave	Requa	Dublin San Ramon Services District
Stephen A.	Rhodes	City of Pacifica
Winston	Rhodes	City of Pinole
Heidi	Rhymes	
Katie	Rice	County of Marin
Steve	Rice	Town of Los Gatos
Dan	Rich	City of Mountain View
C	Richard	Oakland Museum
Allan	Richards	Stetson Engineers
John	Richards	Town of Portola Valley
A. Sepi	Richardson	City of Brisbane
Dave	Richardson	RMC Water and Environment
Ron	Richardson	California Water Service Company

First Name	Last Name	Organization
Don	Ridenhour	Napa County
Eric	Riedner	Balance Hydrologics, Inc.
Len	Rifkind	City of Larkspur
Ann	Riley	State Water Resources Control Board
Kevin	Riley	City of Santa Clara
Kevin L.	Riley	City of Santa Clara
Carol	Rios	City of Oakley
Jeff	Ritterman	City of Richmond
David	Rizk	City of Hayward
Diana	Roberts	Jones & Stokes
Glenn	Roberts	City of Palo Alto
Jennifer	Roberts	
Jennifer	Roberts	StopWaste.org
Marc	Roberts	City of Livermore
Donald	Rocha	City of San Jose
Mary Helen	Rocha	City of Antioch
Michael	Rock	Town of Fairfax
George	Rodericks	City of Belvedere
Matt	Rodriguez	City of San Pablo
John	Roeder	Greak Oaks Water Company
Cindy	Roessler	Mid-Peninsula Regional Open Space Authority
Curtis	Rogers	City of Monte Sereno
Greg	Rogers	City of San Ramon
Jim	Rogers	City of Richmond
Laurette	Rogers	PRBO Conservation Science
Steve	Rogers	Town of Yountville
Kevin	Rohani	Town of Los Gatos
Carlos	Romero	City of East Palo Alto
Dan	Romero	City of Hercules
Kevin	Romick	City of Oakley
Ron	Romines	Town of Woodside
Wendie	Rooney	Town of Los Gatos
Manny	Rosas	City of Redwood City
Chris	Rose	Solano Land Trust
Marvin	Rose	City of Sunnyvale
Mark	Ross	City of Martinez
Roanna	Ross	WHITLEY BURCHETT & Associates
Robert	Ross	City of San Mateo
Lynne	Rosselli	Sonoma County Water Agency
Tom	Rouse	City of Sonoma
Tom	Rouse	
Ron	Rowlett	City of Vacaville
Cynthia	Royer	City of Daly City
Jim	Ruane	City of San Bruno
Kelseay	Rugani	Kearns & West, Inc.
Carol	Russell	City of Cloverdale
Eric	Russell	Green Mountain College
P. Rupert	Russell	Town of Ross
Vance	Russell	BRBNA Conservation Partnership/ Audubon CA Landowner Stewardship Program
John	Russo	City of Alameda
Pauline	Russo Cutter	City of San Leandro
Trudi	Ryan	City of Sunnyvale
Wayne	Ryan	Napa River Steelhead

First Name	Last Name	Organization
Matt	Sagues	County of Marin
Michael	Salazar	City of San Bruno
Mark	Salinas	City of Hayward
Sam	Salmon	Town of Windsor
Samantha	Salvia	RMC Water & Environment
Barbara	Salzman	Marin Audubon Society
Bob	Sampayan	City of Vallejo
Bryn	Samuel	City of Oakland
Catarina	Sanchez	City of St. Helena
Pedro M. (Pete)	Sanchez	City of Suisun City
Joanne	Sanders	City of Sonoma
Deanna J.	Santana	City of Oakland
Mark	Santoro	City of Cupertino
Jeremy	Sarrow	Napa County Flood Control and Water Conservation District
Mike	Sartor	City of Palo Alto
Tito	Sasaki	
Megan	Satterlee	City of Los Altos
Chris	Sauer	Napa County Weed Management Area
Chris	Sauer	WICC Board of Directors
John	Sawyer	City of Santa Rosa
Joe	Sbranti	City of Pittsburg
Tim	Sbranti	City of Dublin
Jim	Scanlin	Alameda County Public Works
Libby	Schaaf	City of Oakland
Nancy	Schaefer	
Tom	Schaefer	Friends of Calabazas Creek
Korie	Schaeffer	National Marine Fisheries Service
Lisa	Schaffner	County of Sonoma Alliance
Greg	Scharff	City of Palo Alto
Rem	Scherzinger	City of Piedmont
Dan	Schiada	City of Benicia
Greg	Schmid	City of Palo Alto
Edward	Schmidt	
Douglas J.	Schmitz	City of Los Altos
Scott	Schneider	County of Marin
Cheryl	Scholar	Town of Windsor
Judy	Schriebman	Leap Frog Productions
Robert S.	Schroder	City of Martinez
Bruce	Schultz	Lawrence Livermore National Laboratory
Irv	Schwartz	ILS ASSOCIATES, INC.
Susan	Schwartz	Friends of Five Creeks
Alan	Schwartzman	City of Benicia
Dan	Schwarz	City of Larkspur
Daniel	Schwarz	Larkspur City Hall
Ken	Schwarz	Horizon Water & Environmental
M.	Schweickert	DOW Chemical Wetlands Team
Jeff	Schwob	City of Fremont
Sandra	Scoggin	San Francisco Bay Joint Venture
Dave	Scola	City of Martinez
Nancy	Scolari	Marin Resource Conservation District
Greg	Scoles	City of Belmont
Kathrin	Sears	County of Marin

First Name	Last Name	Organization
Mark	Seedall	Contra Costa Water District
Michael A.	Segala	City of Suisun City
Linda J.	Seifert	County of Solano
Mary	Selkirk	
Martin	Sellers	
Cece	Sellgren	Contra Costa County Flood Control and Water Conservation District
Maria	Sena	Contra Costa Special Districts Association
Carrie	Sendak	
Harry	Seraydarian	
Joe	Seto	Zone 7 Water Agency
Sue	Severson	City of Orinda
John D.	Seybert	City of Redwood City
Gail	Seymour	California Dept of Fish and Wildlife
Sally	Seymour	Sustainable Napa County
Cyndy	Shafer	California Department of Parks and Recreation
Kathleen	Shaffer	City of Sebastopol
Hamid	Shamsapour	City of Larkspur
Hamid	Shamsapour	Larkspur City Hall
Thomas	Shanahan	Town of Woodside
Sheela	Shankar	Kids for the Bay
Lisa Woo	Shanks	USDA, National Resource Cons. Service
Mo	Sharma	City of Monte Sereno
Jeff	Sharp	Napa County
Jeff	Sharp	Napa County CDPD
Leigh	Sharp	Napa County Resource Conservation District
Andrea	Shelton	Latina Coalition Silicon Valley
Nancy	Sheperd	City of Palo Alto
Brad	Sherwood	Sonoma County Water Agency
Dana	Shigley	City of American Canyon
Fraser	Shilling	Department of Environmental Science and Policy, UC Davis
Chuck	Shinnamon	Friends of the Napa River
George M.	Shirakawa	County of Santa Clara
Chris	Shirley	San Mateo County Parks
Bill	Shoe	County of Santa Clara
Carolyn	Shoulders	National Park Service
Aarti	Shrivastava	City of Cupertino
David	Shuey	City of Clayton
Gordon	Siebert	City of Morgan Hill
David	Siebo	
David	Siedband	
David	Siedband	
Jac	Siegel	City of Mountain View
Joanne	Siew	RMC Water and Environment
Cindy	Silva	City of Walnut Creek
Joseph	Silva	Town of Colma
Bob	Simmons	City of Walnut Creek
Luke	Sims	City of San Leandro
Luke	Sims	City of San Leandro
Daniele	Sinclair	NCTPA
Maia	Singer	Stillwater Sciences
Rod	Sinks	City of Cupertino
Gary	Skrel	City of Walnut Creek

First Name	Last Name	Organization
Christina	Sloop	San Francisco Bay Joint Venture
Karen	Slusser	City of Calistoga
Carla	Small	Town of Ross
Richard	Smelser	City of Gilroy
Matt	Smeltzer	Geomorph Design
Jeffrey V.	Smith	County of Santa Clara
Victoria	Smith	City of Orinda
Laura	Snideman	City of Half Moon Bay
	Solano RCD	Lake Berryessa Watershed Partnership
Chris	Sommers	EOA, Inc.
Ray	Soper	Integra
Ricardo	Sousa	The Watershed Project
Diana M.	Souza	City of San Leandro
Janet	Sowers	Fugro Consultants
Jennifer	Sparacino	City of Santa Clara
Barbara	Spector	Town of Los Gatos
Mark	Spencer	Alameda County Waste Management Authority/StopWaste.org
James P.	Spering	County of Solano
Marley	Spilman	Friends of Coyote Creek
Richard	Spitler	City of Calistoga
Niroop	Srivatsa	City of Lafayette
Pam	Stafford	City of Rohnert Park
Jim	Stallman	Silicon Valley Bicycle Coalition
Daisy	Stark	City of Palo Alto
Joyce	Starosciak	City of San Leandro
Danielle	Staude	City of Mill Valley
Carolyne	Stayton	Tomales Bay Watershed Council
Kent	Steffens	City of Sunnyvale
Eric	Steger	County of Marin
Rita	Steiner	Natural Resources Conservation Service
Todd	Steiner	Turtle Island Restoration Network
Anne	Steinhauer	Napa Valley Vintners
Karen	Stepper	Town of Danville
Gary	Stern	National Marine Fisheries Service
Phil	Stevens	Urban Creeks Council
Michael	Stevenson	Horizon Water & Environmental
Mendel	Stewart	U.S. Fish and Wildlife Service
Rosalyn	Stewart	Jones & Stokes
Ann	Stillman	San Mateo County
Susan	Stompe	
Len	Stone	City of Pacifica
Erick	Stonebarger	City of Brentwood
Robert	Storer	Town of Danville
Ross (Hank)	Stratford	City of Clayton
Richard	Strauss	Town of Ross
Nancy	Strausser	William and Flora Hewlett Foundation
Christina	Strawbridge	City of Benicia
Pam	Strayer	
Aaron	Stressman	CSS ENVIRONMENTAL SERVICES, INC
Dietrich	Stroeh	
Kirsten	Struve	City of San Jose
Debbie	Stutsman	City of San Anselmo

First Name	Last Name	Organization
Debra	Stutsman	Town of San Anselmo
Matt	Sullivan	City of Pleasanton
Ginger	Summit	Town of Los Altos Hills
Jill	Sunahara	Horizon Water and Environment
Jill	Sunahara	Jones & Stokes
Karen	Sundback	League of Women Voters
Herminio	Sunga	City of Vallejo
Matt	Swalberg	Town of Tiburon
Eric	Swalwell	City of Dublin
Charles	Swanson	City of Orinda
Christina	Swanson	The Bay Institute of San Francisco
David	Swartz	Contra Costa County Watershed Program
Roy	Swearingen	City of Pinole
Caitlin	Sweeney	San Francisco Estuary Partnership
Michael	Sweeney	City of Hayward
Leandra	Swent	Southern Sonoma County Resource Conservation District
Mike	Swezy	Marin Municipal Water District
John	Swiecki	City of Brisbane
David	Sykes	City of San Jose
Fari	Tabatabai	United States Army Corps of Engineers
Dawn	Taffler	Kennedy/Jenks Consultants
Dan	Takasugi	City of Calistoga
Dan	Takasugi	City of Calistoga
Lena	Tam	City of Alameda
Nancy	Tamarisk	Napa Sierra Club
Jeff	Tangen	Napa County CDPD
David	Tanner	Town of Woodside
Steve	Tate	City of Morgan Hill
Donald L. (Don)	Tatzin	City of Lafayette
Lori	Taylor	City of Alameda
Robert (Bob)	Taylor	City of Brentwood
Todd	Teachout	City of Sausalito
KJ	Team	DOW Chemical Wetlands Team
Jill	Techel	City of Napa
Claire	Teel	Friends of Los Alamitos Watershed
John C.	Telischak	City of Belvedere
Sue	Teneyck	San Francisco Bay Wildlife Society
J. Edward	Tewes	City of Morgan Hill
Eric	Thaut	U.S. Army Corps of Engineers
Renee	Theriault Webber	Sonoma County Water Agency
Ann	Thomas	
Madeline	Thomas	
Reena	Thomas	Brezak and Associates
Rick	Thomasser	Napa County
Rick	Thomasser	Napa County Flood Control and Water Conservation District
Arnie	Thompson	San Francisquito Watershed Council
Brendan	Thompson	State Water Resources Control Board
Dianne	Thompson	City of Cotati
Holly	Thompson	
Mike	Thompson	Sonoma County Water Agency
Pat	Thompson	Town of Ross
Rick	Thornberry	
Jerry	Thorne	City of Pleasanton

First Name	Last Name	Organization
Claire	Thorp	National Fish and Wildlife Foundation
Peggy	Thorpe	Renteria Vineyard Management
Michael	Throne	City of American Canyon
Bob	Tiernan	Town of Yountville
Adrienne	Tissier	County of San Mateo
Mike	Tognolini	East Bay Municipal Utility District
Mark R.	Tompkins	NewFields
Ken	Torke	City of Palo Alto
Helen	Torres	Hispanas Organized for Political Equality
Cristina	Torresan	County of Marin
Melody	Tovar	City of San Jose
Jon	Tracy	County of Sonoma
Joel	Tranmer	The Land Trust of Napa County
Will	Travis	Bay Area Joint Policy Committee c/o Joseph P. Bort MetroCenter
Marcus	Trotta	Sonoma County Water Agency
Dave	Trotter	Town of Moraga
Vitaly	Troyan	City of Oakland
Lynne	Trulio	Silicon Valley Environmental Partnership
Moses	Tsang	Alameda County Public Works
Randy	Tsuda	City of Mountain View
Cat	Tucker	City of Gilroy
David	Tucker	South Bay Water Recycling
Rebecca	Tuden	City of Oakland
Pamela	Tuft	City of Petaluma
Luann	Tung	Friends of the Arroyos
Laureen	Turner	City of Livermore
David J.	Twa	County of Contra Costa
Scott	Tye	
Elizabeth	Tyree	County of Sonoma
Uchenna	Udemezue	City of San Leandro
Uchenna	Udemezue	City of San Leandro
Josh	Uecker	RMC Water and Environment
Josh	Ueker	RMC Water and Environment
Gayle B.	Uilkema	County of Contra Costa
Emmanuel	Ursu	City of Orinda
Junice	Uy	
Rick	Vaccaro	City of Fairfield
Cecilia	Valdez	City of San Pablo
Luisa	Valiela	EPA
Marie	Valmores	Contra Costa Water District
Mark	van Gorder	City of Napa
Kathleen	Van Velsor	Association of Bay Area Governments
Bill	Vandivere	Clearwater Hydrology
Marsha	Vas Dupre	City of Santa Rosa
John M.	Vasquez	County of Solano
Sam	Veloz	PRBO Conservation Science
Andria	Ventura	Clean Water Action/Clean Water Fund
Erin	Ventura	City of Monte Sereno
Lori	Vereker	City of Concord
Jan	Vick	City of Rio Vista
Phillip	Vince	City of Martinez
Pat	Von Behren	Friends of Pleasant Hills Creeks
Peter	Vorster	The Bay Institute of San Francisco

First Name	Last Name	Organization
James M.	Vreeland	City of Pacifica
Mike	Vukman	Urban Creeks Council
Ken	Wachtel	City of Mill Valley
Phiroze	Wadia	Larkspur City Hall
Graham	Wadsworth	Town of Yountville
Brad	Wagenknecht	County of Napa
Gary	Waldeck	Town of Los Altos Hills
James	Walgren	City of Los Altos
Cassandra	Walker	City of Napa Public Works Department
Victoria	Walker	City of Concord
Ben	Wallace	Solano Land Trust
Mike	Wallace	Zone 7 Water Agency
Carolyn	Walsh	County of Santa Clara
Patrick	Walter	Purissima Hills Water District
Chien	Wang	Alameda County Public Works
Dave	Warden	City of Belmont
Rachael	Wark	RMC Water and Environment
Mike	Wasserman	County of Santa Clara
Ryan	Watanabe	California Dept of Fish and Wildlife
Rich	Waterman	City of Campbell
Alyson	Watson	RMC Water and Environment
Kristina	Watson	Save The Bay
Nancy	Watt	County of Napa
D. Kenyon	Webster	City of Sebastopol
Tina	Wehrmeister	City of Antioch
Tina	Wehrmeister	City of Antioch
Robert	Weil	City of American Canyon
Herb	Weiner	City of Sausalito
David	Weinsoff	Town of Fairfax
Ann	Wengert	Town of Portola Valley
Susan	Wengraf	City of Berkeley
Jennifer	West	City of Emeryville
Alex	Westhoff	Delta Protection Commission
Nelia	White	California Land Stewardship Institute
Peter	White	City of St Helena
Peter	White	City of St. Helena
Dave	Whitmer	Napa County Agricultural Commissioner
Sue	Wickham	Solano Land Trust
Bill	Widmer	Town of Atherton
Jeff	Wieler	City of Piedmont
Scott	Wiener	City and County of San Francisco
Carl	Wilcox	CA Department of Fish & Game
William	Wilkins	City of Hercules
Curtis	Williams	City of Palo Alto
Jennifer	Williams	Santa Clara County Farm Bureau
Laurie	Williams	County of Marin
Mark	Williams	Las Gallinas Valley Sanitary District
Meredith	Williams	San Francisco Estuary Institute
Roland	Williams	Casto Valley Sanitary District
Stan	Williams	Santa Clara Valley Water District
Tom	Williams	City of Milpitas
Paul	Willis	Town of Hillsborough
Russell	Wilsey	Mt Veeder Stewardship Council
Betsy	Wilson	Napa-Sonoma Marsh Restoration Group

First Name	Last Name	Organization
Dan	Wilson	California Dept of Fish and Wildlife
Leo	Winternitz	The Nature Conservancy
Bob	Woerner	City of Livermore
Daniel	Woldesenbet	County of Alameda
Bruce	Wolfe	State Water Resources Control Board
Christy	Wolter	Town of Los Gatos
Gus	Wolter	City of Cloverdale
David	Woltering	City of Clayton
Gilbert	Wong	City of Cupertino
Phil	Wong	City of San Ramon
Vince	Wong	Zone 7 Water Agency
Jim	Wood	City of Healdsburg
Julian	Wood	PRBO Conservation Science
John	Woodbury	Napa County Regional Parks and Open Space District
John	Woodbury	Napa County Regional Park and Open Space District
April	Wooden	City of Suisun City
Bethtina	Woodridge	Public Allies Silicon Valley
David E.	Woods	City of East Palo Alto
Jesse	Woodside	City of Napa Public Works Department
Perry	Woodward	City of Gilroy
Amy	Worth	City of Orinda
Kriss	Worthington	City of Berkeley
Christine	Wozniak	City of Belmont
Gordon	Wozniak	City of Berkeley
Ken	Wright	City of Napa Public Works Department
Susan	Wright	San Mateo County Supervisor Don Horsley
Vanessa	Wyant	PRBO Conservation Science
Aimee	Wyrick	Pacific Union College
Gary	Wysocky	City of Santa Rosa
David	Yam	Caltrans
Gilbert	Yan	City of Belmont
Michael	Yankovich	County of Solano
Ken	Yeager	County of Santa Clara
Yiaway	Yeh	City of Palo Alto
Erica	Yelensky	US EPA Region 9
CC	Yin	Asian Pacific Islander American Public Affairs Association
Chino	Yip	Napa County Regional Park & Open Space District
Andrea	Youngdahl	City of Oakland
Jessica	Zadeh	South Bay Water Recycling
Dan	Zador	Napa County CDPD
Shirlee	Zane	County of Sonoma
Chris	Zapata	City of San Leandro
John	Zentner	Friends of Orinda Creeks
Francisco	Zermeno	City of Hayward
Sam	Ziegler	US Environmental Protection Agency Region 9 Water Division
Tom	Zigterman	Stanford University
Linda	Zimmerman	Contra Costa County
Greg	Zlotnick	Santa Clara Valley Water District
John		Chevron, Inc.
John		
Mark		California Department of Water Resources
Ned		

First Name	Last Name	Organization
Ned		
Norman		Lawrence Livermore National Laboratory
Rochelle		
		Acterra
		Acterra - Stewardship Program
		Acterra - Stewardship Program
		Alameda County Public Works
		Alameda County Public Works Agency
		Alameda County Resource Conservation District
		Alameda County Resource Conservation District
		Alameda County Water District
		Alameda County Water District
		Alnus Ecological
		American Water Enterprises
		ARUP
		ARUP
		Assm. Nancy Skinner
		Assm. Nancy Skinner
		BACWA
		Balance Hydro
		Balance Hydrologics
		Balance Hydrologics
		Balance Hydrologics
		Bay Area Clean Water Agencies
		Bay Area Open Space Council
		Bay Area Open Space Council
		Bay Area Upland Habitat Goals
		Bay Area Water Supply & Conservation Agency
		Bay Area Water Supply and Conservation Agency
		Bay Conservation and Development Commission
		Bay Conservation and Development Commission
		Bay Friendly Coalition
		Bay Friendly Coalition
		California Coastal Conservancy
		California Coastal Conservancy
		California Coastal Conservancy
		California Coastal Conservancy
		California Coastal Conservancy
		California Coastal Conservancy
		California Coastal Conservancy
		California Coastal Conservancy
		California Conservation Corps
		California Department of Parks and Recreation
		California Department of Parks and Recreation
		California Department of Parks and Recreation
		California Department of Parks and Recreation
		California Department of Water Resources
		California Department of Water Resources
		California Department of Water Resources
		California Department of Water Resources
		California Department of Water Resources
		California Department of Water Resources
		California Department of Water Resources
		California Department of Water Resources

First Name	Last Name	Organization
		California Department of Water Resources
		California Dept of Fish and Wildlife
		California Dept of Fish and Wildlife
		California Natural Resources Agency
		California Water Service Company
		California Water Service Company
		California Water Service Company
		Caltrans
		CDM Smith
		Center for Biological Diversity
		Center for Collaborative Policy, California State University, Sacramento
		Center for Collaborative Policy, California State University, Sacramento
		Center for Ecosystem Management and Restoration (CEMAR)
		City of Albany
		City of Belmont
		City of Belmont
		City of Benicia
		City of Benicia
		City of Benicia
		City of Benicia
		City of Benicia
		City of Brisbane
		City of Brisbane
		City of Burlingame
		City of Burlingame
		City of Burlingame
		City of Campbell
		City of Daly City
		City of Dixon
		City of East Palo Alto
		City of East Palo Alto
		City of East Palo Alto
		City of East Palo Alto
		City of East Palo Alto
		City of Foster City
		City of Foster City
		City of Foster City
		City of Half Moon Bay
		City of Half Moon Bay
		City of Hayward
		City of Lafayette
		City of Menlo Park
		City of Menlo Park
		City of Menlo Park
		City of Menlo Park
		City of Menlo Park
		City of Menlo Park
		City of Mill Valley
		City of Millbrae
		City of Millbrae
		City of Millbrae

First Name	Last Name	Organization
		City of Milpitas
		City of Napa
		City of Oakland
		City of Oakland
		City of Pacifica
		City of Pacifica
		City of Pacifica
		City of Pacifica
		City of Pacifica
		City of Palo Alto
		City of Palo Alto
		City of Palo Alto
		City of Palo Alto
		City of Redwood City
		City of Redwood City
		City of Redwood City
		City of Redwood City
		City of Redwood City
		City of Redwood City
		City of San Bruno
		City of San Bruno
		City of San Bruno (Water Department)
		City of San Carlos
		City of San Carlos
		City of San Jose
		City of San Jose
		City of San Jose
		City of San José
		City of San José
		City of San José
		City of San José
		City of San José
		City of San José
		City of San José
		City of San Jose, Watershed Protection Division
		City of San Mateo
		City of San Mateo
		City of San Mateo
		City of South San Francisco
		City of South San Francisco
		City of South San Francisco
		Clean Water Action
		Clean Water Action
		Clearwater Hydrology
		Coastside County Water District
		Coastside County Water District
		Contra Costa County
		Contra Costa County Flood Control and Water Conservation District
		Contra Costa County Flood Control and Water Conservation District
		Contra Costa County Flood Control and Water Conservation District
		Contra Costa Resource Conservation District

First Name	Last Name	Organization
		Contra Costa Resource Conservation District
		Contra Costa Resource Conservation District
		Contra Costa Water District
		Contra Costa Water District
		Contra Costa Water District
		Contra Costa Water District
		Contra Costa Water District
		Corix
		County of Alameda
		County of Marin
		County of Marin
		County of Napa
		County of Sonoma
		County of Sonoma
		Creekcats
		Daly City
		Delta Diablo Sanitary District
		Delta Diablo Sanitary District
		Delta Diablo Sanitary District
		Dublin San Ramon Services District
		Dublin San Ramon Services District
		Ducks Unlimited
		DWR
		DWR
		Earth Island Institute
		East Bay Municipal Utility District
		East Bay Municipal Utility District
		East Bay Municipal Utility District
		East Bay Municipal Utility District
		East Bay Municipal Utility District
		East Bay Municipal Utility District
		East Bay Municipal Utility District
		East Bay Municipal Utility District
		East Bay Regional Park District
		East Bay Regional Park District
		East Bay Regional Park District
		East Contra Costa Habitat Conservancy
		Environmental Justice Coalition for Water
		Environmental Protection Agency
		Environmental Water Caucus
		EOA, Inc.
		EOA, Inc.
		EPA
		EPA
		EPA
		ESA
		ESA
		ESA
		ESA
		ESA/PWA
		ESA/PWA
		ESA/PWA
		ESA/PWA
		Far West Engineering

First Name	Last Name	Organization
		Friends of Alhambra Creek
		Friends of Orinda Creeks
		Friends of the Napa River
		Friends of the Petaluma River
		Golden Gate Audubon
		Golden Gate National Parks Conservancy
		Green Foothills
		Horizon Water and Environment, LLC
		Hydroikos Associates
		ICF Jones & Stokes
		ICF Jones & Stokes
		ICF Jones & Stokes
		ICF Jones & Stokes
		ICF Jones & Stokes
		ICF Jones & Stokes
		Interbill
		Jones & Stokes
		Kamman Hydrology & Engineering, Inc.
		Kamman Hydrology & Engineering, Inc.
		Kearns & West, Inc.
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kennedy/Jenks Consultants
		Kids for the Bay
		Las Gallinas Valley Sanitary District
		Lawrence Livermore National Laboratory
		LMi.net
		Los Medanos College
		Marin County
		Marin County
		Marin County
		Marin County Planning (and OSD)
		Marin Municipal Water District
		Marin Municipal Water District
		Marin Municipal Water District
		Marin Municipal Water District
		Marin Open Space Trust
		Metropolitan Transporation Commission
		Mid Peninsula Open Space District
		Montara Water and Sanitary District
		Morrison & Associates, Inc.
		Morrison & Associates, Inc.
		Mt. View Sanitary District

First Name	Last Name	Organization
		Muir Heritage Land Trust
		MWH Global
		Napa County
		Napa County
		Napa County
		Napa County
		Napa County
		Napa County
		Napa County
		Napa County
		Napa County Resource Conservation District
		Napa Open Space District
		National Marine Fisheries Service
		National Marine Fisheries Service
		National Park Service
		National Park Service
		National Park Service
		National Park Service
		National Park Service
		National Park Service
		Natural Resource Conservation District
		NewFields
		North Bay Water Reuse Authority (NBWRA)
		North Bay Watershed Association
		North Coast County Water District
		North Marin Water District
		OneWorld Communications
		Peninsula Open Space Trust
		Pescadero Municipal Advisory Council
		PRBO Conservation Science
		PRBO Conservation Science
		PRBO Conservation Science
		PRBO Conservation Science
		Presido Trust
		Prunuske Chatham Inc. Environmental Consulting
		Puente de la Costa Sur
		Questa Engineering
		Redwood City
		Redwood City
		Redwood City
		RMC Water and Environment
		RMC Water and Environment
		RMC Water and Environment
		RMC Water and Environment
		RMC Water and Environment
		RMC Water and Environment
		Rural Community Assistance Corporation
		San Francisco Bay Joint Venture
		San Francisco Bay Joint Venture
		San Francisco Bay RWQCB
		San Francisco Estuary Institute
		San Francisco Estuary Institute
		San Francisco Estuary Institute
		San Francisco Estuary Institute

First Name	Last Name	Organization
		San Francisco Estuary Institute
		San Francisco Estuary Institute
		San Francisco Estuary Invasive Spartina Project
		San Francisco International Airport
		San Francisco Public Utilities Commission
		San Francisco Public Utilities Commission
		San Francisco Public Utilities Commission
		San Francisco Public Utilities Commission
		San Francisco Public Utilities Commission
		San Francisco Public Utilities Commission
		San Francisco Public Utilities Commission
		San Francisco Public Utilities Commission
		San Francisquito Creek JPA
		San Francisquito Creek JPA
		San Francisquito Creek JPA
		San Francisquito Creek JPA
		San Mateo County
		San Mateo County
		San Mateo County
		San Mateo County
		San Mateo County
		San Mateo County C/CAG SW Runoff Program
		San Mateo County Farm Bureau
		San Mateo County Parks
		San Mateo County Parks
		San Mateo County Public Works
		San Mateo County Public Works
		San Mateo County Public Works
		San Mateo County Public Works
		San Mateo County Public Works
		San Mateo County Resource Conservation District
		San Mateo County Resource Conservation District
		San Mateo County Road Maintenance
		San Mateo County Supervisor Carole Groom
		San Mateo County Supervisor Don Horsley
		San Mateo County Supervisor Don Horsley
		San Mateo County Supervisor, 3rd District
		Santa Clara Regional OSA
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District
		Santa Clara Valley Water District

First Name	Last Name	Organization
		Sewer Authority Mid-Coastside
		SF Bayland Goals Update
		SF Port
		SF Port
		SF Regional Water Quality Control Board
		SFPUC
		SFPUC
		SFPUC
		Solano County Water Agency
		Solano County Water Agency
		Solano County Water Agency
		Sonoma County Water Agency
		Sonoma County Water Agency
		Sonoma County Water Agency
		Sonoma County Water Agency
		Sonoma County Water Agency
		Sonoma County Water Agency
		Sonoma County Water Agency
		Sonoma County Water Agency
		Sonoma Ecology Center
		Sonoma Ecology Center
		Sonoma Ecology Center
		Sonoma Ecology Center
		Sonoma Land Trust
		Sonoma Land Trust
		Sonoma Land Trust
		Sonoma Land Trust
		Sonoma Valley CAC
		Sotoyome Resource Conservation District
		Sound Watershed Consulting
		Sound Watershed Consulting
		SRT Consultants for MWSD
		State Coastal Conservancy
		State Coastal Conservancy
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		State Water Resources Control Board
		Stevens & Permanente Creeks Watershed
		Stillwater Sciences
		Stillwater Sciences, Inc.
		StopWaste.org

First Name	Last Name	Organization
		StopWaste.org
		StopWaste.org
		Surfrider Foundation - San Mateo County
		Surfrider Foundation - San Mateo County
		Swanson Hydrology & Geomorphology
		TeleScience Networks
		The Bay Institute of San Francisco
		The Bay Institute of San Francisco
		The Bay Institute of San Francisco
		The Watershed Project
		The Watershed Project
		The Watershed Project
		Tomales Bay Watershed Council
		Tomales Bay Watershed Council
		Tomales Bay Watershed Council
		Town of Atherton
		Town of Atherton
		Town of Atherton
		Town of Colma
		Town of Hills Borough
		Town of Hillsborough
		Town of Hillsborough
		Town of Portola Valley
		Town of Portola Valley
		Town of Ross
		Town of Woodside
		Turtle Island Restoration Network
		U.S. Army Corps of Engineers
		U.S. Army Corps of Engineers
		U.S. Fish and Wildlife Service
		U.S. Fish and Wildlife Service
		U.S. Fish and Wildlife Service
		U.S. Fish and Wildlife Service
		U.S. Fish and Wildlife Service
		United States Army Corps of Engineers
		United States Army Corps of Engineers
		Urban Creeks Council
		Urban Creeks Council
		Valley Transportation Authority (VTA)
		Wetlands and Water Resources
		WHITLEY BURCHETT & Associates
		Wolf & Associates
		Zone 7 Water Agency
		Zone 7 Water Agency
		Zone 7 Water Agency
		Zone 7 Water Agency
		Zone 7 Water Agency
		Zone 7 Water Agency
		Zone 7 Water Agency
		Zone 7 Water Agency
		Zone 7 Water Agency
		Zone 7 Water Agency

From: Bay Area IRWMP
To: Ben Gettleman
Subject: July 23 Workshop, Bay Area Integrated Regional Water Management Plan
Date: Monday, July 02, 2012 10:08:49 AM

Email not displaying correctly?
View it in your browser.

July 23, 2012 Public Workshop for the Bay Area Integrated Regional Water Management Plan

Dear Bay Area Water and Land Use Community,

The Bay Area Integrated Regional Water Management Plan (Bay Area IRWMP) is a multi-stakeholder, nine-county roadmap to coordinate and improve water supply reliability, protect water quality, manage flood protection, maintain public health standards, protect habitat and watershed resources, and enhance the overall health of San Francisco Bay.

On behalf of the coalition of water, flood, watershed, and planning agencies and organizations in the Bay Area that is updating the Bay Area IRWMP, I invite you, or someone from your agency or organization, to participate in the first of three public workshops that will provide information and gather input to develop the 2013 update to the Bay Area IRWMP. Importantly, understanding the Plan and its objectives will also help prepare your agency or organization to submit water project concepts by SEPTEMBER 1, 2012 for inclusion in the Plan, thereby qualifying your project for Prop. 84 and other competitive state grant funding.

Public Workshop
The first public workshop will be held on MONDAY, JULY 23, 2012 from 4:00 - 6:00 p.m. at the Association of Bay Area Governments Auditorium, 101 Eighth Street Oakland, CA 94607 (Lake Merritt BART Station). The purpose of the workshop is to inform you about the 2013 Bay Area IRWMP, how it affects your agency or organization, how you can provide input into the Plan, and how you can propose water resource projects to be included in the Plan. Projects serving disadvantaged communities will get special consideration.

The workshop is intended for public agency representatives (particularly water, land use, and sustainable development), policy and planning organizations, environmental and health organizations, community groups, Tribal interests and

individuals interested in water supply, water quality, flood protection/stormwater management, wastewater/recycled water, and watershed and habitat protection. A draft agenda will be posted on the website, www.bairwmp.org.

Speakers from regional and local water and flood organizations, as well as from the Association of Bay Area Governments (ABAG), will explain the objectives of the Bay Area IRWMP which are to promote integrated water management planning at the city, county and regional level, how new state guidelines are modifying integrated regional water management planning, how to collaborate with partners on project development, and potentially to get state assistance for addressing water challenges in your community.

The second workshop will be held Monday, August 27, 2012 and will provide a more in-depth look at how projects will be prioritized in the 2013 Bay Area IRWMP. The date of the third workshop is not yet set.

We hope to see you or a representative of your agency or organization on July 23 in Oakland.

Sincerely,

Paul Helliker
Marin Municipal Water District
Chair, Coordinating Committee
Bay Area Integrated Regional Water Management Plan

P.S. Participation in the Bay Area IRWMP Coordinating Committee is open to anyone interested in regional water projects, programs and policies. Please join us at our monthly meetings, check the website, www.bairwmp.org, for the contact person in your subregion, or contact us at BAIRWMP@kearnswest.com. We are partnering with stakeholder engagement specialists Kearns & West on this project.

From: Bay Area IRWMP
To: Ben Gettleman
Subject: Reminder, July 23 Public Workshop-- Bay Area Integrated Regional Water Management Plan
Date: Friday, July 20, 2012 2:48:23 PM

Reminder, July 23 Public Workshop -- Bay Area Integrated Regional Water Management Plan

Dear Water, Land Use and Community Stakeholder:

This is a reminder of Public Workshop #1 for the 2013 Bay Area Integrated Regional Water Management Plan on **Monday, July 23, 2012, 4-6 p.m., at the Association of Bay Area Governments Auditorium, 101 Eighth St., Oakland, CA.** (Lake Merritt BART Station.)

The workshop will provide an overview of the process to update the Plan, the Plan objectives, and the submittal and evaluation of water –related project proposals. Projects included in the Plan can qualify for competitive state grant funding, and there will be a regional process to prioritize projects.

The deadline to submit a water project proposal is September 1, 2012. Visit www.bairwmp.org **to submit a proposal online.**

Workshop #2 will be held August 27, 2012, 4-6 p.m., Oakland venue to be determined. The main topic of the meeting will be project prioritization for the Bay Area IRWMP.

Public agencies and non-profit organizations are encouraged to submit projects and to collaborate on projects. Projects serving water challenges in disadvantaged, low-income communities will get special consideration. Native American tribes are also encouraged to consider projects that will serve their needs.

For information, please visit the website or email BAIRWMP@kearnswest.com.

Forward this email to a friend.

From: Bay Area IRWMP
To: Ben Gettleman
Subject: Today's Bay Area IRWMP Workshop in Oakland should not be affected by Presidential street closures
Date: Monday, July 23, 2012 9:58:06 AM

Today's Bay Area IRWMP Workshop in Oakland should not be affected by Presidential street closures

Dear Bay Area Water, Land Use and Community Stakeholders:

Today's visit to Oakland by President Obama coincides with our 4-6 p.m. Bay Area IRWMP Workshop, but access to the meeting should not directly be affected by street closures. The President will be at the Scottish Rite Temple across from Lake Merritt at about 18th Street and Lakeside Blvd. The Bay Area IRWMP Workshop is being held about eight blocks away at 101 8th St. between Oak St. and Madison St. at the Association of Bay Area Governments.

FYI, the following streets are currently scheduled for closure today by the Oakland Police Department.

- Telegraph Avenue between 17th Street and Thomas L. Berkley Way
- 17th Street between Broadway and San Pablo Avenue
- 18th Street between Telegraph and San Pablo avenues
- 19th Street between Broadway and San Pablo Avenue
- William Street between Telegraph and San Pablo avenues
- Rashida Muhammad Street between 19th and 20th streets
- San Pablo Avenue from 17th Street to Thomas L. Berkley Way

While there are protests scheduled for the BART station at 12th and Broadway, the BART station closest to the workshop is the Lake Merritt station.

Presentations from the meeting will be posted on July 24, 2012. And please remember, **Project Proposals are due September 1, 2012**. Please visit www.bairwmp.org for the online submittal template.

Sincerely,

The Coordinating Committee of the Bay Area Integrated Regional Water Management Plan

Forward this email to a friend

From:	Bay Area IRWMP
To:	Ben Gettleman
Subject:	BAIRWMP: Follow-up from 7/23 workshop, reminder of 9/1 project submittal deadline
Date:	Wednesday, August 08, 2012 1:08:17 PM

BAIRWMP: Follow-up from 7/23 workshop, reminder of 9/1 project submittal deadline

Thank you to those who attended the Bay Area Integrated Regional Water Management Plan (Bay Area IRWMP) Public Workshop on July 23 in Oakland. We had a great turnout! For those who were unable to attend the workshop, electronic copies of the workshop's presentations and question-and-answer session are posted on the project website (http://bairwmp.org/).

Future workshops
In order to allow agencies and non-governmental organizations to submit project proposals by the September 1 deadline, we will hold Workshops #2 and #3 further along in the Plan development process, likely in early 2013. This will allow stakeholders to learn about and provide input on chapters dealing with topics such Bay Area IRWM Plan performance and monitoring, financing integrated projects, and the relationship of integrated water management to land use planning and climate change. Please visit the project website (www.bairwmp.org) where information will be posted as it becomes available. We will also send a notice of the workshops, so please make sure to include our email address in your "approved" list.

Reminder - September 1 project submittal deadline
The deadline for submitting projects to be included in the 2013 Bay Area IRWMP is September 1, 2012. Please visit the following link for more information on how to submit a project on the project website: http://bairwmp.org/projects/submitting-a-project-to-the-bay-area-irwmp

If you have any questions regarding your project proposal or how to submit on the website, please contact your subregional outreach lead:
· North (Marin, Sonoma, Napa, Solano counties) – Harry Seraydarian: harryser@comcast.net
· East (Contra Costa, Alameda counties) – Mark Boucher: mbouc@pw.cccounty.us
· South (Santa Clara County) – Brian Mendenhall: BMendenhall@valleywater.org)
· West (San Francisco, San Mateo counties) – Cheryl Muñoz: cmunoz@sfwater.org

Disadvantaged community (DAC) maps available
If you are considering submitting a project proposal that serves a disadvantaged community, maps that incorporate 2010 Census data are now available on the project website at http://bairwmp.org/dac/dac-info. For assistance with developing DAC project proposals, please contact Caitlin Sweeney: CSweeney@waterboards.ca.gov.

Thank you for your continued interest in the development of the 2013 Bay Area IRWMP!

Forward this email to a friend

From:	Bay Area IRWMP
To:	Ben Gettleman
Subject:	IRWMP Projects – New deadline....Sept. 7
Date:	Tuesday, August 21, 2012 3:54:15 PM

IRWMP Projects – New deadline…Sept. 7

Dear project proponents:

As you may know, the Bay Area Integrated Regional Water Management Plan is currently being updated. As part of this process, the Plan will include proposed projects for water resources management in the Bay Area. These proposed projects are due **September 7** and can either be new projects, or can be updated versions of projects already in the Plan. In either case, information about the projects must be included in the online database housed at the Bay Area IRWMP website.

A complete new or updated project description is required to be eligible for inclusion in the 2013 Bay Area Integrated Regional Water Management Plan and to be eligible for future grant funding.

New Projects
If you are proposing a new project, please visit the Bay Area IRWMP website at www.bairwmp.org and click on the link in the left column entitled "Submitting a Project" and follow the instructions. You may click the blue "Submit a project" button at the bottom of that page.

Updating Existing Projects
If your project has already been submitted and included in the Plan, you will need to confirm that you want to continue to include it in the Plan. Please visit the IRWMP website at www.bairwmp.org and click on the link in the left column entitled "Submitting a Project," and then click on the link "Click here for instructions on how to update existing projects." If you do not update the project information, the project will be put in an inactive file and not included in the Active Project List.

Reviewing and Scoring Projects
All projects submitted or updated by the deadline of **September 7** will be reviewed in accordance with a Project Review Process and scoring methodology authorized by the Coordinating Committee. The original deadline was set for September 1. Drafts of these materials are now available on the IRWMP website, "Submitting a Project" page.

DRAFT Project Review Process: http://bairwmp.org/bairwm-2013-plan-update/2013 Proj review process
DRAFT Review Process Schedule: http://bairwmp.org/bairwm-2013-plan-update/2013 Proj Rev Process Schedule
DRAFT Project Scoring and Ranking Methodology: http://bairwmp.org/bairwm-2013-plan-update/Project Scoring & Ranking Method/

Deadline
Please note that the deadline for submitting a new project or updating an existing project has been extended to September 7, 2012. This date has been selected to allow adequate time to review, score and prioritize projects included in the Plan, and to consider projects for further analysis and inclusion in a proposal for implementation grant funding.

Website Bulletin Board
In order to provide an opportunity for further collaboration, the Bay Area IRWMP website now includes a bulletin board for project proponents: http://bairwmp.org/projects/needs-board/

Please note that you will need to register with the Bay Area IRWMP website in order to edit project information. If you need assistance or have questions, you may seek technical support by contacting projects@bairwmp.org.

Thank you,

Paul Helliker
Chair, Bay Area IRWMP Coordinating Committee

Important NEW information - DAC projects

Dear project proponents:

The purpose of this message is to provide NEW information regarding IRWM projects benefitting disadvantaged communities.

The Department of Water Resources has confirmed that IRWM projects benefitting a disadvantaged community (DAC) and included in a future IRWM Implementation Grant proposal may be eligible for special treatment, as summarized below.

Match waiver
A cost match waiver (minimum 25% match) can be requested for any IRWM DAC project that specifically addresses a need of a DAC. This means that matching funds requirements could be waived for any IRWMP project specifically benefitting a disadvantaged community.

Funding appropriation
The IRWM program requires that 10% of statewide funding for Implementation Grants must address critical water supply/water quality needs of a DAC. DWR has confirmed our understanding that flood control projects in a DAC are eligible for this DAC-dedicated funding (in addition to the match funding waiver), if they meet a critical water supply or water quality need. For a flood control project, the project sponsor must present the argument for how the flood control project addresses a critical water supply/water quality need. For example, if a flood control project is located in a DAC and is designed to prevent public health risks associated with exposure to bacterial or chemical pollutants that could result from flooding (such as happened in New Orleans during Hurricane Katrina), the project could be considered by DWR to meet a critical water quality need.

The deadline for submitting new or updated project descriptions to be eligible for inclusion in the 2013 Bay Area Integrated Regional Water Management Plan, and future IRWM Implementation Grant proposals, is September 7, 2012.

New or updated project descriptions received after 12:00 midnight on September 7 will not be considered during the Project Review Process for inclusion in the 2013 IRWM Plan.

Please note that you will need to register with the Bay Area IRWMP website in order to edit project information. If you need assistance or have questions, you may seek technical support by contacting projects@bairwmp.org.

Thank you,
Paul Helliker
Chair, Bay Area IRWMP Coordinating Committee

Forward this email to a friend

From: Bay Area IRWMP
To: Ben Gettleman
Subject: Bay Area IRWMP Public Workshop #2 - January 28, 2013
Date: Thursday, December 20, 2012 5:10:18 PM

January 28, 2013
Public Workshop #2 for the Bay Area Integrated Water Management Plan

You are invited to the second public workshop for the development of the Bay Area Integrated Regional Water Management Plan. The workshop will be held on **Monday, January 28, 2013 from 4-6 p.m.** at StopWaste.org, 1537 Webster Street, Oakland, CA. (12th St. BART)
The purpose of the workshop is to provide water, flood and watershed agencies and organizations with information about water-related projects and funding sources related to integrated water resource management projects in the Bay Area.

The topics for the workshop will include:

· **2013 Bay Area IRWMP Projects** – Scoring and Ranking Projects for Inclusion in the Plan – Harry Seraydarian, North Bay Watershed Association and Bay Area IRWMP Project Selection Committee, and

· **Financing and Collaboration** – Opportunities, Challenges, Successes: Current and Emerging Opportunities for Funding Water Resource Projects

1) Water and wastewater public-private partnerships – Grant Schlereth, ARUP
2) Flood management projects – Carol Mahoney, Zone 7 Water Agency
3) Non-governmental organization projects – Caitlin Sweeney, San Francisco Estuary Partnership

The topics will provide ample opportunity for discussion by participants.

The workshop is intended for public agency representatives (particularly water, land use, and sustainable development), policy and planning organizations, environmental and health organizations, community groups, Tribal interests and individuals interested in water supply, water quality, flood protection/stormwater management, wastewater/recycled water, and watershed and habitat protection. For further information, please visit the website, www.bairwmp.org.

The Bay Area IRWMP is a multi-stakeholder, nine-county roadmap to coordinate and improve water supply reliability, protect water quality, manage flood protection, maintain public health standards, protect habitat and watershed resources, and enhance the overall health of San Francisco Bay.

P.S. Participation in the Bay Area IRWMP Coordinating Committee is open to anyone interested in regional water projects, programs and policies. Please join us at our monthly meetings, check the website, www.bairwmp.org, for the contact person in your subregion, or contact us at BAIRWMP@kearnswest.com.

From: Bay Area IRWMP
To: Ben Gettleman
Subject: January 28 Water Workshop - Bay Area Integrated Regional Water Management Plan
Date: Monday, January 14, 2013 1:46:30 PM

Use this area to offer a short teaser of your email's content. Text here will show in the preview area of some email clients.

Is this email not displaying correctly?
View it in your browser.

January 28, 2013

Public Workshop #2 for the

Bay Area Integrated Regional Water Management Plan

"Project Selection, Financing and Collaboration"

You are invited to the second public workshop for the development of the Bay Area Integrated Regional Water Management Plan. The workshop will be held on Monday, January 28, 2013 from 4-6 p.m. at StopWaste.org, 1537 Webster Street, Oakland, CA. (12th St. BART)

Topics for the workshop include:

- **Scoring, ranking and selecting projects for inclusion in the 2013 Bay Area IRWMP**
- **Funding sources and collaborations for water project implementation, including public-private and public-non-profit**

partnerships

Speakers include:

- **Harry Seraydarian, North Bay Watershed Association**
- **Carol Mahoney, Zone 7 Water Agency**
- **Grant Schlereth, ARUP**
- **Caitlin Sweeney, San Francisco Estuary Partnership**
- **Steve Ritchie, San Francisco Public Utilities Commission**

There will also be a discussion with participants about removing barriers to collaboration between public agencies and non-profit organizations as well as with for-profit organizations. Please visit www.bairwmp.org **for an agenda and further information about the Bay Area Integrated Regional Water Management Plan.**

The workshop is intended for public agency representatives (particularly water, land use, and sustainable development), policy and planning organizations, environmental and health organizations, community groups, Tribal interests and individuals interested in water supply, water quality, flood protection/stormwater management, wastewater/recycled water, and watershed and habitat protection.

The Bay Area IRWMP is a multi-stakeholder, nine-county roadmap to coordinate and improve water supply reliability, protect water quality, manage flood protection, maintain public health standards, protect

habitat and watershed resources, and enhance the overall health of San Francisco Bay.

P.S. Participation in the Bay Area IRWMP Coordinating Committee is open to anyone interested in regional water projects, programs and policies. Please join us at our monthly meetings, check the website, www.bairwmp.org**, for the contact person in your subregion, or contact us at** BAIRWMP@kearnswest.com**.**

From: Bay Area IRWMP
To: Ben Gettleman
Subject: Reminder: Bay Area IRWMP January 28th Workshop
Date: Wednesday, January 23, 2013 3:37:10 PM

Use this area to offer a short teaser of your email's content. Text here will show in the preview area of some email clients.

Is this email not displaying correctly?
View it in your browser.

January 28, 2013
Public Workshop #2 for the Bay Area Integrated Regional Water Management Plan

"Project Selection, Financing and Collaboration"

As a reminder, you are invited to the second public workshop for the development of the Bay Area Integrated Regional Water Management Plan. The workshop will be held on Monday, January 28, 2013 from 4-6 p.m. at StopWaste.org, 1537 Webster Street, Oakland, CA. (12th St. BART)

Topics for the workshop include:

- **Scoring, ranking and selecting the 300+ projects for**

inclusion in the 2013 Bay Area IRWMP

· Funding sources and collaborations for water project implementation, including public-private and public-non-profit partnerships

Please visit the website, www.bairwmp.org, for an agenda and further information about the Bay Area Integrated Regional Water Management Plan.

From:	Bay Area IRWMP
To:	Ben Gettleman
Subject:	Bay Area IRWMP Draft Chapters Available for Public Review
Date:	Tuesday, February 26, 2013 4:41:47 PM

Use this area to offer a short teaser of your email's content. Text here will show in the preview area of some email clients.

Is this email not displaying correctly?
View it in your browser.

Three draft chapters are now available for public review as part of the Bay Area IRWM Plan Update process:

- Chapter 2: Region Description
- Chapter 3: Objectives
- Chapter 6: Regional Priorities (includes Appendix 6-2: Project Template)

Please visit the BAIRWMP website at http://bairwmp.org/bairwm-2013-plan-update/public-drafts/drafts to access the draft chapters.

How to provide comments
Please submit your substantive comments on Chapters 2, 3 and 6 using a Chapter Review Form (available at the link above) and send to Dana Haasz (DanaHaasz@KennedyJenks.com) by March 28, 2013. Please use a separate form for each chapter reviewed.

Review of additional Plan Update chapters
Each of the Bay Area IRWM Plan Update's chapters will be available for public review prior to being combined into one document (note: this combined Plan Update will also be available for review in June 2013). The draft chapters will be available on the BAIRWMP website (http://bairwmp.org/bairwm-2013-plan-update/public-drafts/drafts), and a message will be sent to this distribution list at the beginning of each chapter's 30-day review period.

Below is the list of BAIRWM Plan Update chapters:

Chapter : Title
Chapter 1: Governance

Chapter 2: Region Description
Chapter 3: Objectives
Chapter 4: Resource Management Strategies
Chapter 6: Project Review
Chapter 7: Impacts & benefits
Chapter 8: Performance & Monitoring
Chapter 9: Data Management
Chapter 10: Financing
Chapter 11: Technical analysis
Chapter 12: Relation to Water planning
Chapter 13: Relation to land use planning
Chapter 14: Stakeholder Engagement
Chapter 15: Coordination
Chapter 16: Climate change

forward to a friend

Appendix E-2

Stakeholder Assessment

Bay Area Integrated Regional Water Management Plan Update

Summary of Interviews with
Coordinating Committee Members
February 2012

Members Interviewed:

- Thomasin Grim, Marin MWD
- Paul Helliker, Marin MWD (CC Chair)
- Jennifer Krebs, ABAG/SFEP
- Brian Mendenhall, Santa Clara Valley Water District
- Carl Morrison, Morrison & Associates
- Harry Seraydarian, North Bay Watershed Association
- Brad Sherwood, Sonoma County Water Association

I. 2006 Plan Development Stakeholder Efforts

A. Adequate to very good stakeholder: engagement of "the usual suspects"

- Local water agencies/special districts/ local government
- Water-specific state agencies
- Regional NGOs
- And, particularly for Plan *development*

B. Minimal/not successful engagement of:

- Disadvantaged and Environmental Justice Communities (DACs/EJ). except for some outreach done by Carl Morrison on behalf of his clients/the effort
- Environmental groups
- Tribal organizations

AND ALSO

- Research institutions
- Consulting firms
- Stormwater agencies
- County/city planning directors/agencies
- Resource Conservation Districts

- Some state agencies (e.g. Fish & Game)
- Federal agencies
- And, engagement after Plan adoption was minimal

C. Legacy of 2006 BAIRWMP collaboration efforts

- Flood agencies are now working together (Bay Area Flood Protection Association -- BASFPA)
- Also a water agency coalition, a clean water agency, a stormwater group (BAWAC, BASWA, BAWN)
- Subregional efforts may take it to the next step (e.g. NBWA sea-level-rise planning
- BUT, everyone is busy doing their own jobs and is likely to have less time to contribute to the CC or to "mentoring" DACs or other community-based organizations

D. Stakeholder engagement goals were not clearly defined

- General notions range from "it's the right thing to do" to "we need to get the most complete set of products we can so we need to hear from people in addition to agencies"
- Some local water agencies thought the state funds were for them and didn't consider "integration" a priority
- Much of the engagement was actually "outreach," i.e. informing stakeholders, but if you weren't a local water agency you might not have really gotten a sense of how decisions were made and how your interests/group could influence decisions or benefit by them.
- After the plan was adopted in 2006, the attention shifted to identifying projects for submission to DWR for funding. There was very little if any ongoing stakeholder outreach other than public Coordinating Committee meetings and the more recent subregional groups

E. Hurdles to Disadvantaged Communities and tribal engagement

- Need to develop a consolidated list of DACs and tribal groups, including relationships that subregional groups have
- DACs often don't have the staff or volunteer time to participate in engagement activities, let alone submit a project proposal
- Their interests/priorities may not relate to the four functional areas (supply, quality, wastewater, flood protection); further, DAC projects must address water supply and/or water quality

- Even if they have a water problem, it may be local and not obviously solved by a regional or integrated project
- Lack of knowledge of how to identify a project, find a partner, provide input to the application. Potential partner agencies may not see it in their interest to partner.
- Tribes are a challenge. They don't seem to have specific water needs, unless the gaming industry generates demand that can't be met. We'll need to work with some agency resources to identify tribal representatives to talk to.
- DACs may underestimate the amount of resources and money a project will take and, consequently, they may never propose to do the work.

II. 2013 Plan Update: More explicit stakeholder engagement goals should be part of an overall stakeholder engagement plan

A. A successful stakeholder engagement plan would look like:

- Generate a sizeable number of projects, with both geographic and functional diversity
- There are projects that span the cross functional areas. For example, a habitat restoration project that includes flood management and groundwater recharge and maybe some recycled water.
- We go to the DACs and tribes to talk! Don't make them come to our meetings! Ask them what their water problems are and what they want done about them.
- Manage expectations. Boil down the IRWMP to the types of projects that would make sense for DACs and also qualify for DWR's criteria. Determine *quickly* whether their needs would be met by qualified projects. If not, tell them it's not going to work but we'll keep you on the mailing list and keep the BAIRWMP process in mind for the future.
- Empower NGOs to go to the DACs and tribes to raise awareness, interest and participation.
- Make some of the time at CC meeting specific so we can do a "deep dive" on more limited topics of interest to stakeholders rather than just do reviews and updates.
- Make the groups aware of state funding. You can lead a horse to water….

B. DWR should provide appropriate, region-specific criteria for what constitutes a disadvantaged community (DAC)

- 80% of median household income of state? Or region?
- And, more broadly, who IS the public? Does it include the likes of the Tea Party?

C. DWR should provide guidance on tribal-related projects

- Few distinct tribal communities of a significant size in Bay Area
- Don't tend to have region- or culture-specific water deficiencies
- DWR's focus on water quality and water supply often does not relate to the challenges and concerns of Bay Area DACs and tribal communities. Their access to adequate quantities of clean water is not different from other residents.
- DAC and tribal water needs may not be the type that is easily integrated in geography or functional areas

D. Foster a culture of collaboration that extends beyond the plan

- Clearly define "collaboration" and "integrated" so they can be considered from the start of project identification/development
- Beyond projects, convey necessity and benefit of region-wide water planning
- Provide a compelling reason for stakeholders, particularly DACs/EJ/tribes, to participate
- Provide opportunities in addition to CC meetings for DACs/tribes to participate

E. Of the stakeholder engagement, how much should be geared toward DACs and tribes?

- Ranges from "Top priority!" to "Less than half our engagement efforts."
- It's in the work plan. A third should go to the DACs. But that might be too much given the potential for meeting state criteria.
- Need to clarify criteria with DWR!
- Given current understanding of DWR's criteria that 10% of proposed project dollars should go to DACs and tribes, some felt it may be unreasonable because of the low numbers of communities that meet state requirements for income and for discrete water problems that qualify.

- We might be tempted to try to find problems that aren't there. Why should we expend the effort on projects with a low likelihood of qualifying for state funds?
- If DACs don't have the interest or bandwidth to participate, we can't force them and we shouldn't spend our time trying to create problems to solve.
- Not realistic to think a small community organization is going to put together an IRWMP organization

F. Flood control and sea-level rise may be most promising DAC projects

- Find a map of flood-prone communities and target them
- Potential for climate change to create flooding in Low-lying communities would be more subject to flooding and to the effects of sea-level rise could meet state criteria for funding
- Flood management AND riparian or wetlands management together. With sea level rise, we'd want more wetlands in which to disperse the water
- Consider solutions: sea walls, evacuation plans (would these qualify as inter-regional and multi-benefit?)

G. Other projects of interest to DACs may be:

- Conservation
- Rate reductions
- Watershed management
- Reduction of mercury pollution via stormwater drainage into Bay
- Impact of habitats on water quality
- Wastewater treatment plants

H. The subregional approach has the best likelihood for engagement success.

- Subregional leads know the organizations and the territory. "Map" their relationships. Consolidate their lists of organizations.
- Regional watershed groups have good potential to cross multiple geographic and functional boundaries
- Recruit additional subregion stakeholder "co-captains"
- Compensate NGOs to engage community representatives who can identify potential problems that could be addresses by state bond money

I. Outreach techniques might include:

- An outreach and engagement plan that has the buy-in from key players in the update
- Develop a simple, consistent message about why people/organizations should care about the IRWMP, how they can benefit, and how they can get help to get state money
- Deliver the messages:
  - In person by going to the groups
  - In simple text and graphics using project examples and photos
  - Via a more user-friendly website, including an online sign-up for announcements and e-newsletters
  - Via a quarterly e-newsletter

Bay Area Integrated Regional Water Management Plan Update

Summary of Interviews Focusing on Disadvantaged Communities (DACs)
April 2012

Stakeholders Interviewed:

- Jennifer Clary – Clean Water Action
- Debbie Davis – former member of Environmental Justice Coalition for Water
- Melanie Denninger – State Coastal Conservancy
- Karen Gaffney – North Coast IRWMP
- Carol Mahoney – Zone 7 Water Agency
- Karen Pierce – SF Department of Public Health, Bayview-Hunters Point environmental justice advocate
- Chuck Striplen – SFEI, member of Amah Mutsun Tribal Band

Reflections on 2006 IRWMP DAC Engagement

- Process was frustrating for organizations serving DACs.
- Proposed edits to the draft Plan from DAC perspectives/interests were largely not incorporated into the final Plan.
- Organizations serving DACs were unable to involve DACs and integrate their projects because outreach to DACs occurred too late in the process and grantee funding was limited.
- There were resources allocated and staff assigned to "fill the gaps" – identify DAC needs, vet ideas, develop project proposals, etc. This was essential.

Challenges/Obstacles to Effective DAC Engagement in 2012-2013

DAC Criteria

- There are a limited number of DACs in the Bay Area.
- Water quality/water supply is not a significant concern in the Bay Area.

Resources

- DACs are often represented by people with limited bandwidth (full-time jobs and other responsibilities). Water issues are usually not high on their list of priorities and participating in meetings/workshops and developing proposals requires a significant time investment.
- DACs have limited resources/experience to identify projects and develop project proposals, and there are no guarantees that projects will be funded.
- BAIRWM participating agency staff have limited resources to target DAC communities.

Structure/Process

- CC meetings take place during the day, and DAC representatives are not typically able or willing to attend.
- BAIRWM leadership is comprised of water resource agency staff, without direct connections to residents. Many other IRWM regions have elected officials involved, and there is a built-in mechanism/incentive to conduct outreach.
- BAIRWM outreach efforts are not centralized, making it challenging to be strategic with time and resources.

Relationships

- Water resource agencies often do not have strong working relationships with DACs and the organizations that serve them.

- Some DACs have lingering distrust from the 2006 BAIRWMP development process, including skepticism that DAC input will be incorporated if they participate and contribute feedback.

Initial Recommendations for Engaging DACs

Resources

- Determine how best to use limited resources to engage DACs in the review of draft chapters, project identification, and other Plan Update activities.
- Inventory resources (staff and funding) available to engage and provide technical assistance to DACs. Determine what additional resources will be needed and make plan for acquiring/allocating them.

Structure/Process

- Leverage existing BAIRWM structure to conduct outreach and identify potential projects
  - Functional Areas (FA), particularly the Water quality/Water supply FA, can coordinate internally and provide guidance/information to help identify DAC projects. Encourage more direct interaction and information sharing between water resource agencies and DACs.
  - Consistent with broader outreach, DAC outreach should be implemented and coordinated on the sub-regional level.
  - Identify ways of involving DACs in existing activities.
  - Be very clear about how DAC input will be incorporated; ensure that commitments are upheld. Be clear about the decision-making process and how they will be assisted in preparing proposals.

Outreach and Engagement

- Develop DAC-specific outreach messages and materials.
- Structure DAC outreach to reflect the criteria for selecting projects. Be clear about what kinds of projects are being sought.
- Educate DACs to better make the connection between water and other environmental priorities.
- Inventory existing relationships with DACs and the organizations that serve them. Use a spider-webbing approach to reach additional organizations.
- Go to the DACs – provide presentations during their standing meetings. DACs want to see/hear from the water agencies directly.
- Conduct community visits to better understand issues, build relationships and establish trust.

Project Identification

- Engage environmental/public health officers, who often know about water quality issues and the needs of DACs.
- Identify Bay Area communities that do not have access to safe water/sewer. Consider beginning with county department of public health or local governments, who can identify places with poor housing stock. The Water Board can provide information on violations.

Tribal-Specific Issues and Recommendations

- Some tribes have professional environmental staff; most do not.
- Most Bay Area tribes are diffused, making it difficult to address geographic needs.
- Tribal engagement is unique, and tribes themselves are unique. Direct government-to-government consultation is often expected.
- The EPA Regional Tribal Operations Committee and DWR's Tribal Liaison will be helpful resources.

Appendix E-3

Agenda for April 17, 2012 Stakeholder Engagement Planning Workshop

Bay Area IRWMP
Stakeholder Engagement Planning Meeting

Tuesday, April 17, 2012, 9:00 a.m. – 12:00 noon
East Bay Municipal Utilities District (EBMUD)
375 11th St., Oakland, CA
Large Training Room – 2nd Floor

Meeting Objectives

- Identify objectives for stakeholder engagement (both for IRWMP development and for implementation moving forward)
- Confirm current and anticipated engagement activities (in all sub-regions and across all functional areas) and identify gaps
- Discuss strategies to engage and identify projects in DACs and tribal communities

Agenda

Time	Item
9:00 – 9:20	Agenda review and introductions • Introduce meeting participants • Review agenda topics and objectives • Framing the discussion – where we've been and where we're going
9:20 – 10:30	Stakeholder Engagement Plan (SEP) to support BAIRWMP development and project identification/selection • Discuss proposed BAIRWMP engagement objectives • Review current and anticipated outreach and engagement activities and roles/responsibilities • Discuss gaps and overlaps
10:30 – 11:40	DAC/tribal engagement planning • Review findings from Kearns & West DAC interviews • Discuss DAC/tribal participation challenges and potential recommendations • Discuss proposed DAC/tribal engagement objectives
11:40 – 11:55	Wrap-up discussion • Additional challenges, recommendations, and guidance for development of SEP and DAC/tribal engagement
11:55 – 12:00	Next steps

Meeting Materials

1. Draft timeline of BAIRWMP development and public engagement/outreach milestones
2. Proposed BAIRWMP engagement objectives
3. Compiled results from Outreach and Engagement Activity Survey
4. Summary of findings from DAC interviews
5. Proposed DAC/tribal engagement objectives

Appendix E-4

Stakeholder Engagement Plan

Stakeholder Engagement Plan

Bay Area Integrated Regional Water Management Plan Update

Prepared by:

KEARNS & WEST

TABLE OF CONTENTS

I. INTRODUCTION AND PROJECT OVERVIEW

The regional water management group for the Bay Area Integrated Regional Water Management Plan (Bay Area IRWMP) is preparing the 2013 Plan Update to guide water management efforts in the Bay Area. Using the 2006 Plan as a basis, the new version will update existing information, add a new chapter on climate change, and update portions of the Plan to be current with the California Department of Water Resources' guidelines and criteria for integrated regional water management plans.

This Stakeholder Engagement Plan is a guide for the Coordinating Committee and its consultants to inform and engage stakeholders in learning about and contributing to the development of the Plan and for identification of water-related projects to include in the Plan for potential state grant funding. It was developed with input from interviews with seven members of the Coordinating Committee, six interviews with external stakeholders, a half-day Stakeholder Engagement Workshop held April 17, 2012, discussions with DWR staff, additional conversations with stakeholders, and discussion at the April and May 2012 Coordinating Committee meetings.

II. STAKEHOLDER ENGAGEMENT GOALS AND OBJECTIVES

The development of the Bay Area IRWMP will only be possible with the participation of a range of stakeholders including water professionals, non-profit organizations, and community members. These stakeholders are most able to identify Bay Area water-related challenges and opportunities to address them. In order to secure this type of input, efforts must be made to educate the public about integrated water project s and what constitutes an integrated regional water management plan. In addition, opportunities to share information about problems and solutions must be provided. With this understanding and these opportunities in place, interested stakeholders and broader members of the public can be involved in the development of the Bay Area IRWMP, including identifying potential projects to be included.

This Stakeholder Engagement Plan (SEP) identifies how stakeholder and public input will help shape the Bay Area IRWMP and how stakeholders can identify projects to be included in the Bay Area IRWMP. The SEP is intended to direct stakeholder engagement during the plan update process through August 2013, and it will also be used to guide stakeholder engagement subsequent to adoption of the Bay Area IRWMP.

Kearns & West organized a Stakeholder Outreach and Engagement Workshop in April 2012 to confirm Coordinating Committee Goals, Objectives and Priorities for stakeholder outreach and engagement. Fourteen persons attended. Based on that input the following goals and objectives were developed and brought to the Coordinating Committee. Subsequent to the workshop, some of the participants are serving on the Stakeholder Engagement Subcommittee to provide ongoing input and outreach.

GOALS: Key stakeholder engagement goals for the Bay Area IRWMP include:

1. Develop a broader understanding of the water needs of the Bay Area
2. Increase broad public awareness of regional water management planning
3. Expand the scope of the Bay Area IRWMP to include planning for climate change impacts and to provide for greater collaboration with land use agencies
4. Further engage non-governmental organizations in the IRWMP planning process
5. Further engage disadvantaged communities in the IRWMP planning process
6. Identify and address the needs of disadvantaged communities
7. Develop more multi-benefit projects than previously submitted

OBJECTIVES: The stakeholder engagement objectives that will support the goals of stakeholder engagement include:

1. **Plan Update Awareness**
    - BAIRWMP stakeholders know the Plan is being updated and understand why it is important for their respective groups.
    - Stakeholders understand the opportunities for public participation in content development and review.
    - Stakeholders understand the decision-making processes associated with the Plan Update, including:
        - How, when and by whom decisions are made regarding Plan Update content
        - How, when and by whom decisions are made regarding potential water projects and their prioritization

2. **Stakeholder Inclusion and Identification**
   - The CC listserv is easy to join, open to anyone, and the list of participants is well maintained and expanding in number.
   - As identified, people are invited to join the CC listserv and participate as stakeholders. The expansion includes:
     - Individuals who are on the contact lists of the four BAIRWMP subregional groups
     - Members of Bay Area regional water- and flood-related coalitions, organizations, and listservs
     - Members of public policy organizations interested in regional planning
     - Representatives of organizations in Disadvantaged Communities (DACs) who have an interest in water issues addressed by the BAIRWMP
     - City and County government representatives, particularly those involved in land use planning, flood protection, habitat management, and public health
     - Experts , individuals and organizations responsible for/interested in impacts of climate change/sea level rise relative to water management
     - Organizations and individuals involved in watershed protection/habitat restoration
     - Businesses and associations which impact and/or are impacted by water-related decisions
     - Native American tribal representatives
     - Organizations and individuals interested in specific BAIRWMP issues
     - Other self-identified individuals and organizations
   - Stakeholders representing DACs and tribes have been identified for targeted outreach/engagement.

3. **BAIRWMP Stakeholder Input and Review**
   - Stakeholders impact content development by providing information and data to the Plan Update Team and/or the technical consultants, including at CC meetings, at subregional meetings, at workshops, and in person. Stakeholders can help frame issues, identify challenges and recommend solutions, including recommendations for policies and programs that involve collaboration and integration among organizations and agencies.
   - Stakeholders are able to review and provide feedback on the Plan Update during public review of draft chapters, which is publicized online, and in CC listserv notices. Stakeholders will also be able to make comments at Public Workshops.
   - Stakeholders see their input reflected in the Plan Update and/or are informed why their comments are not reflected.

4. **Project Identification**
   - The 2013 BAIRWMP includes projects that meet the needs of the Bay Area region and conform to Proposition 84 requirements.

- Stakeholder involvement in the 2013 BAIRWMP produces projects that reflect integration among water management functions, agencies, and organizations to provide multiple benefits to communities.
- Stakeholder involvement produces projects that feature greater collaboration among public agencies, non-governmental organizations, and communities.
- Stakeholder involvement will identify projects that will disadvantaged commuities

5. **Coordination and collaboration**
    - The BAIRWMP process and its participants foster coordination, collaboration, and creative thinking among public agencies, non-governmental organizations, businesses and individuals to identify and address the region's water resource challenges and opportunities.
    - Agencies, organizations and individuals involved in the Plan Update are informed of the stakeholder engagement activities of other participants, which allows for the effective and efficient use of resources and relationships.

III. STAKEHOLDER IDENTIFICATION

Since the development of the 2006 Bay Area IRWMP, a core group of water agencies and non-profit organizations has continued to operate as the Coordinating Committee (CC), whose membership is open to any interested person. The CC holds monthly meetings and makes decisions on a consensus basis. The region is divided into four subregions to facilitate interaction on a more localized basis. There is a lead or co-leads for each subregion. An effort will be made to enlist water/flood agency representatives in San Mateo County, which is not currently represented.

The CC participants and the stakeholder engagement consultant, Kearns & West, will identify potential additional stakeholders for engagement, including regional planning organizations and non-profit groups, land use and planning agencies and organizations, elected officials, disadvantaged communities and Native American tribal representatives, expanding the existing 200-person CC listserv as well as increasing the numbers of people on subregional contact lists. The goal of stakeholder identification is to capture all organizations, agencies and communities that may have an interest in the four functional areas of the Bay Area IRWMP – water supply/water quality, wastewater/stormwater, flood control, and watershed and habitat protection.

Bay Area IRWMP stakeholders will include:

1. Wholesale and retail water purveyors
2. Wastewater agencies
3. Flood control agencies
4. Municipal and county governments and special districts
5. Elected officials
6. Regional planning organizations
7. County and local land use planners
8. Utilities
9. Climate change experts
10. Self-supplied water users

11. Environmental stewardship organizations
12. Community organizations
13. Industry organizations
14. State, federal, and regional agencies or universities
15. Disadvantaged community representatives
16. Native American tribal representatives
17. Any other interested group appropriate to the region

Disadvantaged Communities

Kearns & West will seek to identify representatives of disadvantaged communities as determined by the California Department of Water Resources' criteria of less than 80% of the statewide median household income (MHI). Using 2010 U.S. Census data, Kearns & West will update a regional map to clearly indicate disadvantaged communities. Working with water agencies and county and local planning departments, as well as non-profit organizations that represent such communities, Kearns & West will identify a select number of organizations/individuals who are interested in water-related issues and willing to participate in plan development and/or project identification. These representatives will be invited to Bay Area IRWMP public workshops and will also be advised of other ways to collaborate with partner agencies and organizations to submit projects for consideration.

Goals and Objectives for Disadvantaged Communities outreach and engagement include:

1. **Plan Update Awareness and Participation**
    - Water agencies and non-government organizations that serve Disadvantaged Communities understand the purpose of the Bay Area IRWMP and the participation and decision-making processes supporting the Plan Update so that they can be involved.

2. **DAC Projects Included**
    - The Plan Update includes three to five projects that benefit DACs, particularly in the areas of water quality and water supply. These DAC projects have a water agency co-sponsor to provide technical and administrative assistance and support.

3. **Internal Coordination**
    - Internal coordination among the water agencies and other organizations involved in the Plan Update allows for the effective and efficient use of resources for engaging DACs and engagement activities are informed by a clear understanding of priorities for DAC engagement.

4. **Ongoing/Future DAC Engagement**
    - Outreach and engagement activities build awareness of integrated, regional water management opportunities and result in enhanced trust and long-lasting positive relationships between water agencies and DACs.

Native American Tribes

Kearns & West will consult with individuals and organizations familiar with Bay Area tribes and tribal communities to identify appropriate tribal representatives. Kearns & West will also consult with neighboring IRWMPs to determine Bay Area tribes participating on other regional IRWMPs. We will also consult with the California Native American Heritage Commissions to confirm tribes and their contacts as well as strategies for contact. We will then contact, inform and seek involvement from tribes in the development of the Bay Area IRWMP in order to serve the water needs and interests of these populations to the extent possible. The CC participants acknowledge that tribal members are dispersed into existing communities in the Bay Area rather than concentrated in location-specific communities. These initial efforts will provide a foundation for future tribal outreach.

IV. STAKEHOLDER OUTREACH AND ENGAGEMENT ACTIVITIES

Key components of the stakeholder outreach and engagement methods are outlined below. They are also included in a process timeline at the end of this document.

A. **Informational Materials**
   1. **Flyer** -- Kearns & West will develop a basic descriptive flyer to be posted to the project website and to be distributed by CC participants at meetings.
   2. **FAQs** -- Kearns & West will revise the Bay Area IRWMP Frequently Asked Questions (FAQs) section of the project website.
   3. **Website and CC Listserv** -- The project website, www.bairwmp.org, will provide information about the Bay Area IRWMP, including notices about public workshops and comment opportunities. The website will include links to presentations and handouts from public workshops. Visitors will also be able to sign up for the CC listserv in order to be notified of upcoming CC meetings. http://bairwmp.org/contact-info

B. **Consolidated Email List** -- Kearns & West will compile a master stakeholder email list to be used for disseminating information, noticing public workshops, and identifying opportunities for stakeholders to review documents. The email list will include the representatives from the organizations and agencies identified in Section III. Kearns & West will select an email contact management system for distributing notices to the list, which is expected to include approximately 2,000 stakeholders.

C. **Coordinating Committee Meetings**

   The Coordinating Committee (CC) is the regional water management organization developing the Bay Area IRWMP. The CC meets monthly, and these meetings will be used to inform stakeholders on the development of the Plan Update and solicit input on the Plan and potential water projects. Participation in the CC meetings is open to the public; anyone interested in water issues and planning is invited to attend and participate. Kearns & West will work with the CC and the consultant team to organize and facilitate these meetings to ensure that they are open, inclusive, efficient and effective. Summary notes of the meetings are available to the public via the project website.

D. **Subregional Meetings, Participation in Local Workshops, Email Communications**

   A significant and effective stakeholder outreach strategy since the 2006 Plan was the voluntary appointment of four subregional leads who coordinate and communicate with water interests in their areas. This has been an effective way to break down such a large region as the Bay Area into smaller regions where the subregional leads have knowledge and contacts. Each lead and/or co-lead initiates communication with subregional water interests and hosts and/or participates in subregional meetings. Additionally, each lead maintains a separate email list of local meetings and contact.

E. Public Workshops

Kearns & West will work with the CC and its subregional leads to design and implement up to four public workshops to inform stakeholders about the Bay Area IRWMP process and content, how they can provide input into the plan, and how to submit water projects to be included in the plan. Since the majority of contacts on the stakeholder email list, and those who visit the project website, will likely have prior understanding of water issues, the workshops will be aimed primarily at those audiences. Secondarily, the workshops will be aimed at those who may not have a professional role in water issues but who have specific water needs or interests. Representatives of disadvantaged communities will also be invited to public workshops and to subregional public meetings.

The public workshops will be two hours in length and will be located at central locations within the Bay Area with access to public transportation. They will include presentations and interactive discussions, and may be held in conjunction with the monthly meeting of the Coordinating Committee. Additionally, subregional leads may use the materials developed for the workshops to hold local, subregional meetings that are specific to their stakeholders.

Public Workshop #1 – Bay Area IRWMP Overview and Objectives

Overview: This workshop will provide an orientation to the Plan Update process.
Date: July 23, 2012
Objectives: To help attendees understand:

- IRWM Plan Update goals, objectives, process, requirements and how they can participate
- General criteria and requirements for projects to be included in the 2013 Bay Area IRWMP as well as the process for submitting projects on the website in order to meet the September 1, 2012 deadline.
- Criteria for prioritization of projects for the Plan

Public Workshop #2 – Topic-specific Elements of the Bay Area IRWMP (Revised 10/12)

Overview: This workshop will provide an overview of the 380+ projects submitted by September 7, 2012 and will discuss measuring progress and financing IRWM efforts and projects
Date: January 22, 2013 (dependent on CC meeting date)
Objectives: To help attendees understand and provide input on:

- o Projects to be included in Plan Update
- o Measuring progress toward achieving Bay Area IRWM goals
- o Finance

Public Workshop #3 – Project Identification and Orientation (To be developed and approved in Q4 2012)

Overview: Tentative; This workshop will provide an in-depth look at the impacts of and opportunities for inclusion of land use and climate change considerations in planning for the Bay Area's water future.

Date: Early 2013 depending on chapter development

Objectives: To help attendees understand and provide input on:

- The overlapping and related elements of land use and water use planning and how to integrate these elements in general and in the development of projects for inclusion in the Bay Area IRWMP
- The new California Department of Water Resources requirements for identifying and planning for the impacts of climate change on water management in general and in the development of projects for inclusion in the Bay Area IRWMP

Public Workshop #4 – Review of Draft Bay Area IRWMP (Optional and TBD)

The CC may sponsor a fourth workshop once the draft plan has been developed in order to review the elements, including the prioritized list of projects. This workshop would be held in the first quarter of 2013.

F. **Outreach and Publicity for Public Workshops**

Kearns & West will employ the following outreach and publicity strategies to ensure awareness about the workshops:

- Project website workshop notice/invitation, including specific invitations to representatives of disadvantaged communities
- E-mail notice/invitation to the project's master stakeholder email list (estimated at 2,200)
- Media release and distribution
    - Kearns & West will utilize an electronic media release service or a custom-designed Bay Area media distribution list to inform the public about the workshops. This media release would go to major Bay Area newspapers and community newspapers. (Note: The project budget does not allow for paid advertising in metropolitan newspapers.)
- Partnering with CC participants to distribute information via their channels
- Posting on the DWR eNews email blast, received by people with an interests in California water news

Appendix E-5

Summary of Subregional Outreach Activities

Bay Area IRWMP Subregional Stakeholder Outreach Activities

North, South, West, East -- As reported by Subregional Leads

January 2011 - September 2012

(Additional meetings and communications occurred in the subregions between plan adoption and the beginning of the Plan Update process.)

Subregion , lead	Dates 2011 -2012	Type/purpose of meeting/activity/communication	#/Types of attendees	Outcomes
NORTH: **Lead, Harry Seraydarian, North Bay Watershed Association**	11/21/11	First meeting with County leads on Plan Update		Initial organizing and awareness
	1/24/12	NBWA Watershed Council	42 stakeholders	Common understanding of Plan Update
	2/6/12	MCSTOPPP (Marin County Stormwater Pollution Prevention Program) Citizen's Advisory Committee meeting	5 committee members	Announcement of IRWMP program and Marin meeting
	2/9/12	Marin County meeting San Rafael	~30 stakeholders	Dialogue on "integrated" projects
	2/21/12	Napa County meeting Yountville	~30 stakeholders	Dialogue on "integrated" projects
	3/1/12	Sonoma County meeting Petaluma	~20stakeholders	Dialogue on "integrated" projects
	3/20/12	North Bay county leads conference call	5 county leads	Multiple County e-mails announcing template to stakeholders and updates as needed.
	4/11/12	Marin County Flood Control staff meeting update	~20 county staff	Update on the IRWMP process and timeline
	4/13/12	NBWA Conference **"Climate Change: How Can We Be Ready?"**	200 stakeholders, elected officials	Table and handouts on BAIRWMP update
	4/18/12	City of Sonoma meeting	10 stakeholders	Sonoma watershed project integration

	5/7/12	Sonoma County Water Agency Water Advisory Committee		BAIRWMP Update
	6/13/12	NBWA Watershed Council	15 stakeholders	BAIRWMP Plan update-focus on projects
	7/6/12	NBWA Board	30 elected officials and stakeholders	BAIRWMP update
	7/17/12	City of Petaluma meeting	5 stakeholders	Petaluma watershed project integration
	7/19/12	North Bay county leads conference call	5 county leads	County e-mails to stakeholders with plan update information
	8/6/12	Sonoma County Water Agency Water Advisory Committee		BAIRWMP Update
	8/2/12	Marin Municipal Water District, Marin County Parks, Marin County Flood Control project collaboration meeting	8 staff	Planning and coordination for several projects in the County.
SOUTH: Lead, Brian Mendenhall, SCVWD	8/20/12	IRWM Workshop	26 internal and external stakeholders	Provided information on IRWM, the project review process, and project solicitation
WEST: Lead, Mark Boucher, Contra Costa County Flood Control and Water Conservation District	7/21/2011	East Subregion Meeting	15 stakeholders	Coordination, Announcements, Collection of potential projects on maps
	8/18/2011	East Subregion Meeting	16	
	9/15/2011	East Subregion Meeting	16	
	11/3/2011	East Subregion Meeting	10	
	2/16/2012	East Subregion Conf Call	11	
	4/19/2012	East Subregion Conf Call	10	

	6/21/2012	East Subregion Conf Call	?	
	8/16/2012	East Subregion Conf Call	13	
	10/11/11	Emails to gather East Subregion Projects	Database coordinator for SF Bay Joint Venture	Received habitat projects in GIS format to plot on map.
	Prior to 7/21/11	Email Agenda and info	150+	Coordination, Announcements, Collection of potential projects on maps
	Prior to 8/18/11	Email Agenda and info	150+	
	Prior to 9/15/11	Email Agenda and info	150+	
	Prior to 11/3/11	Email Agenda and info	150+	
	Prior to 2/16/12	Email Agenda and info	160+	
	Prior to 4/19/12	Email Agenda and info	160+	
	Prior to 6/21/12	Email Agenda and info	160+	
	Prior to 8/16/12	Email Agenda and info	160+	
	11/17/12	2011 Contra Costa County Creek and Watershed Symposium	200-300	Manned a table with fliers and map of Subregion asking people to pinpoint their project on the 3'x4' map.

	7/2011-6/2012	Webpages: http://bairwmp.org/subregions/east/home	-	Setup and maintained information on East Subregion web pages to keep information about meetings and deadlines visible to the public and subregion.
	7/2011-8/2012	Emails	several dozen	coordinate web accounts, projects, answer questions
WEST: Co-lead, Kevin Murray, San Francisquito Creek JPA	8/9/11 10/5/11 11/14/12	Meetings in San Mateo County to provide update on Bay Area IRWMP	varied	
Kellyx Nelson, SMC RCD	7/26/2012-9/4/2012	Three emails sent to RCD distribution list to notify potential Coastside San Mateo County project proponents to propose projects for BA IRWMP and offering assistance to propose projects	About 100 recipients	
Kellyx Nelson	July-September 2012	Regular communication with the office of Supervisor Don Horsley about IRWMP		Two projects for coastal San Mateo County submitted for consideration

Kellyx Nelson

From:	Joe Issel
Sent:	Tuesday, July 24, 2012 12:46 PM
To:	Kellyx Nelson; Joe Issel
Subject:	Get your project listed in the IRWMP!
Attachments:	Bay Area IRWMP Project Template Final 040212.xlsx

The San Mateo County Resource Conservation District (RCD) has been contracted by the County of San Mateo to help ensure inclusion of San Mateo County projects in the **Bay Area Integrated Regional Water Management Plan** (IRWMP). The benefits of listing your project include eligibility for bond funds that are administered through IRWMP.

There are two deadlines for submitting project information to the **IRWMP**:
August 1st is a soft deadline – this would allow time for them to identify areas of potential synergies between projects, which will help projects score higher for most funding sources. **The September 1st is the hard deadline** to be considered for project inclusion this year.

Attached to this email is the required form for submission of a project. Please note the form does not need to be filled out completely to be considered for inclusion. Visit http://bairwmp.org/projects/submitting-a-project-to-the-bay-area-irwmp for more information about submitting projects to the IRWMP.
If you have any questions about this effort or would like RCD assistance to help you think through or list a project, please contact the RCD at my email address or by calling **(650) 712-7765 x 106** for **Joe** Issel. If you submit a project on your own, please let us know so that we can track it and help advocate for it.
Thank you to Supervisor Horsley for supporting this effort.

-Joe

Joseph Issel
Conservation Assistant
San Mateo County Resource Conservation District
625 Miramontes Street Suite 103
Half Moon Bay, CA 94019
phone: 650.712.7765 x 106
fax: 650.726.0494
www.sanmateorcd.org

Appendix E-6

General Outreach Materials

Time to update the Bay Area Integrated Regional Water Management Plan!

The Bay Area Integrated Regional Water Management Plan (IRWMP) is a multi-stakeholder, nine-county roadmap to coordinate and improve water supply reliability, protect water quality, manage flood protection, maintain public health standards, protect habitat and watershed resources, and enhance the overall health of San Francisco Bay.

The Bay Area IRWMP was developed in 2006 by a coalition of water and wastewater agencies, flood protection agencies, cities, non-governmental organizations, watershed groups, and regional planning associations. Acceptance of the 2006 Plan by the California Department of Water Resources has made approximately **$107 million** in Propositions 50, 84 and 1E state grant money available to implement Bay Area projects to improve the health of our water and flood protection systems.

It's time to update the plan to guide future resource planning for:

- Water supply and water quality
- Wastewater and recycled water
- Flood protection and stormwater management
- Watershed management, habitat protection and restoration

New to the updated plan is a section on the impacts of climate change on water resources planning. This will be of particular interest to those interested in water and land resources in the low-elevation areas surrounding the San Francisco Bay.

Additionally, the 2013 IRWMP will emphasize the integration of water management strategies across the Bay Area achieved by collaboration among agencies and jurisdictions. The update of the IRWMP is being guided by a Coordinating Committee composed of the Bay Area's water, wastewater, flood protection and ecosystem and restoration agencies, as well as resources and regulatory agencies and non-governmental organizations.

Grant-funded flood protection project, Lower Silver Creek, Santa Clara Co.

Why you should care about the 2013 IRWMP Update

Water resources cross jurisdictional boundaries. A systems approach is needed to manage water effectively, and the IRWMP guides that approach. The development and implementation of an effective, multi-interest IRWMP requires the attention of all jurisdictions and interest groups to ensure that key challenges are identified and effective solutions are funded.

In addition to your input into the Plan Update itself, that means that if your organization can identify a water-related need, you may be able to get a project funded, in part, by state grants. Projects selected for inclusion in the 2013 Plan Update may be eligible for future funding.

Qualified organizations and collaborations may include Bay Area water supply, water quality, wastewater, stormwater, flood management, watershed and habitat protection and restoration agencies, as well as local governments, environmental groups, business groups and other interested parties.

How to Get Involved

The Bay Area IRWMP Update process will begin in spring 2012 and continue through 2013. You are invited to participate in a number of ways. By accessing the project website, www.bairwmp.org, you will be able to:

- Read the most current Plan Update information and schedule. We'll be adding to it regularly.
- Sign up to receive email updates
- See announcements about IRWMP-specific public workshops around the Bay Area
- Track the work of the Coordinating Committee
- See the date and location of the monthly Coordinating Committee meetings as well as sub-regional meetings, all open to the public

www.bairwmp.org info@bairwmp.org

2013 Bay Area Integrated

Regional Water Management Plan

Frequently Asked Questions

Introduction to the 2013 Bay Area IRWMP

1. What is the Bay Area Integrated Regional Water Management Plan (Bay Area IRWMP)?

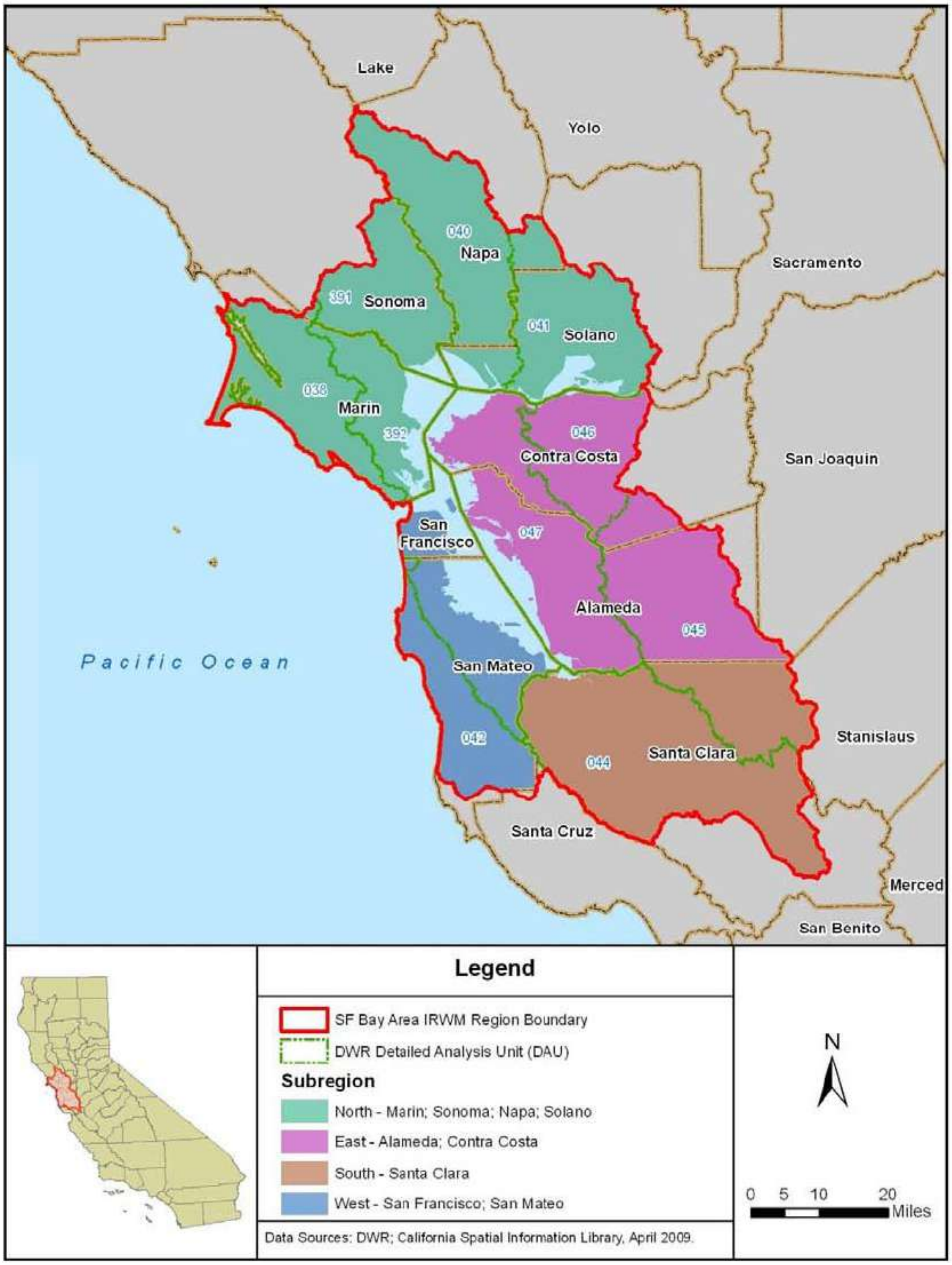
The San Francisco Bay Area Integrated Regional Water Management Plan (Bay Area IRWMP) is a planning process and document that identifies Bay Area water challenges and opportunities and how water resources management agencies and communities can work together to plan for and manage the whole lifecycle of this essential resource for the benefit of the region's seven million residents, its ecosystem and its wildlife. The region qualifies and can compete for specific state funding when the state approves its Integrated Regional Water Management Plan. The region also becomes part of a statewide network of integrated regional water management planning regions.

2. What geographic region does the Bay Area IRWMP include?

The IRWM Regions and Funding Areas are based on hydrological watersheds rather than city/county boundaries. In the Bay Area, the Funding Area described in Proposition 84 and the San Francisco Bay Area IRWM Region is coterminous, including all or part of nine counties and 110 cities. The counties include San Francisco, and parts of San Mateo, Santa Clara, Alameda, Contra Costa, Solano, Napa, Sonoma, and Marin. The region is further divided into four subregions to address local issues and projects. (See Question 21 for subregion contact information.)

The specific geographic extent of the Bay Area IRWMP is based on the boundary of the San Francisco Bay Regional Water Quality Control Board Region 2. Hydrologically, the Region 2 boundary generally represents the watershed interfluve for Bay-draining surface flows and runoff. Although some coastal Marin, San Francisco, and San Mateo County lands are included within the Region 2 boundary, a majority of lands drain to the Bay. For the purposes of developing a plan to manage integrated water resources, using a physically based watershed boundary that drains (a majority of) lands to a common receiving water body (the Bay) is advantageous. Additionally, Region 2 is a historically defined jurisdictional boundary. Using a well-understood and existing jurisdictional boundary reduces confusion for participating agencies who are already familiar with its geography.

Boundaries of the Bay Area Integrated Regional Water Management Plan



3. What is the status of the 2013 Bay Area IRWMP Update?

The Bay Area IRWMP was adopted in 2006. The plan is being updated in 2012 and 2013 to meet revised IRWM Plan Standards set forth in California's Proposition 84 Integrated Regional Water Management Program Guidelines published by the Department of Water Resources in August of 2010. The Bay Area IRWMP Coordinating Committee (CC) is using a Proposition 84 IRWM Planning Grant to develop the updated Bay Area IRWMP. The CC has hired a team of technical, planning, and stakeholder engagement consultants (Kennedy/Jenks, ESA and Kearns & West) to develop the updated Bay Area IRWMP with input from partner agencies, associations, non-profit organizations and the public. First-time participation by new agencies, organizations and individuals is encouraged.

Public workshops will be held in the summer of 2012 to explain the 2013 Plan and seek comment and feedback. The project team will update the website to provide information as well as announcements of workshops and public participation opportunities. (www.bairwmp.org). See also Question 20 about how you can get involved..

4. Who is involved in the Bay Area IRWMP?

San Francisco Bay Area water, wastewater, flood protection and stormwater management agencies; cities and counties; watershed management interests, planning agencies and organizations, and non-governmental organizations are involved in the Bay Area IRWMP. They voluntarily participate in the Coordinating Committee (CC), which is the Regional Water Management Group for the Bay Area IRWMP. Additional agencies and organizations are encouraged to learn about the process, provide feedback on the 2013 Plan's chapters as they are released in 2012 and 2013, and to identify and submit projects to be included in the Bay Area IRWMP so that the projects can compete for state IRWM grants. Agencies and organizations dealing with land use and climate change are particularly encouraged to participate as water resource management is increasingly related to these topics.

5. What is integrated water planning?

Integrated Regional Water Management (IRWM) is a collaborative effort to manage all aspects of water resources in a region. IRWM crosses jurisdictional, watershed, and political boundaries and involves multiple agencies, communities, groups and individuals. It attempts to address the issues and differing perspectives of all the entities involved through mutually beneficial solutions. For instance, water supply, water quality, and habitat projects might be combined with a flood control project in a way that benefits a much larger area than the original jurisdiction. The result is a multi-objective approach that multiplies the benefits of any individual agency's or organization's single project.

6. What water resource management challenges will the Bay Area IRWMP address?

The Bay Area IRWMP will inform future water resource management planning, including the relationship between water and land use planning, by creating a roadmap that will help enhance water supply reliability, protect water quality, manage flood protection, maintain public health standards, improve habitat conditions and enhance the overall health of San Francisco Bay. New to the 2013 Plan will be a chapter that identifies how Bay Area water resources are vulnerable to the impacts of climate change. Awareness of potential climate change impacts can help communities plan for and mitigate expected water changes and threats.

7. Why is the Bay Area IRWMP important?

The Bay Area IRWMP is the regional plan for managing and leveraging our water resource systems, an effort no individual water or flood agency could do on its own. Collaboration strengthens regional clout, reduces resource management conflict, increases benefits across the region, and may reduce costs for individual agencies. On the practical side, water-related agencies that participate in an IRWMP and submit projects qualify to compete for state grant money to fund projects that will help their communities. Non-profit organizations, neighborhood groups, interest groups and Native American tribes can also benefit by collaborating with the public agencies to propose projects to the state that help solve their water resources challenges.

8. What is the impetus behind regional and integrated water management planning?

The California Department of Water Resources encourages and –provides funds to communities to collaborate on managing their water resources. In 2002, and again in 2006, California voters recognized the importance of forward-thinking water planning when they approved Propositions 50, 84 and 1E. People and natural resources in the almost 50 California IRWM regions benefit from this bond money designated for Integrated Regional Water Management planning and implementation.

9. What topics, services, and functions does an IRWMP address?

IRWMPs include a physical and demographic description of the region and its populations, regional water resources management objectives and priorities, water resources management strategies, implementation impacts and benefits, impacts of climate change (an addition for the 2013 Plan), data management, financing, relationship to local planning, and coordination with state and federal agencies whose jurisdictions and service topics overlap with the IRWMP. It also includes projects that agencies and collaborations of agencies and non-profit organizations and communities have submitted for consideration. The plan serves as a guide to enhance water supply reliability, protect water quality, manage flood protection, maintain public health standards, improve habitat conditions, and enhance the overall health of San Francisco Bay.

10. Why will climate change be included in the 2013 Plan Update?

This new chapter is intended to make water resources management and land use planners, as well as policy makers, throughout the Bay Area aware of climate change impacts on water resources so they can evaluate, prioritize and incorporate policies and strategies that anticipate, plan for, and mitigate climate change. Preliminary evidence suggests that sea level rise may have its greatest impact in low-lying, flood-prone areas that ring the Bay. The 2013 Plan will identify the most vulnerable areas. It will also suggest mitigation measures to address climate change impacts.

11. What types of projects are eligible for state grant funding?

IRWM Implementation Grant funding provided under Propositions 50, 84 and 1E seeks to fund water resources projects with a multiplier effect -- multiple strategies for improving water systems that result in multiple benefits to multiple communities. Projects that might qualify for funding include, among others, improved water supply reliability, long-term attainment and maintenance of water quality standards, eliminated or reduced pollution in impaired water and sensitive habitat areas, planning and implementation of multipurpose flood control programs, and drinking water and water quality projects that serve disadvantaged communities. The IRWM funds are also -available identify and address water needs specific to Native American communities.

Organizational Structure, Governance and Funding

12. Who is updating the Bay Area IRWMP?

The Bay Area IRWMP Coordinating Committee (CC) is the Regional Water Management Group for the Bay Area IRWMP and its 2013 update. Participation in the CC and its monthly meetings is open to anyone and the group operates on a consensus basis.

13. Who is administering the Planning and Implementation Grants?

The Marin Municipal Water District holds the contract with the California Department of Water Resources to administer the Proposition 84 Planning Grant which is funding the 2013 Plan. Bay Area Clean Water Agencies (BACWA) is administering the two Implementation Grants received to date by the Bay Area IRWMP -- one under Proposition 50 and one under Proposition 84. Future planning and implementation grants may be administered by other participating Bay Area agencies.

14. Who adopts the Bay Area IRWMP?

In 2006, the Bay Area IRWMP was adopted by participating Bay Area agencies and organizations. The 2013 Bay Area IRWMP will be adopted by participating Bay Area agencies and organizations, including any additional agencies and organizations interested in participating. The projects that are funded by competitive state grants are implemented by the individual project proponents.

15. Where does California IRWM funding come from?

IRWM funding comes from California taxpayers as a result of approval of three important ballot propositions. Key IRWM grant funding milestones include:

2002 - Senate Bill 1672 created the Integrated Regional Water Management Act to encourage local agencies to work cooperatively to manage local and imported water supplies to improve the quality, quantity, and reliability.

November 2002 - California voters passed Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002, which provides $500,000,000 (CWC §79560-79565) to fund competitive grants for projects consistent with an adopted IRWM plan.

November 2006 - California voters passed Proposition 84, the Safe Drinking Water, Water Quality, and Supply, Flood Control, River and Coastal Protection Bond Act, which provides $1,000,000,000 (PRC §75001-75130) for IRWM Planning and Implementation.

November 2006 - California voters passed Proposition 1E, the Disaster Preparedness and Flood Prevention Bond Act, which provides $300,000,000 (PRC §5096.800-5096.967) for IRWM Stormwater Flood Management.

16. What happens to projects not initially funded under Prop 50 or Prop 84?

It will not be possible to fund all projects through the funding sources identified above. Funding for projects identified in the IRWMP may come from a variety of other sources as those funding sources are identified over time. Inclusion of a project in the IRWMP does not guarantee that funding is (or will be), available.

17. How will projects be prioritized in the 2013 Bay Area IRWMP?

The 2013 Plan will include a list of projects, some of which are carryovers from the 2006 Plan and some of which are being identified during 2012. The consultant team, with input from the Coordinating Committee, is drafting criteria for prioritization. Public workshops in the summer and fall of 2012 will present proposed criteria for prioritization and will seek public input on the criteria. The workshops, as well as information on the website, will also provide details about project applications. Based on the proposed criteria, the consulting team will develop a draft, prioritized list of projects for discussion at the September 2012 Coordinating Committee meeting. (Open to the public, check website for details.) Subsequent public workshops will present the prioritized list for public discussion. A final list of prioritized projects will be completed in December 2012 and will be included in the 2013 Plan.

18. How can the Bay Area IRWMP be used for other grant funding sources?

Depending on the grant requirements of other funding sources, particularly those seeking integrated approaches, it is conceivable that there may be other related funding opportunities. The Bay Area IRWMP provides a foundation for pursuing such opportunities.

How to Get Involved and to Submit Projects for the Plan

19. Who can and should be involved in regional water resources management and the Bay Area IRWMP process?

Anyone interested in water resources management and decisions is encouraged to learn and to share his or her knowledge, ideas and questions. Participants include people representing water providers, flood agencies, utility districts, cities and counties, regional governments and coordinating bodies, non-profit and community organizations, educational institutions, and individuals.

20. How can I and my organization participate in the development of the 2013 Bay Area IRWMP?

There are a number of avenues for participation in the 2013 Bay Area IRWMP:

Subregion Activities: The Bay Area is divided into four subregions to allow more specific discussions of topics pertinent to the area. Each subregion has a coordinator(s) and holds meetings and conference calls that are open to all. For information about issues and activities in any of the subregions, and/or to be added to a subregion-specific email listserv, please contact a subregion coordinator listed in Question 22 *Who can I contact*?

Coordinating Committee: Participation in the broad-based, regional water resources management group known as the Coordinating Committee (CC) of the San Francisco Bay Area Integrated Regional

Water Management Plan is open to all, whether or not one has an official capacity related to water resources management. Those interested are invited to participate in discussions at monthly meetings, receive email updates, submit comments on chapters as they are released for public review, attend any of the public workshops to be held in 2012 and 2013, and may seek to collaborate with agencies and organizations to submit water resources project proposals. (Check website www.bairwmp.org to sign up for the master email listserv to receive updates, to view meeting details, and submit project ideas.) Please join us at our monthly meetings on the last Monday of the month. See website for details.

Working within your organization: Agencies and organizations can consider sponsoring forums to discuss the Bay Area IRWMP and can also distribute information about the Bay Area IRWMP to their constituencies or membership to encourage them to provide information and ideas that might be valuable to the development of the plan. Additionally, individuals in organizations can help by working to build support for the concept of a regional approach to water resource management as well as for adoption of the Bay Area IRWMP in 2013. See the website for a one-page flyer that can be downloaded.

Website: Please visit the Bay Area IRWMP website www.bairwmp.org to get information about plan content and 2013 IRWMP update process.

Regional email master list: Periodic updates and notices will be issued to the master email listserv for the entire Bay Area. To sign up to receive information via email, please visit the website or go directly to http://lists.bairwmp.org/mailman/listinfo/updates.

Subregion email lists: Please contact the subregion leads listed under Question 21 *Who can I contact?* to be notified of local information and meetings.

Bay Area IRWMP Public Workshops: Public workshops are scheduled at key milestones in the summer and fall of 2012 to share information on the elements of the Plan update and to solicit feedback on the draft chapters and important topics, such as project identification and prioritization. The meetings are intended to involve a broad audience, including organizations and individuals who have not been involved in the Bay Area IRWMP previously. Workshop details and information are posted on the website.

21. How can my agency or organization have its water project(s) included in the Bay Area IRWMP?

In order to be considered for state IRWM grant funding, a proposed water resources project must be included in the Bay Area IRWMP. If your agency or organization is aware of a water-related problem that can be addressed by a resources project that solves a water-related problem and may meet state grant funding criteria, please complete a project template, or submit project information via the web-based project submittal tool available on the project website, www.bairwmp.org on the left panel. The information does not have to constitute a full proposal during the initial stages.

22. Who can I contact if I want to discuss a water project idea or get added to a subregional email list?

If you want to be added to a subregional email list for updates and/or If you have a project idea, please contact any of the leads in the Bay Area's four subregions.

- **North:** portions of Sonoma, Napa, Solano Counties and the majority of Marin County -- Harry Seraydarian, North Bay Watershed Association,(415) 389-8237717, harryser@comcast.net

- **West:** San Francisco, San Mateo Counties – Cheryl Munoz, San Francisco Public Utilities Commission, cmunoz@sfwater.org; Molly Petrick, San Francisco Public Utilities Commission, 415-934-5767, MPetrick@sfwater.org; Kellyx Nelson, San Mateo County Resource Conservation District, 650.712.7765, kellyx@sanmateorcd.org; Kevin Murray, San Francisquito Creek Joint Powers Authority, 650-324-1972, kmurray@sfcjpa.org

- **South:** Santa Clara County -- Brian Mendenhall, Santa Clara Valley Water District, 408-265-2607, ext 3093, BMendenhall@valleywater.org; Tracy Hemmeter, 408-265-2600, themmeter@valleywater.org

- **East:** Alameda, Contra Costa Counties -- Mark Boucher, Contra Costa County Flood Control and Water Conservation District, 925-313-2274, mbouch@pw.cccounty.us; Carol Mahoney, Zone 7 Water Agency, (925) 454-5064, cmahoney@zone7water.com

Additionally, you can email a general question to Projects@bairwmp.org.

23. When are the project proposals due and how should they be submitted?

Project proposal for inclusion in the 2013 Bay Area IRWMP are due September 1, 21012. This will allow the consultant team to review them to determine if modifications, such as collaborations and/or better integration, would make them more competitive for state grant funds. It will also allow the consultant team to apply ranking criteria to the projects that are submitted so that a draft prioritized list of projects can approved by the Coordinating Committee. The final, prioritized list will be part of the Bay Area IRWMP submittal to the Calif0ornia Department of Water resources in 2013.

Projects should be submitted via the project website, www.bairwmp.org , where a web-based template is available.

24. What is the objective of the Bay Area IRWMP public involvement process?

Ensuring an open, transparent process of plan development and project prioritization is essential to developing a Bay Area IRWMP that is sustainable and implementable. Ongoing public participation during 2013 Plan process, as well as project identification and project prioritization, will help ensure all the key issues identified in the Plan are addressed and will build the foundation for broad-based support of the Bay Area IRWMP.

25. How will the Bay Area IRWMP address disadvantaged communities and Native American tribes?

The Coordinating Committee and the public and stakeholder engagement consultants are seeking to determine what water resources-related problems face disadvantaged communities in particular. California considers a “disadvantaged community” one whose median household incomes less than 80% of the statewide median household income (MHI is about $48,500 per year per household). Applying 2010 U.S. Census data to graphical information system (GIS) maps, the team is mapping Bay Area disadvantaged communities. Working with organizations that represent people in vulnerable, disadvantaged communities, the team will seek to identify significant current and potential water resources problems. The California Department of Water Resources has indicated that in order to qualify for a state IRWM grant, a project serving a disadvantaged community must address a critical water supply or water quality need.

The CC and the consultants will seek to involve disadvantaged communities in partnering with water resources management agencies to propose water resources projects that will qualify for IRWM grant funding. If you are aware of water-related problems facing low-income, disadvantaged communities or populations in the Bay Area, please contact stakeholder engagement consultant, Ben Gettleman, Kearns & West, bgettleman@kearnswest.com.

The stakeholder engagement team has identified Bay Area Native American tribal representatives and will seek to identify water resources needs and concerns as well as water resources projects that might address them. If you are aware of water-related problems facing tribal communities in the Bay Area, please stakeholder engagement consultant, Ben Gettleman, Kearns & West, bgettleman@kearnswest.com.

Appendix E-7

Materials from Public Workshops

Bay Area IRWMP

Public Workshop:

Regional Water Planning and Projects

Monday, July 23, 2012

4:00 – 6:00 p.m.

Association of Bay Area Governments Auditorium, 101 Eighth Street Oakland, CA (Lake Merritt BART Station)

2013 BAY AREA INTEGRATED REGIONAL WATER MANAGEMENT PLAN

This workshop is for people in public agencies, policy and planning organizations, environmental and health organizations, community groups, Tribal interests, and individuals interested in:

- Water Supply/Water Quality
- Flood Protection/Stormwater
- Wastewater/Recycled Water
- Watershed/Habitat Protection

Your projects can qualify for funding.

This is first of a series of public workshops to get input into the 2013 Plan and to identify Bay Area water projects that can be included in the Plan to qualify for competitive state grant funding. Brief project idea proposals are due September 1, 2012 and can be submitted via the project website: *www.bairwmp.org*

Contact:
Pam Jones
415-430-1208
pjones@kearnswest.com

Bay Area Integrated Regional Water Management Plan

For Immediate Release

Public Workshop -- Regional Water/Flood/Watershed Planning

The first public workshop for development of the Bay Area Integrated Regional Water Management Plan will be held on Monday, July 23, 2012 from 4:00 – 6:00 p.m. at the Association of Bay Area Governments Auditorium, 101 Eighth Street, Oakland, CA (Lake Merritt BART Station).

The purpose of the workshop is to inform water professionals, land-use planners, environmental planners, non-profit organizations and community members about the 2013 update to the Bay Area IRWMP, how it affects communities, how public agencies and non-profit organizations can have input into the plan, and how to submit a water project to be included in the Plan, thereby qualifying agencies and non-profit organizations to compete for state water bond grants. Organizations representing disadvantaged, low-income communities are encouraged to submit project ideas.

The Bay Area IRWMP is a multi-stakeholder, nine-county roadmap to coordinate and improve water supply reliability, protect water quality, manage flood protection, maintain public health standards, protect habitat and watershed resources, and enhance the overall health of San Francisco Bay.

A second workshop will be held August 27, 2012, 4 – 6 p.m., location to be determined.

For more information, visit www.bairwmp.org.

###

Bay Area Integrated Regional Water Management Plan
Public Workshop #1
Monday, July 23, 2012
4:00 – 6:00 p.m.
Association of Bay Area Governments Auditorium
101 Eighth St. Oakland CA (Lake Merritt BART Station)

AGENDA

3:45 – 4:00 p.m. **Registration**

4:00 – 4:10 p.m. **Welcome and Introductions**
Paul Helliker, Marin Municipal Water District
Chair, Bay Area IRWMP Coordinating Committee

4:10 – 4:30 p.m. **2013 Bay Area IRWMP Overview**
Carol Mahoney, Zone 7 Water Agency, Alameda County

4:30 – 5:00 p.m. **Plan Objectives: How They Guide Successful Project Proposals (with discussion and input)**
Harry Seraydarian, North Bay Watershed Association

5:00 – 5:30 p.m. **Project Submittals: How to Submit and How it Will be Evaluated (with Q&A)**
Carl Morrison, Morrison & Associates

5:30 – 5:35 p.m. **Wrap-up and Next Steps**
Ann Draper, Santa Clara Valley Water District
Vice Chair, Bay Area IRWMP Coordinating Committee

5:35 – 6:00 p.m. **Subregional and Regional Breakout Groups: Informal Discussion/Q&A with Subregional and Regional Leads**

- **North Subregion: Marin, Sonoma, Napa, Solano**
  Harry Seraydarian, North Bay Watershed Association (harryser@comcast.net)
- **West Subregion: San Francisco, San Mateo**
  Cheryl Munoz, SFPUC (cmunoz@sfwater.org)
- **South Subregion: Santa Clara**
  Brian Mendenhall, Santa Clara Valley Water District (BMendenhall@valleywater.org)
- **East Subregion: Alameda, Contra Costa**
  Carol Mahoney, Zone 7 Water District (cmahoney@zone7water.com)
- **Regional Projects**
  Caitlyn Sweeney, San Francisco Estuary Partnership (CSweeney@waterboards.ca.gov)

If you have thoughts on BAIRWMP "Objectives,"
please fill out a Comment Card today or send an email to: BAIRWMP@kearnswest.com
Also, visit **www.bairwmp.org**

Área de la Bahía Integrada Regional del Agua el Plan de Gestión
Taller Público # 1
Lunes, 23 de julio 2012
4:00-6:00 p.m.
Asociación de Área de la Bahía gobiernos Auditorio
101 Octava St. Oakland, en California (la estación de BART de Lake Merritt)

ORDEN DEL DÍA

3:45-4:00 pm Registro

4:00-4:10 pm Bienvenidos y presentaciones
Paul Helliker, Marín Distrito de Agua Municipal
Presidencia, Área de la Bahía IRWMP Comité de Coordinación

4:10-4:30 pm 2013 Área de la Bahía IRWMP Información general
Carol Mahoney, Zona 7 Agencia del Agua, del Condado de Alameda

4:30 - 5:00 pm Objetivos del Plan: La forma en que las propuestas exitosas Guía de proyectos (con la discusión y la entrada)
Harry Seraydarian, North Bay Asociación de Cuencas

5:00 - 5:30 pm Presentaciones del proyecto: ¿Cómo enviar y cómo será evaluado (con Q & A)
Carl Morrison, Morrison & Associates

5:30-17:35 Resumen y próximos pasos
Ann Draper Valle de Santa Clara del Distrito de Agua
Vicepresidente, Área de la Bahía IRWMP Comité de Coordinación

5:35 - 6:00 pm subregionales y regionales Trabajo en grupos informales de discusión: / Q & A con cables subregionales y regionales:

• **Norte Subregión**: Marin, Sonoma, Napa, Solano
Harry Seraydarian, North Bay Watershed Association (harryser@comcast.net)

• **Subregión Occidental**: San Francisco, San Mateo
Cheryl Muñoz, SFPUC (cmunoz@sfwater.org)

• **Subregión Sur:** Santa Clara
Brian Mendenhall, Valle de Santa Clara del Distrito de Agua (BMendenhall@valleywater.org)

• **Este Subregión:** Alameda, Contra Costa
Carol Mahoney, la zona 7 del Distrito de Agua (cmahoney@zone7water.com)

• **Proyectos Regionales**
Caitlin Sweeney, San Francisco, Asociación Estuario (CSweeney@waterboards.ca.gov)

Si usted tiene pensamientos sobre BAIRWMP "Objetivos"
por favor llene una tarjeta de comentarios de hoy, o envíe un correo electrónico a:
BAIRWMP@kearnswest.com; También, visite www.bairwmp.org

23 de julio 2012 Taller Público para el 2013 Área del Plan Integrado de la Bahía Regional de Administración del Agua

Estimado Agua Área de la Bahía y de la Comunidad Uso de la Tierra,

El Área de la Bahía de Agua Integrada Plan Regional de Gestión (Área de la Bahía IRWMP) es una de múltiples partes interesadas, los nueve condados del plan de trabajo para coordinar y mejorar la confiabilidad del suministro de agua, proteger la calidad del agua, gestión de la protección contra inundaciones, mantener los estándares de salud pública, proteger el hábitat y los recursos de las cuencas hidrográficas, y mejorar la salud general de la Bahía de San Francisco.

El primer taller público sobre el desarrollo de la actualización de 2013 del Área de la Bahía IRMWP se celebrará el Lunes, 23 de julio 2012 de 4:00 - 6:00 pm en la Asociación de Área de la Bahía Gobiernos Auditorio, 101 8th St. Oakland, CA 94,607 (estación de BART de Lake Merritt).

Entender los objetivos del Plan aumentará las probabilidades de éxito de su proyecto ya que no todos los proyectos presentados se financiarán. Las propuestas preliminares de proyectos se deben 01 de septiembre 2012 y pueden enviarse a través de la página web del proyecto www.bairwmp.org. El proyecto de temario de la reunión también se ha publicado, como son las preguntas más frecuentes.

Los oradores de las agencias de agua locales y regionales se explican los objetivos de la IRWMP Área de la Bahía para promover la planificación integrada de la gestión del agua en la ciudad, el condado ya nivel regional, ¿cómo las nuevas directrices estatales están modificando la planificación regional integrada de la gestión del agua, y cómo puede presentar proyectos que aborden los retos del agua en su comunidad que le permiten competir con los fondos estatales de subvención. Proyectos destinados a los desfavorecidos, en comunidades de bajos ingresos obtener una consideración especial.

El segundo taller se llevará a cabo Lunes, 27 de agosto 2012 y proporcionará una mayor profundidad vistazo a cómo los proyectos se dará prioridad en el Plan 2013.

Para obtener más información acerca de la IRWMP Área de la Bahía, por favor visite nuestro sitio web, www.bairwmp.org o enviar un correo electrónico a BAIRWMP@kearnswest.com. Pre-inscripción para el taller no es necesario.
Esperamos que usted o un representante de su agencia u organización el 23 de julio en Oakland.

Atentamente,
Paul Helliker
Marin Municipal Water District
Presidente, Comité de Coordinación
Área de la Bahía Integrada Regional del Agua el Plan de Gestión

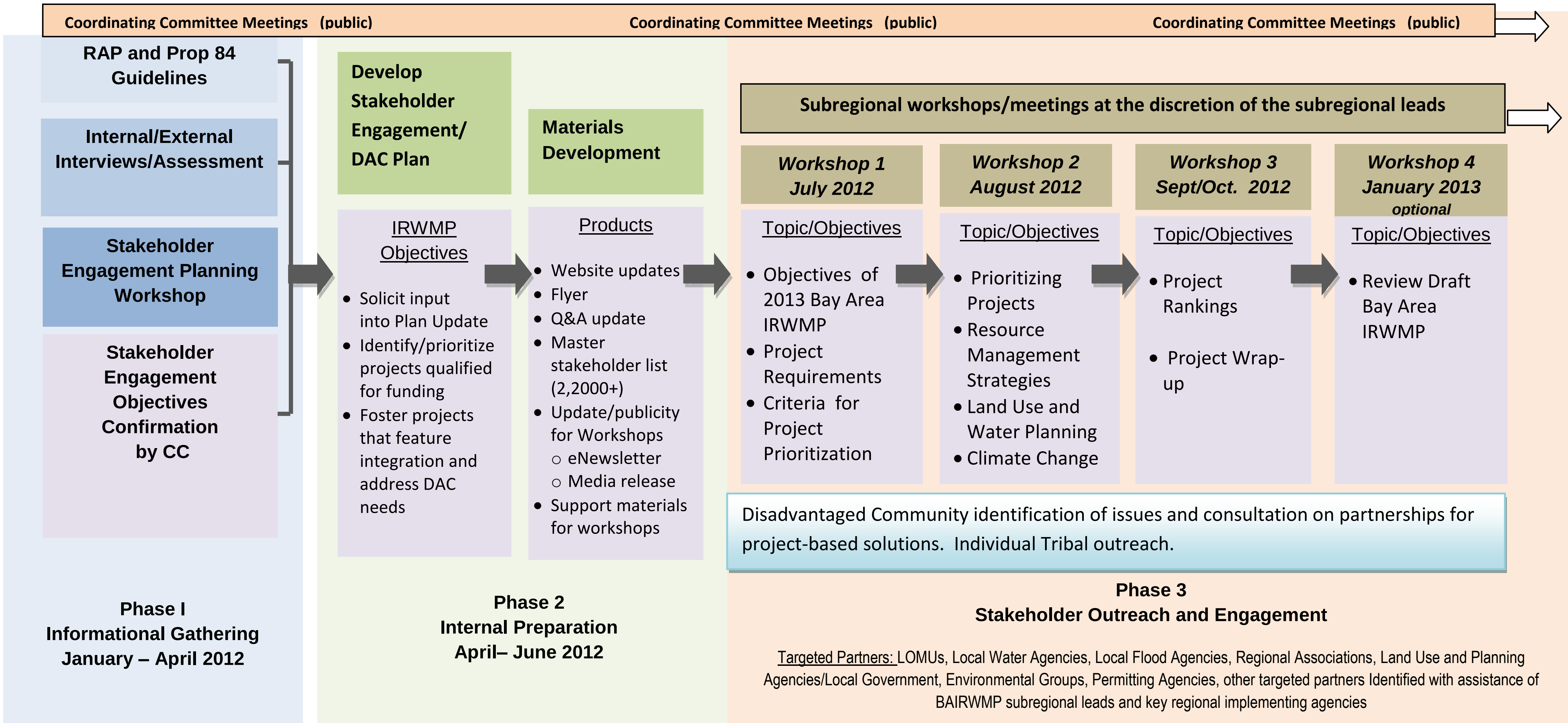
PD -- Participación en el Comité de Coordinación está abierta a cualquier persona interesada en los proyectos regionales de agua, programas y políticas. Por favor, únase a nosotros en nuestras reuniones mensuales. Para más información, visite nuestro sitio web, www.bairwmp.org.

	IRWMP Goals	Comments
1	**Promote environmental, economic and social sustainability**	
2	**Improve water supply reliability and quality**	
3	**Protect and improve watershed health and function and Bay water quality**	
4	**Improve Regional Flood Management**	
5	**Create, protect, enhance, and maintain environmental resources and habitats**	

	Objectives	Potential Measures	Comments/Suggestions
	Goal 1: Promote Environmental, Economic and Social Sustainability		
1.1	Increase water resources related recreational opportunities	Miles of trails, acres of parklands, access, amenities, visitor days	
1.2	Encourage implementation of integrated, multi-benefit projects	Collaboration between government and regulatory agencies, project proponents and stakeholders.	
1.3	Secure adequate support, funding and partnerships to effectively implement plan.	Process to successfully respond to funding opportunities; dollars of outside funding; long-term project viability	
1.4	Avoid disproportionate impacts to disadvantaged communities	Community support for local projects	
1.5	Protect cultural resources	Acres of culturally valuable area and/or resource acquired or preserved through conservation easements	
1.6	Promote community education, involvement and stewardship	Number of informational brochures, workshops, educational and technical assistance events that address water reliability, watershed health, flood risks, flood protection and other IRWM goals; educational curricula for K-12	
1.7	Reduce energy use and/or use renewable resources where appropriate	Megawatts reduction in energy use; megawatts of renewable power sources.	
1.8	Plan for and adapt to sea level rise	Keep important infrastructure out of hazard zone; consider range of sea level projections when evaluating proposed water management projects practice and promote integrated flood management ; AF water storage and conjunctive management of surface and groundwater resources; water resources management strategies that restore and enhance ecosystem services; avoid significant new development in areas that cannot be adequately protected from flooding or erosion	
1.9	Plan for and adapt to more frequent extreme climate events		
1.10	Support data gathering for climate change vulnerabilities	Number of monitoring stations	
1.11	Enhance monitoring network and information sharing to support proper management of watersheds		
1.12	Minimize health impacts associated with polluted water.	Compliance with all applicable water quality standards; number of customer complaints	
1.13	Work with local land, water, wastewater and stormwater agencies, project proponents and other stakeholders to develop policies, ordinances and programs that promote IRWM goals, and to determine areas of integration among projects	Number of local policies, ordinances, incentives and other programs that promote integrated planning and development of LID projects; number of integrated projects	
	Goal 2: Improve water supply reliability and quality		

	Objectives	Potential Measures	Comments/Suggestions
2.1	Provide adequate water supplies to meet demands.	Reliability of supplies of appropriate quality	
2.2	Implement water use efficiency to meet or exceed state and federal requirements.	Progress towards SBX7-7 goals, number of water conservation measures adopted	
2.3	Minimize vulnerability of infrastructure to catastrophes and security breaches.	Number of vulnerability assessments	
2.4	Expand water storage and conjunctive management of surface and groundwater	AF of water storage; number of conjunctive management projects developed	
2.5	Provide for groundwater recharge while protecting groundwater resources from overdraft.	AFY artificial groundwater recharge	
2.6	Increase opportunities for recycled water use.	AFY of potable water use replaced by non-potable supply; AFY recycled water production	
2.7	Provide clean, safe, reliable drinking water.	Compliance with drinking water standards; constituents of concern in drinking water at point of delivery	
2.8	Protection of groundwater resources from contamination.	Migration of contaminant plumes; recharge area protection	
Goal 3: Protect and improve watershed health and function and Bay water quality			
3.1	Protect, restore, and rehabilitate watershed processes.	Miles of natural streams restored and/or rehabilitated; acres of wetlands protected and/or restored; acres of conservation easements	
3.2	Control excessive erosion and manage sedimentation.	Established sediment TMDL requirements	
3.3	Minimize point-source and non-point-source pollution.	Nutrient and pesticide application (in Pounds?); implementation of delivery reduction practices; number LID projects that store and infiltrate stormwater runoff; AFY stormwater capture; compliance with TMDLs and NPDES.	
3.4	Improve floodplain connectivity.	Acres of private property purchased and preserved in 100-year floodplains	
3.5	Improve infiltration capacity	Miles of natural streams restored and/or rehabilitated; miles of streams de-channelized; LID projects implemented that include bioswales to increase perviousness; AFY stormwater capture	
3.6	Maintain health of watershed vegetation, land cover, natural stream buffers and floodplains, to improve filtration of point and nonpoint source pollutants.		
3.7	Control pollutants of concern	Compliance with existing and future TMDLs	
Goal 4: Improve Regional Flood Management			
4.1	Manage floodplains to reduce flood damages to homes, businesses, schools, and transportation.	Annual flood damages ($); frequency and extent of flooding; number of innovative flood management projects; annual flood flows	
4.2	Achieve effective floodplain management that incorporates land use planning and minimizes risks to health, safety and property by encouraging wise use and management of flood-prone areas	Policies and programs that encourage LID in new and rehabilitated development	
4.3	Identify and promote integrated flood management projects to protect vulnerable areas	Number of integrated flood management projects	
Goal 5: Create, protect, enhance, and maintain environmental resources and habitats			
5.1	Protect, restore, and rehabilitate habitat for species protection	Acres of critical habitat protected and/or acquired; number of at-risk species; miles of wildlife corridors; acres of riparian habitat restored and/or protected	
5.2	Enhance wildlife populations and biodiversity (species richness).	Number of species; population numbers	
5.3	Protect and recover fisheries (natural habitat and harvesting).	Number of listed species; access to spawning habitat for imperiled fish	
5.4	Reduce geographic extent and spread of pests and invasive species.	Invasive species cover; invasive species numbers	

Stakeholder-based Approach to Developing the 2013 Bay Area IRWMP



Bay Area IRWMP
Project Submittal Guidance

The Bay Area Integrated Regional Water Management Plan (IRWMP) is currently being updated. As part of this process, the Plan will include proposed projects for water resources management in the Bay Area. These proposed projects can either be new projects, or can be updated versions of projects already in the Plan. In either case, information about the projects must be included in the online database housed at the Bay Area IRWMP website.

A complete new or updated project description is required to be eligible for inclusion in the 2013 Bay Area Integrated Regional Water Management Plan and to be eligible for future grant funding.

New Projects

If you are proposing a new project, please visit the Bay Area IRWMP website at www.bairwmp.org and click on the link in the left column entitled "Submitting a Project" and follow the instructions. You may click the blue "Submit a project" button at the bottom of that page.

Updating Existing Projects

If your project has already been submitted and included in the plan, you will need to confirm that you want to continue to include it in the plan. Please visit the IRWMP website at www.bairwmp.org and click on the link in the left column entitled "Submitting a Project," and then click on the link "Click here for instructions on how to update existing projects." If you do not update the project information, the project will be put in an inactive file and not included in the active project list.

Deadline

Please note that the deadline for submitting a new project or updating an existing project is **September 1, 2012**. This date has been selected to meet the deadline required by the Department of Water Resources for the Plan update, to allow adequate time to review, score and prioritize projects included in the Plan, and to consider projects for further analysis and inclusion in a proposal for implementation grant funding, expected to be due to DWR by March, 2013.

Please note that you will need to register with the Bay Area IRWMP website in order to edit project information. If you need assistance or have questions, you may seek technical support by contacting projects@bairwmp.org.

Summary of Question and Answer Session

Bay Area IRWMP Public Workshop

July 23, 2012, 4:00 – 6:00 PM
Association of Bay Area Governments
1515 Clay St., Oakland, CA

Overview
What follows is a summary of the question and answer session that took place during the Bay Area Integrated Regional Water Management Plan (IRWMP) public workshop held on July 23, 2012. Answers were provided by several different members of the Bay Area IRWMP Coordinating Committee.

Question (Q): **What is the definition of a disadvantaged community (DAC) in the context of the Bay Area IRWMP?**
Answer (A): The California Department of Water Resources (DWR) defines a disadvantaged community as a community or neighborhood with an annual median household income (MHI) less than 80 percent of the statewide average ($48,706). DWR allows some flexibility in defining the geographic area that meets the 80 percent threshold. In addition, DWR initially emphasized that DAC projects should meet a critical water supply or water quality need, but in the latest guidelines it seems they are allowing more flexibility.

Q: **How can more than one person populate the online submittal form for the same project?**
A: When viewing the project profile on the Bay Area IRWMP website (http://bairwmp.org), the lead submitter can share and delegate access to the project submittal form to others.

Q: When will the matrix of project ranking criteria be available?
A: The ranking criteria will be prepared by mid-August 2012. The Coordinating Committee (CC) will not act on the criteria, however, until the August 27, 2012 CC meeting. The current thinking with respect to the project ranking criteria can be viewed on the website, located in the materials for the July 23 CC meeting. Prior to that, project proponents will be able to predict how well their projects will fair by reviewing the DWR guidelines. In general, the more resources management strategies and goals that a project covers, the higher it will rank.

Q: **For the goal of enhancing environmental resources, are there any subcomponents that will be used for evaluation?**
A: Yes, there are four to five objectives that correspond to the goal of enhancing environmental resources.

Q: If I am submitting an update to an existing project, can I modify the Excel file that was originally developed?
A: If you are making changes to the project, it would be best to create a new project template online to make sure it is included in the Plan Update.

Q: What is the best way to get smaller projects integrated into other projects so they rank well in the Plan Update?
A: You can review the projects that have already been submitted on the project website and look for overlap. The better you are able to increase the scale of collaboration, the stronger the project will be. In addition, habitat projects, for example, should be integrated with other functions like stormwater run-off or working with a flood control agency on groundwater recharge. If the project is just focused on habitat projects it will not likely be scored well. Look for other water resource efforts and try to integrate with them.

Q: Do project applicants need to find partners for project integration prior to the September 1, 2012 project submittal deadline, or will there be opportunities to identify partners after that?
A: Identifying partners for project integration can take place after the September 1, 2012 deadline. It will also be beneficial to participate in subregional meetings to get a better sense of what other projects are being submitted.

Q: If my city has a shovel-ready project that is already partially funded, can we apply for additional funds for a disadvantaged (DAC)-specific project for the remainder of the funding?
A: If it is a local project, it can still be integrated with other projects. It could be integrated with projects that address different functional areas, for example. There is dedicated funding for DACs, and the Bay Area IRMWP is actively looking for DAC projects to include in the Plan Update.

Q: Can IRWMP funds be used to acquire land for habitat?
A: Yes, the project does need to be related to water resources, however.

Q: What is the schedule for prioritizing projects in the Plan Update?
A: Projects will be submitted by September 1, 2012. There is a more detailed project schedule, including project prioritization, in the meeting packet for the July 23 CC meeting, which is on the project website.

Q: How important is it for projects to meet sustainable water objectives to receive funding?
A: It depends on the grant round. DWR's criteria have been identified and this will influence how they are ranked in the Plan Update. Project proponents should aim to meet DWR's criteria when developing proposals – in the grant funding stage, a work plan will need to be developed that responds to the objectives.

Q: If there is a project that is scale-able (i.e., can be made larger), would it be advantageous to keep the project small if that would make it an eligible DAC project?
A: If your community is structured to serve a DAC, it will meet that criterion and will be prioritized by DWR since it is important to them. Expanding that project beyond the DAC will take away that advantage, so there will be a trade-off.

SIGN-IN SHEET

Bay Area Integrated Regional Water Management Plan
Public Workshop #1
Monday, July 23, 2012, 4:00 – 6:00 p.m.
Association of Bay Area Governments – 101 Eighth St., Oakland, CA

Name	Organization	Email	Phone
Carol Arnold	Contra Costa RCD	carol.arnold@cc.nacdnet.net	925-672-6522 x106
Joan Hultberg	Sonoma County Water Agency	joan@scwa.ca.gov	707-547-1902
Mike Britten	Carollo Engineers	mbritten@carollo.com	925-932-1710
Brian Campbell	EBMUD	bcampbel@ebmud.com	
Courtney Rubin	City of Redwood City	crubin@redwoodcity.org	650-780-5971
Jeff Rasmussen	East Bay Regional Park District	jrasmussen@ebparks.org	[illegible]-544-2204
Cathleen Brennan	Coastside County Water	cbrennan@coastsidewater.org	650 726-4405
Russell Wilsey	Mt Veeder Stewardship Council	russ@purityinc.com	510-681-5280
Teresa Eade	Stopwaste.org	teade@stopwaste.org	510-891-6515
Mike Boulland	FOLAW	Boullandmike@gmail.com	408 268 2703
Claire Teel	FOLAW	thebookelf@yahoo.com	
Alex Westhoff	Delta Protection Commission	alex.westhoff@delta.ca.gov	916-375-4237
Andria Loutsch	CDM Smith	LOUTSCHAR@CDMSMITH.COM	925-296-8064
Ricardo C. Sousa	The Watershed Project	ricardo@thewatershedproject.org	510 984 8316

Name	Organization	Email	Phone
CARL KONNERT	FRIENDS OF SAUSAL CREEK	CCKONNERT@SBCGLOBAL.NET	510.654.4062
RUSS Greenfield	LGVSD	RGMXMAN@gmail.com	415 578 2580
Jennifer Roberts	StopWaste.Org	jroberts@stopwaste.org	415 695 1721
PAUL WILLIS	TOWN OF HILLSBOROUGH	PWILLIS@HILLSBOROUGH.NET	650 375 -7444
David Swartz	Contra Costa County Flood Control Dist	dswar@pw.cccounty.us	925.313.2281
Junice Wy	Gallinas Watershed council	juniceuy@berkeley.edu	
Bill Gass	San Mateo County Farm Bureau	SMCFB hmb@aol.com	650 726 4485
Nico Procos	City of Palo Alto	nicolas.procos@cityofpaloalto.org	650.329.2214
Brad Daniels	Trout Unlimited	bdaniels@tu.org	510-647-9311
Susan McGuire	Las Gallinas Valley SD	SMcGuire@lgvsd.org	415-472-1734 x19
MAX KORTEN	CONSERVATION CORPS NORTH BAY	mkorten@conservationcorpsnorthbay.org	415.454.4554
Ken Schwarz	Horizon Water & Environment	Ken@horizonh2o.com	510-421-7664
Katie Bergman	NRCS + ACRCD	Katie.Bergman@ca.usda.gov	925-371-0154 x117
REBECCA Tuden	CITY OF OAKLAND	RTUDEN@oaklandnet.com	510-238-6266
Josh Bradt	SFEP	jbradt@waterboards.ca.gov	510 622 5048
Chien Wang	ACPWA	chien@acpwa.org	510-670-5552
Gilbert Yau	City of Belmont	gyau@belmont.gov	650-595-7467

SIGN-IN SHEET

Bay Area Integrated Regional Water Management Plan
Public Workshop #1
Monday, July 23, 2012, 4:00 – 6:00 p.m.
Association of Bay Area Governments – 101 Eighth St., Oakland, CA

Name	Organization	Email	Phone
Mitch Avalon	CCC FCD	maval@pw.cccounty.us	925-313-2208
Claire Elliott	Acterra	clairee@acterra.org	650-962-9876 ext 311
Karen Sundback	LWV Palo Alto	already have	
Sami Ghossain	USD	" "	510-477-7601
Erika Barraza	Carollo Engineers	ebarraza@carollo.com	925-932-1710
Roanne Ross	WBA	rross@whitleyburchett.com	925/945 6850
Lisa McEvilly	Sloan Valve/Kliman Sales	lisa@klimansales.com	916-379-0784
Brad Swain	City of East Palo Alto	BSwain@CityofEPA.Org	650-853-3159
Craig Conner	USACE, San Francisco Dist.	Craig.S.Conner@usace.army.mil	415-503-6903
Trathen Heckman	Daily Acts	Trathen@dailyacts.org	707 789-9664
Jeff Sharp	Napa County	jeff.sharp@countyofnapa.org	707-259-5936
Leigh Sharp	Napa Co. RCD	leigh@naparcd.org	707-252-4188 x 110
Larry Kolb	Sierra Club	LPKolb@gmail.com	510 655-9720

Name	Organization	Email	Phone
Marilyn Mosher	City of Hayward	marilyn.mosher@hayward-ca.gov	510-583-4723
Will Travis	Joint Policy Committee	travis@bayareajpc.net	415-601-7148
Bob Bundy	Corte Madera Flood Board	bundyworld@comcast.net	415-924-8186
Vince Geronimo	AECOM	Vince.Geronimo@AECOM.com	510 879 4533
Natalya Blumenfeld	Golden Gate National Parks Conservancy	NBlumenfeld@parksconservancy.org	415-561-3046
Jim Scanlin	ACCWP	jims@acpwa.org	
Brad Sherwood	SCWA	Sherwood@scwa.ca	–
David Sidobano	Zentraal	info@zentraal.com	+1 415 670 9420
Pamela Boyle	Sound Watershed Consulting	pam@soundwatershed.com	(510) 759-1689
Darcie Luce	Ca Land Stewardship Inst.	darcie@fishfriendlyfarming.org	
Betty Andrews	ESA PWA	bandrews@esassoc.com	707-285-0581
Jill Bicknell	EOA / SCVURPPP	jcbicknell@eoainc.com	408-720-8811
Kevin Murray	San Francisquito Creek JPA	kmurray@sfcjpa.org	650.324.1972
Kwablah Attiogbe	ACFCWCD	kwablaa@acpwa.org	670-5772
Juliana Gonzalez	The Watershed Project	juliana@thewatershedproject.org	510-665-3430
Stephanie Faulkner	ICARE	sfaulkner@valleyinternet.com	707/224.2676
Chris Malan	ICARE	cmalan@oneearth.com	707/255.7434
Stan Kolodzie	DSRSD	kolodzie@dsrsd.com	(925) 875-2253

Name	Organization	Email	Phone
Barbara Salzman	Marin Audubon Society	bsalzman@att.net	415-924-6057
BRIAN FULFROST	SAN FRANCISCO BAY BIRD OBSERVATORY	BFACONSULT@GMAIL.COM	831-566-7686
Carlos Martinez	City of East Palo Alto	cmartinez@cityofepa.org	650 799-4772
MATT O'CONNOR	TOWN OF HILLSBOROUGH	MTOCONNOR@HILLSBOROUGH.NET	650-375-7454
Reena Thomas	Brezack & Assoc. Planning	rthomas@brezack.com	925 405 2267
MATTHEW GRAUL	EAST BAY REGIONAL PARK DISTRICT	mgraul@ebparks.org	510-544-2327
Josh Uecker	RMC Water & Environment	juecker@rmcwater.com	415-321-3400
Thomasin Grim	MMWD	tgrim@marinwater.org	415-945-1542

Bay Area Integrated Regional Water Management Plan

Public Workshop #2

"Project Selection, Financing and Collaboration"

Monday, January 28, 2013, 4:00 – 6:00 p.m.

StopWaste.org, 1537 Webster Street, Oakland, CA

AGENDA

3:45 – 4:00 p.m. **Registration**

4:00 – 4:10 p.m. **Welcome and Introductions**

Steve Ritchie, San Francisco Public Utilities Commission
Chair, Bay Area IRWMP Coordinating Committee

4:10 – 4:40 p.m. **2013 Bay Area IRWMP Projects**

Harry Seraydarian, **North Bay Watershed Association** and Bay Area IRWMP Project Selection Committee

- Scoring and ranking projects for inclusion in the 2013 BAIRWMP
- Project criteria for DWR Grant Applications
- Future, new projects for rounds 2 and 3 of grant funding

4:40 – 5:50 p.m. **Financing Sources and Collaboration Strategies**

- Funding Sources – Opportunities, Successes, Challenges
  1) Flood management projects – **Carol Mahoney, Zone 7 Water Agency**
  2) Non-governmental organization projects **– Caitlin Sweeney, San Francisco Estuary Partnership**
  3) Public-Private water and wastewater projects – **Grant Schlereth, ARUP**

- Promoting Agency/Non-governmental Collaborations and Addressing Barriers (*Facilitated group discussion of panelists and attendees*)

- Summary

5:50 – 6:00 p.m. **Wrap-up and Next Steps**

Steve Ritchie, San Francisco Public Utilities Commission
Chair, Bay Area IRWMP Coordinating Committee

2013 Active Project List --
Bay Area Integrated Regional Water Management Plan

October 29, 2012

	A	B	C	D
1	**Project Name**	**Subregion**	**Sponsoring Agency**	**Contact Person Email**
2	350 Home and Garden Challenge Bay Area	East North South West	Daily Acts	trathen@dailyacts.org
3	ACPWA Low Impact Development Implementation and Demonstration Project: Parking Lot Stormwater Treatment Improvements	East	Alameda County Public Works Agency	chien@acpwa.org
4	Agricultural Riparian Buffer and Habitat Enhancement	East	Alameda County RCD	amy.evans@acrcd.org
5	Airway Improvement Project (R5-2)	East	Zone 7 Water Agency	cmahoney@zone7water.com
6	Alameda County Adopt-A-Creek-Spot	East	Alameda County Resource Conservation District	Leslie.koenig@acrcd.org
7	Alameda County Foothill Blvd. Transportation Stormwater Quality Improvement	East	Alameda County	paulk@acpwa.org
8	Alameda County Habitat Easements	East	Alameda County Resource Conservation District	leslie.koenig@acrcd.org
9	Alameda County Healthy Watershed Program	East	Alameda County Resource Conservation District	Leslie.koenig@acrcd.org
10	Alameda County Norbridge/Strobridge Road Transportation Stormwater Quality Improvement	East	Alameda County	paulk@acpwa.org
11	Alameda County Patterson Pass Road Transportation Stormwater Quality Improvement	East	Alameda County	paulk@acpwa.org
12	Alameda County Riparian Invasive Mapping and Removal	East	Alameda County Resource Conservation District	Leslie.koenig@acrcd.org
13	Alameda County Tesla Road Transportation Stormwater Quality Improvement	East	Alameda County	paulk@acpwa.org
14	Alameda County Vasco Road Transportation Stormwater Quality Improvement	East	Alameda County	paulk@acpwa.org
15	Alameda Creek Flood Protection, Fish Passage and Habitat Enhancement Project	East	Alameda County Flood Control & Water Conservation District	chien@acpwa.org

	A	B	C	D
16	Alamo Canal Flood Control Program (R9-7)	East	Zone 7 Water Agency	cmahoney@zone7water.com
17	Alamo Canal/South San Ramon Creek Erosion Control (R9-1)	East	Zone 7 Water Agency	cmahoney@zone7water.com
18	Albany Beach Restoration and Public Access Project	East	East Bay Regional Park District	cbarton@ebparks.org
19	Alhambra Valley Creek Coalition - Erosion Control and Riparian Restoration Project	East	Contra Costa County Public Works Dept.	csell@pw.cccounty.us
20	Alkali Sink Management (R1-2)	East	Zone 7 Water Agency	cmahoney@zone7water.com
21	Almaden Dam Improvements	South	Santa Clara Valley Water District	vgutierrez@valleywater.org
22	Altamont and Las Positas Creeks/Springtown Alkali Sink Restoration	East	Natural Resources Conservation Service, Alameda County	sjbainbridge@berkeley.edu
23	Altamont Creek Improvement (R1-1)	East	Zone 7 Water Agency	cmahoney@zone7water.com
24	Anderson Dam Seismic Retrofit	South	Santa Clara Valley Water District	fmaitski@valleywater.org
25	Ardenwood Creek Flood Protection and Restoration Project	East	Alameda County Flood Control & Water Conservation District	chien@acpwa.org
26	Arroyo De La Laguna (ADLL) Improvement Project 1 (R10-1)	East	Zone 7 Water Agency	cmahoney@zone7water.com
27	Arroyo De La Laguna (ADLL) Improvement Project 2 (R10-2)	East	Zone 7 Water Agency	cmahoney@zone7water.com
28	Arroyo De La Laguna (ADLL) Improvement Project 3 (R10-3)	East	Zone 7 Water Agency	cmahoney@zone7water.com
29	Arroyo De La Laguna (ADLL) Improvement Project 4 (R10-4)	East	Zone 7 Water Agency	cmahoney@zone7water.com
30	Arroyo De La Laguna (ADLL) Improvement Project 5 (R10-5)	East	Zone 7 Water Agency	cmahoney@zone7water.com
31	Arroyo las Positas Diversion Project (R5-3)	East	Zone 7 Water Agency	cmahoney@zone7water.com

2013 Active Project List --
Bay Area Integrated Regional Water Management Plan

	A	B	C	D
32	Arroyo las Positas Habitat Enhancement and Recreation Project (R1-5)	East	Zone 7 Water Agency	cmahoney@zone7water.com
33	Arroyo las Positas Multi-Purpose Project (R1-6)	East	Zone 7 Water Agency	cmahoney@zone7water.com
34	Arroyo Mocho Bypass and Regional Storage at Chain of Lakes (R6-2)	East	Zone 7 Water Agency	cmahoney@zone7water.com
35	Arroyo Mocho Management Plan (R6-1)	East	Zone 7 Water Agency	cmahoney@zone7water.com
36	Arroyo Seco Improvements (R2-2)	East	Zone 7	cmahoney@zone7water.com
37	Ash Creek Stormwater Management and Wildlife Enhancement Project	North	Southern Sonoma County Resource Conservation District	kheckert@sotoyomercd.org
38	Assessment of an urban watershed and implementation of urban stormwater retrofit projects	East	Friends of Sausal Creek	coordinator@sausalcreek.org
39	Bay Area Green Infrastructure Initiative: Scientific support related to planning and implementation of water infrastructure upgrades toward green alternatives	East North South West	San Francisco Estuary Institute	davids@sfei.org
40	Bay Area Regional Desalination Project (BARDP) - Alternative Analysis Report	East South West	EBMUD, CCWD, Zone 7, SCVWD, SFPUC	habdulla@ebmud.com
41	Bay Area Regional Reliability Interties - EBMUD/CCWD	East South West	EBMUD / Zone 7 / CCWD / SCVWD / SFPUC	ecorwin@ccwater.com
42	Bay Area Regional Water Conservation and Education Program	East North South West	Zone 7 Water Agency, San Francisco PUC and Contra Costa Water District	rnavarra@zone7water.com
43	Bay Area Water Supply and Conservation Agency (BAWSCA) – East Bay Municipal Utility District (EBMUD) Short-Term Water Transfer Pilot Project (Pilot Project)	East South West	Bay Area Water Supply and Conservation Agency (BAWSCA), East Bay Municipal Utility District (EBMUD)	NSandkulla@bawsca.org, ADutton@bawsca.org
44	Bay Area Water Supply and Conservation Agency (BAWSCA) Brackish Groundwater Field Investigation Project (Brackish Groundwater Project)	East South West	BAWSCA (Bay Area Water Supply & Conservation Agency)	ADutton@bawsca.org, NSandkulla@BAWSCA.org

	A	B	C	D
45	Bay Point Regional Shoreline Wetland Restoration	East	East Bay Regional Park District	jrasmussen@ebparks.org
46	Bay-Friendly Landscape Standards for Green Infrastructure Projects: Maximizing Watershed Benefits	East North South West	Bay-Friendly Landscaping & Gardening Coalition	gretchen@bayfriendlycoalition.org
47	Bay-Friendly Outreach Campaign for Home Gardeners and Nurseries	East North South West	Bay-Friendly Landscaping & Gardening Coalition	gretchen@bayfriendlycoalition.org
48	Bay-Friendly Qualified Landscape Professionals Training	East North South West	Bay-Friendly Landscaping & Gardening Coalition	gretchen@bayfriendlycoalition.org
49	Bayfront Canal Flood Management and Habitat Restoration Project	West	City of Redwood City	gle@redwoodcity.org
50	Bayside Groundwater Project Phase 2	East	EBMUD	tfrancis@ebmud.com
51	Beach Watch Program	North South West	Farallones Marine Sanctuary Association	sbeck@farallones.org
52	Bel Marin Keys Phase of the Hamilton Wetlands Restoration	North	Coastal Conservancy	tgandesbery@scc.ca.gov
53	Berryessa Creek Flood Protection Project	South	Santa Clara Valley Water District	DCheong@valleywater.org

2013 Active Project List -- Bay Area Integrated Regional Water Management Plan

	A	B	C	D
54	Bockman Canal Area Flood Control Improvement Project	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
55	Bolinas Avenue Stormwater Quality Improvements and Fernhill Creek Restoration	North	Town of Ross	randell@harrison-engineering.com
56	Bolinas Lagoon Ecosystem Restoration Project	North	Marin County Open Space District	JRaives@marincounty.org
57	Breuner Marsh Restoration, Richmond	East	East Bay Regional Park District	bolson@ebparks.org
58	Building Climate Change Resiliency Along the Bay with Green Infrastructure & Treated Wastewater	East North South	San Francisco Estuary Partnership	jkrebs@waterboards.ca.gov
59	Butano Creek Stream Course Restoration	West	California State Parks	jkerb@parks.ca.gov
60	Canal Liner Rehabilitation and Slope Stability at Milepost 23.03	East	Contra Costa Water District	mvalmores@ccwater.com
61	Capacity Improvement at Arroyo las Positas (R1-7)	East	Zone 7 Water Agency	cmahoney@zone7water.com
62	Castro Valley Flood Control Improvement Project	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
63	CCCSD Refinery Recycled Water Project	East	Central Contra Costa Sanitary District	dberger@centralsan.org
64	CCCSD-Concord Recycled Water Project	East	Central Contra Costa Sanitary District	dberger@centralsan.org
65	Central Dublin RW Distribution and Retrofit Project	East	Dublin San Ramon Services District	Biagtan@dsrsd.com
66	Central/Eastshore Pump Station Improvement Project	East	City of Alameda	lkozisek@ci.alameda.ca.us
67	Cesar Chavez Street Flood and Stormwater Managment Sewer Improvement Project	West	San Francisco Public Utilities Commission	aroche@sfwater.org
68	Chabot Canal Improvement Project (R8-2)	East	Zone 7 Water Agency	cmahoney@zone7water.com
69	Charcot Storm Pump Station	South	City San Jose	elaine.marshall@sanjoseca.gov
70	Chelsea Wetlands Restoration Project	East	Ducks Unlimited, Inc. and City of Hercules	amercado@ci.hercules.ca.us

	A	B	C	D
71	City of Berkeley Watershed Management Plan	East	City of Berkeley	pharrington@cityofberkeley.info
72	City of Hayward Recycled Water Project	East	City of Hayward	Alex.Ameri@hayward-ca.gov
73	City of San Jose Citywide Storm Drain Master Plan	South	City of San Jose	shelley.guo@sanjoseca.gov
74	City Watersheds of Sonoma Valley	North	Sonoma County Water Agency	joan@scwa.ca.gov
75	Cleaning up trash in the Bay Area's stormwater	East North South West	Association of Bay Area Governments/SF Estuary Partnership	jwcox@waterboards.ca.gov
76	Collaborative Aquatic Resource Protection in the Watershed Context: Science and Technology to Visualize Alternative Landscape Futures	North	San Francisco Estuary Institute	rainer@sfei.org
77	Conserving Our Watersheds	North	Marin Resource Conservation District	nancy@marinrcd.org
78	Contra Costa County Green Street Retrofit Network	East	Contra Costa County	csell@pw.cccounty.us
79	Contra Costa County LID School Program	East	The Watershed Project	ricardo@thewatershedproject.org
80	Contra Costa County Low Impact Development Rebate Program	East	The Watershed Project	ricardo@thewatershedproject.org
81	Corte Madera Bayfront Flood Protection and Wetlands Restoration Project	North	Marin Audubon Society/Marin Bayland Advocates	BSalzman@att.net
82	Corte Madera Creek Headwaters Restoration Plan	North	Marin County Parks	msagues@marincounty.org
83	Corte Madera Creek Tidal Marsh Restoration	North	Friends of Corte Madera Creek Watershed; Marin County Water Conservation and Flood Control District; Marin County Parks Dept.	sandra.guldman@gmail.com

2013 Active Project List -- Bay Area Integrated Regional Water Management Plan

	A	B	C	D
84	Corte Madera Creek Watershed - Broadmoor Avenue Bridge Replacement and Creek Bank Restorations	North	Marin County Flood Control and Water Conservation District	jcurley@marincounty.org
85	Corte Madera Creek Watershed - Fairfax Creek Improvements	North	Marin County Flood Control and Water Conservation District	jcurley@marincounty.org
86	Corte Madera Creek Watershed - Lefty Gomez Field Detention Basin	North	Marin County Flood Control and Water Conservation District	jcurley@marincounty.org
87	Corte Madera Creek Watershed - Loma Alta Tributary Detention Basin	North	Marin County Flood Control and Water Conservation District	jcurley@marincounty.org
88	Corte Madera Creek Watershed - Memorial Park Detention Basin, San Anselmo	North	Marin County Flood Control and Water Conservation District	jcurley@marincounty.org
89	Corte Madera Creek Watershed - Merwin Avenue Bridge Replacement and Creek Bank Restorations	North	Marin County Flood Control and Water Conservation District	jcurley@marincounty.org
90	Corte Madera Creek Watershed - Nokomis-Madrone Neighborhood Flood Protection	North	Marin County Flood Control and Water Conservation District	jcurley@marincounty.org
91	Corte Madera Creek Watershed - San Anselmo Creek Improvements	North	Marin County Flood Control and Water Conservation District	jcurley@marincounty.org
92	Corte Madera Creek Watershed - Sleepy Hollow Creek Improvements	North	Marin County Flood Control and Water Conservation District	jcurley@marincounty.org
93	Corte Madera Creek Watershed Infiltration and Storage Assessment	North	Ross Valley Watershed Program, Friends of Corte Madera Creek Watershed	sandra.guldman@gmail.com
94	Corte Madera Creek Watershed Sediment Control and Drinking Water Reliability Project	North	Marin Municipal Water District	mswezy@marinwater.org

	A	B	C	D
95	Corte Madera Creek Watershed: Barriers to Fish Passage in Sleepy Hollow Creek	North	Town of San Anselmo, Marin County Department of Public Works	sandra.guldman@gmail.com
96	Corte Madera Creek Watershed: Saunders Fish Barrier Removal	North	Town of San Anselmo, Friends of Corte Madera Creek Watershed, Ross Valley Sanitary District	sandra.guldman@gmail.com
97	Corte Madera Creek Watershed: Sedimentation Management	North	Marin County Flood Control and Water Conservation District	jcurley@marincounty.org
98	Corte Madera Creek Watershed: Smolt Trapping	North	Friends of Corte Madera Creek Watershed	sandra.guldman@gmail.com
99	Creek Signage	East	Alameda County Resource Conservation District	Amy.evans@acrcd.org
100	Cull Canyon Dam and Reservoir Project	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
101	DA 48B Storm Drain Line A at Port Chicago Highway, Bay Point (#201)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
102	DA 48C Storm Drain Line at Marina Road, Bay Point (#_)	East	Contra Costa County Flood Control and Water Conservation District	pdetj@pw.cccounty.us
103	Daly City Expansion Recycled Water Project	West	SFPUC, City of Daly City	cmunoz@sfwater.org
104	DDSD Advanced Wastewater Treatment	East	Delta Diablo Sanitation District	DeanE@ddsd.org
105	DDSD Advanced Water Treatment	East	Delta Diablo Sanitation District	DeanE@ddsd.org
106	DDSD Recycled Water Distribution System Expansion	East	Delta Diablo Sanitation District	DeanE@ddsd.org
107	Decoto District Green Streets Phase 3	East	City of Union City	thomasr@ unioncity.org
108	DERWA Pump Station 1 - Phase 2	East	Dublin San Ramon Services District	Biagtan@dsrsd.com

2013 Active Project List --
Bay Area Integrated Regional Water Management Plan

	A	B	C	D
109	DERWA Recycled Water Plant - Phase 2	East	Dublin San Ramon Services District	Biagtan@dsrsd.com
110	Developing a Conservation Reserve Enhancement Program Proposal (CREP) to improve water quality and protect rangeland habitats in the Bay Area	East North South West	Defenders of Wildlife	palvarez@defenders.org
111	Diablo Country Club Satellite Recycled Water Project	East	East Bay Municipal Utility District (EBMUD)	lhu@ebmud.com, fwedingt@ebmud.com
112	East Bayshore Recycled Water Project Phase 1A	East	East Bay Municipal Utility District (EBMUD)	lhu@ebmud.com, abartlet@ebmud.com
113	East Bayshore Recycled Water Project Phase 1B - Alameda	East	EBMUD	lhu@ebmud.com, abartlet@ebmud.com
114	East Bayshore Recycled Water Project Phase 1B - Oakland-Alameda Estuary Crossing	East	EBMUD	lhu@ebmud.com, abartlet@ebmud.com
115	East Bayshore Recycled Water Project Phase 2	East	East Bay Municipal Utility District (EBMUD)	lhu@ebmud.com, abartlet@ebmud.com
116	East Palo Alto Groundwater Supply Conjunctive Use Project	South West	City of East Palo Alto	BSwain@CityofEPA.org
117	East Palo Alto Storm Water Conveyance, Tidal Flood Protection, Ecosystem Restoration, and Recreational Enhancement Project	West	San Francisquito Creek Joint Powers Authority	kmurray@sfcjpa.org
118	EBMUD - Pretreatment Facilities	East	EBMUD	dbruzzon@ebmud.com
119	EBMUD/ZONE 7 Regional Reliability Intertie	East South West	EBMUD / Zone 7 / CCWD / SCVWD / SFPUC	cmahoney@zone7water.com
120	Estudillo Canal Area/San Leandro Flood Control Improvement Project - Phase 1	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
121	Estudillo Canal Area/San Leandro Flood Control Improvement Project - Phase 2	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
122	Estudillo Canal Area/San Leandro Flood Control Improvement Project - Phase 3	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
123	Exterior Painting of Skyline Tanks	West	Westborough Water District	dbarrow@westboroughwater.co m

	A	B	C	D
124	Fish Barrier Removal at Railroad Overcrossing (R3-5b)	East	Zone 7 Water Agency	cmahoney@zone7water.com
125	Fish Passage Improvements at Memorial County Park, San Mateo County	West	San Mateo County Resource Conservation District	Kellyx@sanmateorcd.org
126	Goat Island Marsh Tidal Marsh Restoration & Interpretive Nature Trail	North	Solano Land Trust	Ben@Solanolandtrust.org
127	Grant Avenue Green Street Water Quality/Flood Protection Demonstration Site	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
128	Grayson and Murderer's Creek Subregional Improvements, Pleasant Hill (#106)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
129	Grayson Creek Levee Raising and Rehabilitation, Pacheco (#_)	East	Contra Costa County Flood Control and Water Conservation District	pdetj@pw.cccounty.us
130	Grayson Creek Levee Rehabilitation at CCCSD Treatment Plant, Pacheco (#107)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
131	Grayson Creek Sediment Removal, Pacheco (unincorp.)(#109)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
132	Grimmer Greenbelt Gateway (Line G Channel Enhancement)	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
133	Hayward Marsh Restoration and Enhancement Project	East	East Bay Regional Park District	mgraul@ebparks.org
134	Headquarters Facility - Landscaping	East	Alameda County Water District	patricia.dustman@acwd.com
135	Hillman Area Improvements Project	West	City of Belmont	gyau@belmont.gov
136	Holmes Street Sedimentation Basin and Granada/Murrieta Protection and Enhancement Project (R3-4)	East	Zone 7 Water Agency	cmahoney@zone7water.com
137	Implementation of High Priority Projects Identified in the Pilarcitos Creek Integrated Watershed Management Plan	West	San Mateo County Resource Conservation District (RCD)	Kellyx@sanmateorcd.org
138	Implementation of Pond Management Plan	West	Midpeninsula Regional Open Space District	jandersen@openspace.org

	A	B	C	D
139	Implementation of the Napa River Watershed Assessment Framework	North	Napa County Resource Conservation District	rwflint@eeeee.net
140	Implementing "Slow It, Spread It, Sink It!" in Sonoma and Napa Counties	North	Southern Sonoma Resource Conservation District	kheckert@sotoyomercd.org
141	Implementing LandSmart Plans to Improve Water Quality	North	Napa County Resource Conservation District	leigh@naparcd.org
142	Implementing TMDLs in the Napa River, Sonoma and Suisun Creek watersheds with the Fish Friendly Farming/Fish Friendly Ranching programs	North	California Land Stewardship Institute	laurelm@fishfriendlyfarming.org
143	Improving Quantitative Precipitation Information for the San Francisco Bay Area	East North South West	Zone 7 Water Agencies for Bay Area Flood Protection Agencies Association (BAFPAA)	cmorrison@zone7water.com
144	Installation of a New Seismic Valve at Skyline Tanks	West	Westborough Water District	dbarrow@westboroughwater.com
145	Laguna Creek Flood Protection and Restoration Project	East	Alameda County Flood Control & Water Conservation District	chien@acpwa.org
146	Lagunitas Booster Station	North	Marin Municipal Water District	gandrew@marinwater.org
147	Lagunitas Creek Watershed Sediment Reduction and Management Project	North	Marin Municipal Water District	gandrew@marinwater.org
148	Lagunitas Creek Winter Habitat Enhancement Implementation	North	Marin Municipal Water District	gandrew@marinwater.org
149	Lake Chabot Raw Water Expansion Project	East	East Bay Municipal Utility District (EBMUD)	lhu@ebmud.com, abartlet@ebmud.com
150	LID and Stormwater Management - Lagunitas Watershed	North	The Watershed Project	harold@thewatershedproject.org
151	Line G-1-1 Maintenance Plan (R9-6)	East	Zone 7 Water Agency	cmahoney@zone7water.com
152	Line T Crossing Retrofit (R9-4)	East	Zone 7 Water Agency	cmahoney@zone7water.com

	A	B	C	D
153	Lower Arroyo del Valle Restoration and Enhancement Project (R7-3)	East	Zone 7 Water Agency	cmahoney@zone7water.com
154	Lower Arroyo Mocho Improvement Project (R8-3)	East	Zone 7 Water Agency	cmahoney@zone7water.com
155	Lower Walnut Creek Restoration Project, Martinez (#110)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
156	Lynch Canyon Watershed Improvements	North	Solano Land Trust	sue@solanolandtrust.org
157	Mapping Marin County's Flood Control Levees	North	Marin County Flood Control and Water Conservation District	lwilliams@marincounty.org
158	Marin County Flood Control Asset Management	North	Marin County Flood Control and Water Conservation District	lwilliams@marincounty.org
159	Marin County Sea Level Rise Land Use Adaptation	North	Marin County CDA	jliebster@marincounty.org
160	Martinez Adult School Flood Protection & Creek Enhancement	East	Martinez Unified School District	scasey@martinez.k12.ca.us
161	Martinez Water Quality and Supply Reliability Improvement Project	East	City of Martinez / Contra Costa Water District	jquimby@ccwater.com
162	McInnis Marsh Habitat Restoration Project	North	Marin County Parks	eholland@marincounty.org
163	Memorial Park Waste Water Treatment	West	San Mateo County	charris@co.sanmateo.ca.us
164	Mercury Reduction Benefits of Low Impact Development	East	Contra Costa County	csell@pw.cccounty.us
165	Miller Avenue Green Street Plan	North	City of Mill Valley	jbarnes@cityofmillvalley.org
166	Milliken Creek Flood Reduction, Fish Passage Barrier Removal and Habitat Restoration	North	Napa County	richard.thomasser@countyofnapa.org
167	Milliken Diversion Dam Flow Control	North	City of Napa Water Division	jeldredge@cityofnapa.org
168	Mission Boulevard to Meek Estate Creekside Trail and Habitat Improvements	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
169	Mission Creek Flood Protection and Restoration Project	East	Alameda County Flood Control & Water Conservation District	chien@acpwa.org

2013 Active Project List --
Bay Area Integrated Regional Water Management Plan

	A	B	C	D
170	Montalvin Manor Stormwater Harvest and Use, Bioretention, and Flood Risk Reduction Project	East	Contra Costa County	csell@pw.cccounty.us
171	Montezuma Creek Rehabilitation and Fish Passage Project	North	Marin County Parks Department	kkull@marincounty.org
172	Mountain View/ Sunnyvale Recycled Water Intertie Alignment Study	South	City of Mountain View	alison.turner@mountainview.gov
173	Napa County Groundwater/Surface Water Monitoring Wells	North	Napa County	deborah.elliott@countyofnapa.org
174	Napa River Arundo Removal Lodi Lane to Zinfandel Lane	North	Napa County Flood Control and Water Conservation District	christopher.sauer@countyofnapa.org
175	Napa River Restoration, Bioassessment & Education Project	North	Napa County Resource Conservation District	cmalan@myoneearth.com
176	Napa River Restoration: Oakville to Oak Knoll Reach	North	Napa County	richard.thomasser@countyofnapa.org
177	Napa River Rutherford Reach Restoration Project	North	Napa County	Richard.Thomasser@countyofnapa.org
178	New Pressure Reducing Valve (PRV) Station	West	Westborough Water District	dbarrow@westboroughwater.com
179	New Tank Mixer for Skyline Tanks	West	Westborough Water District	dbarrow@westboroughwater.com
180	Niles Cone Groundwater Basin Monitoring Well Construction Project	East	Alameda County Water District	douglas.young@acwd.com
181	NMWD Gallagher Well and Pipeline Project	North	North Marin Water District	cdegabriele@nmwd.com
182	North Bay Water Reuse Program	North	North Bay Water Reuse Authority (NBWRA)	Kevin.Booker@scwa.ca.gov

	A	B	C	D
183	North Marin Water District Marin Country Club Recycled Water Expansion	North	North Marin Water District	cdegabriele@nmwd.com
184	North Richmond Pump Station - Retrofit and Replumb	East	Contra Costa County Flood Control District	csell@pw.cccounty.us
185	Pacheco Marsh Restoration, Martinez (#111)	East	Contra Costa County Flood Control District / Muir Heritage Land Trust / East Bay Regional Park District	pdetj@pw.cccounty.us
186	Palo Alto Golf Course Redesign Wetlands Enhancement and Restoration Project	South	City of Palo Alto	brad.eggleston@cityofpaloalto.org
187	Palo Alto Recycled Water Project	South West	City of Palo Alto	nicolas.procos@cityofpaloalto.org
188	Parks Floodplain Dedication and Levee Construction (R3-3)	East	Zone 7 Water Agency	cmahoney@zone7water.com
189	Peacock Gap Recycled Water Extension Project	North	Marin Municipal Water District	mban@marinwater.org
190	Permanente Creek Flood Protection	South	Santa Clara Valley Water District	arouhani@valleywater.org
191	Pescadero Water Supply and Sustainability Project	West	County of San Mateo Department of Public Works and Parks	mchow@smcgov.org
192	Petaluma Flood Impact Reduction, Water & Habitat Quality, Recreation, Phase IV	North	City of Petaluma, Southern Sonoma County Resource Conservation District	Kheckert@sotoyomercd.org
193	Pilarcitos Creek Equestrian Bridge	West	California State Parks	jkerb@parks.ca.gov
194	Pine Creek Dam Seismic Assessment, Walnut Creek (#122)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
195	Pine Creek Reservoir Sediment Removal and Capacity Restoration, Walnut Creek (#124)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
196	Pinole Creek Fish Passage Improvements project at I-80 Culverts	East	Contra Costa RCD	carol.arnold@ca.nacdnet.net

2013 Active Project List -- Bay Area Integrated Regional Water Management Plan

	A	B	C	D
197	Pinole Creek Habitat Restoration (1135 Project), Pinole (#12)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
198	Portola Redwood State Park Wastewater System	West	(unknown)	rarias@parks.ca.gov
199	Recycled Water Distribution and Retrofit for County and Federal Facilities	East	Dublin San Ramon Services District	Biagtan@dsrsd.com
200	Recycled Water Facility Renewable Energy System	East	Delta Diablo Sanitation District	DeanE@ddsd.org
201	Redwood City Recycled Water Project Phase 2 – Central Redwood City	West	City of Redwood City	crubin@redwoodcity.org
202	Redwood Creek Restoration at Muir Beach, Phase 5	North	Golden Gate National Parks Conservancy	SFarrell@parksconservancy.org
203	Refugio Creek and North Channel Restoration	East	City of Hercules	sduran@ci.hercules.ca.us
204	Regional Green Infrastructure Capacity Building Program	East North South West	SFEP	jkrebs@waterboards.ca.gov
205	Regional Groundwater Storage and Recovery Project	West	SFPUC, Cities of Daly City and San Bruno and California Water Service Company	gbartow@sfwater.org
206	Regional Sea Level Rise Adaptation Strategy	East North South West	Bay Area Joint Policy Committee	travis@bayareajpc.net
207	Reliez Valley Recycled Water Project	East	EBMUD	Lhu@ebmud.com
208	Removing Fish Passage Barriers in the Napa River Watershed	North	Napa County Resource Conservation District	leigh@naparcd.org
209	Resilient Landscapes Climate Adaptation Strategy: Tools for Designing Sustainable Bay Area Stream, Wetland, and Riparian Habitats	East North South West	San Francisco Estuary Institute - Aquatic Science Center	robin@sfei.org
210	Rheem Creek Conservation Project (Shortcut Pipeline Improvement Project)	East	Contra Costa Water District	mseedall@ccwater.com
211	Richardson Bay Erosional Shoreline Adaptation to Sea Level Rise: Draft Conceptual Designs and Opportunity/Constraints Assessment	North	Marin County Flood Control and Water Conservation District	rleventhal@marincounty.org
212	Richmond Advanced Recycled Expansion (RARE) Water Project - Future Expansion	East	East Bay Municipal Utility District (EBMUD)	lhu@ebmud.com

	A	B	C	D
213	Richmond Advanced Recycled Expansion (RARE) Water Project Phase 2	East	East Bay Municipal Utility District (EBMUD)	lhu@ebmud.com
214	Rindler Creek: Habitat Restoration and Erosion Control	North	Solano Resource Conservation District	Chris.Rose@solanorcd.org
215	Robertson Park Enhancement Project and Levee Construction (R3-2)	East	Zone 7 Water Agency	cmahoney@zone7water.com
216	Rodeo Creek Sediment Removal, Rodeo (#14)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
217	Rodeo Creek Stabilization near Christie Road, Rodeo (#16)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
218	Rodeo Recycled Water Project	East	East Bay Municipal Utility District (EBMUD)	lhu@ebmud.com
219	Roseview Heights Mutual Water Tanks & Main upgrades	South	Roseview Heights Mutual Water Company	tim.rvhmwc@gmail.com
220	Rossmoor Well Replacement Project	East	City of Pittsburg	wpease@ci.pittsburg.ca.us
221	Rubber Dam No. 1 Fish Ladder	East	Alameda County Water District	anna.lloyd@acwd.com
222	Rubber Dam No. 3 Fish Ladder	East	Alameda County Water District	anna.lloyd@acwd.com
223	Rush Ranch HQ Storm Water Management, Public Access & Rangeland Improvements	North	Solano Land Trust	ben@solanolandtrust.org
224	Salvador Creek Intregrated Flood and Watershed Improvements	North	Napa County Flood Control and Water Conservation District	richard.thomasser@countyofnapa.org
225	San Catanio Creek culvert repair and enhancement	East	City of San Ramon	rbartlett@sanramon.ca.gov
226	San Francisco Bay Livestock and Land Program	East North South West	Ecology Action	kliske@ecoact.org
227	San Francisco Bay Tidal Marsh-Upland Transition Zone Decision Support System (DSS)	East North South West	San Francisco Bay Bird Observatory	dthomson@sfbbo.org
228	San Francisco Eastside Recycled Water Project	West	San Francisco Public Utilities Commission	cmunoz@sfwater.org
229	San Francisco Groundwater Supply Project	West	San Francisco Public Utilities Commission	jgilman@sfwater.org

2013 Active Project List -- Bay Area Integrated Regional Water Management Plan

October 29, 2012

	A	B	C	D
230	San Francisco International Airport Industrial Waste Treatment Plant and Reclaimed Water Facility	West	City and County of San Francisco, Airport Commission	Jonathan.Kocher@flysfo.com
231	San Francisco Westside Recycled Water Project	West	San Francisco Public Utilities Commission	cmunoz@sfwater.org
232	San Francisquito Creek Flood Reduction, Ecosystem Restoration and Recreation Project, Highway 101 to El Camino Real	South West	San Francisquito Creek Joint Powers Authority	kmurray@sfcjpa.org
233	San Francisquito Watershed Plan	South West	San Francisquito Creek Joint Powers Authority	kmurray@sfcjpa.org
234	San Geronimo Landowner Assistance Program- Habitat Restoration Projects	North	Marin County Department of Public Works/SG Planning Group	kkull@marincounty.org
235	San Gregorio Creek Tributary Water Quality and Flow Monitoring	West	San Gregorio Environmental Resource Center	amychaas@gmail.com
236	San José Green Alleys Demonstration Project	South	City of San Jose	elaine.marshall@sanjoseca.gov
237	San José Green Streets Demonstration Project	South	City of San Jose	elaine.marshall@sanjoseca.gov
238	San Leandro Creek Environmental Education Center, Alameda County	East	Alameda Count Flood Control and Water Conservation District	Chien@acpwa.org
239	San Leandro Creek Hazard Tree Management and Riparian Habitat Restoration	East	ACFCWCD	Chien@acpwa.org
240	San Leandro Water Reclamation Facility Expansion Project	East	East Bay Municipal Utility District (EBMUD)	lhu@ebmud.com, abartlet@ebmud.com
241	San Lorenzo Creek Flood Control Project - Phase 1	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
242	San Lorenzo Creek Flood Control Project - Phase 2	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org

	A	B	C	D
243	San Lorenzo Creek Tidal Wetlands Restoration	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
244	San Lorenzo Creek Watershed Fisheries Restoration Project - Major Fish Passage Barrier Removal (MB-10) Phase 2	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
245	San Lorenzo Creek Watershed Fisheries Restoration Project - Phase 1	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
246	San Lorenzo Creek Watershed Stewardship Program	East	Alameda Flood Control and Water Conservation District	Chien@acpwa.org
247	San Pablo Bay South Watershed Awareness and Action Plan	East	The Watershed Project	harold@thewatershedproject.org
248	San Pablo Bay South Watershed Community Stewardship Program	East	The Watershed Project	juliana@thewatershedproject.org
249	San Ramon Valley Recycled Water Program - Phase 2A (DSRSD-EBMUD Recycled Water Authority)	#N/A	DSRSD-EBMUD Recycled Water Authority	lhu@ebmud.com, fwedingt@ebmud.com
250	San Ramon Valley Recycled Water Program - Phase 3 - 4 (DSRSD-EBMUD Recycled Water Authority)	#N/A	DSRSD-EBMUD Recycled Water Authority	lhu@ebmud.com, fwedingt@ebmud.com
251	San Ramon Valley Recycled Water Program - Phase 5-6 (DSRSD-EBMUD Recycled Water Authority)	#N/A	DSRSD-EBMUD Recycled Water Authority	fwedingt@ebmud.com
252	Santa Clara Valley Water District Advanced Recycled Water Treatment Facility Expansion Project	South	Santa Clara Valley Water District	tligon@valleywater.org
253	Satellite Recycled Water Treatment Plant Project	East	EBMUD	Lhu@ebmud.com
254	Sausal Creek Restoration Project	East	City of Oakland	khathaway@oaklandnet.com
255	SCADA System Major Upgrades	East	Alameda County Water District	patricia.dustman@acwd.com
256	School District Green Infrastructure Capacity Building/Pilot Projects	East West	San Francisco Estuary Partnership	jbradt@waterboards.ca.gov
257	Sears Point Restoration Project	North	Sonoma Land Trust	julian@sonomalandtrust.org

2013 Active Project List --
Bay Area Integrated Regional Water Management Plan

	A	B	C	D
258	SEDIMENT MANAGEMENT PLAN FOR THE GRAVEL CREEK WATERSHED	North	Vedanta Society of San Francisco	fanshen@clearwater-hydrology.com
259	SFPUC Eastside Watershed Green Infrastructure Early Implementation Projects	West	SFPUC	aroche@sfwater.org
260	SFPUC Westside Watershed Green Infrastructure Early Implementation Projects	West	San Francisco Public Utilities Commission	aroche@sfwater.org
261	Shinn Pond Fish Screen	East	Alameda County Water District	anna.lloyd@acwd.com
262	Sinbad Creek Project (R11-2)	East	Zone 7 Water Agency	cmahoney@zone7water.com
263	Solano Project Terminal Reservoir Seismic Mitigation	North	Solano County Water Agency	tpate@scwa2.com
264	Sonoma Valley Groundwater Banking Program	North	Sonoma County Water Agency	joan@scwa.ca.gov
265	Sonoma Valley Integrated Water Management Program	North	Sonoma County Water Agency	joan@scwa.ca.gov
266	Soulajule Mercury Remediation	North	Marin Municipal Water District	psellier@marinwater.org
267	South Bay Aqueduct Turnout Construction and Low-Flow Crossings (R3-1)	East	Zone 7 Water Agency	cmahoney@zone7water.com
268	South Bay Salt Pond Restoration Project & South San Francisco Bay Shoreline Study: Early Implementation Activities	South	California State Coastal Conservancy	bbuxton@scc.ca.gov
269	South East Bay Plain Basin Groundwater Model Enhancements	East	EBMUD	tfrancis@ebmud.com
270	South East Bay Plain Basin Subsidence Monitoring Network	East	EBMUD	tfrancis@ebmud.com
271	South San Francisco Recycled Water Facility	West	South San Francisco/SFPUC	terry.white@ssf.net
272	Southwestern Solano County Open Space Acquisition and Watershed Assessment	North	Solano Land Trust	sue@solanolandtrust.org

	A	B	C	D
273	Spring Branch Creek Tidal Marsh & Seasonal Creek Restoration	North	Solano Land Trust	Ben@Solanolandtrust.org
274	Springtown Golf Course Improvements (R1-4)	East	Zone 7 Water Agency	cmahoney@zone7water.com
275	Springtown Improvements (R1-3)	East	Zone 7 Water Agency	cmahoney@zone7water.com
276	Stanley Enhancement and Restoration Project (R3-5a)	East	Zone 7 Water Agency	cmahoney@zone7water.com
277	Stinson Beach flood protection and habitat enhancement project	North	Marin County Department of Public Works	cchoo@marincounty.org
278	Stivers Lagoon Marsh Project	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
279	Streambank and Habitat Restoration Projects	East	Alameda County Resource Conservation District	Katie.bergmann@ca.usda.gov
280	Study of Mercury methylation in South San Francisco Bay in Relation to Nutrient Sources	South	San Francisco Estuary Institute	jay@sfei.org
281	Suisun City Flood Management and Habitat Restoration Project	North	City of Suisun City	adum@suisun.com
282	Suisun Valley Flood Management	North	Solano County Water Agency	tpate@scwa2.com
283	Sulphur Creek/Hayward Flood Control Improvement Project	East	Alameda County Flood Control and Water Conservation District	Chien@acpwa.org
284	Sycamore Grove Recharge Bypass Project (R4-1)	East	Zone 7 Water Agency	cmahoney@zone7water.com
285	Tassajara Creek Improvement Project (R8-1)	East	Zone 7 Water Agency	cmahoney@zone7water.com
286	The Bay Area Creek Mouth Assessment Tool	East North South West	San Francisco Estuary Partnership	adbaudrimont@watersheds.ca.gov
287	The Students and Teachers Restoring A Watershed (STRAW) Project	East North West	PRBO Conservation Science	jparodi@prbo.org

2013 Active Project List -- Bay Area Integrated Regional Water Management Plan

	A	B	C	D
288	Tice Creek Bypass (Drainage Area 67), Walnut Creek, CA (#117)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
289	Tomales Bay Watershed Water Quality Monitoring and Improvement Program	North	Tomales Bay Watershed Council Foundation	robcarson@tomalesbaywatershed.org
290	Total Dissolved Solids Reduction/Salinity Management Project	East	Delta Diablo Sanitation District	DeanE@ddsd.org
291	Tule Ponds Education Center Rehabilitation	East	Alameda County Flood Control & Water Conservation District	Chien@acpwa.org
292	Upland Transition Zone Mapping for Southern San Pablo Bay (West):	North	Gallinas Watershed Council/Marin County DPW/marin County Parks and Openspace	Rachel@KHE-Inc.com
293	Upper Alameda Creek Filter Gallery Project	East	SFPUC	msargent@sfwater.org
294	Upper Arroyo de la Laguna (ADLL) Improvement Project (R8-4)	East	Zone 7 Water Agency	cmahoney@zone7water.com
295	Upper Napa River Water Quality Improvement and Habitat Enhancement Project	North	California Land Stewardship Institute	laurelm@fishfriendlyfarming.org
296	Upper York Creek Dam Removal -- St. Helena, Napa River Watershed	North	City of St. Helena/U.S. Army Corps of Engineers	JohnF@cityofsthelena.org
297	Velocity Control Project (R2-1)	East	Zone 7 Water Agency	cmahoney@zone7water.com
298	Veterans' Court Seawall Reconstruction	East	City of Alameda	cclark@ci.alameda.ca.us
299	Vista Grande Drainage Basin Improvement Project	West	San Francisco Public Utilities Commission	onzewi@sfwater.org
300	Walnut Creek Levee Rehabilitation at Buchanan Field Airport, Concord (#119)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
301	Walnut Creek Sediment Removal - Clayton Valley Drain to Drop Structure 1 , Concord (#118)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
302	Wastewater Renewable Energy Enhancement	East	Delta Diablo Sanitation District	DeanE@ddsd.org

	A	B	C	D
303	Water Conservation and Mobile Water Lab Program	North	Southern Sonoma Resource Conservation District	kheckert@sotoyomercd.org
304	Water Dog Lake Sediment Removal	West	City of Belmont	gyau@belmont.gov
305	Water Supply and Instream Habitat Improvements in Suisun Creek	North	Ca. Land Stewardship Institute	laurelm@fishfriendlyfarming.org
306	Water Treatment Plant Improvement Project	East	City of Pittsburg	wpease@ci.pittsburg.ca.us
307	Watershed Information Center & Conservancy of Napa County	North	County of Napa	jeff.sharp@countyofnapa.org
308	Westborough Main Pump Station Generator	West	Westborough Water District	dbarrow@westboroughwater.com
309	Western Dublin Recycled Water Distribution Expansion and Retrofit Project	East	Dublin San Ramon Services District	Biagtan@dsrsd.com
310	White Slough Flood Control and Improvement Project	North	Vallejo Sanitation and Flood Control District	rohlemutz@vsfcd.com
311	Wildcat and San Pablo Creeks Restoration and Management Plan	East	Contra Costa County Flood Control and Water Conservation District	Cece Sellgren
312	Wildcat Creek Fish Passage and Habitat Restoration (1135)(#7)	East	Contra Costa County Flood Control and Water Conservation District	pdetj@pw.cccounty.us
313	Wildcat Creek Watershed Erosion and Sediment Control Project	East	East Bay Regional Park District	palexander@ebparks.org
314	Wildcat Sediment Basin Desilt, North Richmond (#5)	East	Contra Costa County Flood Control District	pdetj@pw.cccounty.us
315	Wildcat/San Pablo Creeks Phase II Channel Improvements, San Pablo (#9)	East	City of San Pablo	adeleh@SanPabloCA.gov
316	Zone 1 Recycled Water- Pleasant Hill Build Out	East	Contra Costa Sanitary District	dberger@centralsan.org

Coordinating Committee
San Francisco Bay Area
Integrated Regional Water Management Plan
c/o San Francisco Public Utilities Commission
525 Golden Gate Avenue, 13th Floor
San Francisco, CA 94102

December 21, 2012

Dear Project Proponents,

As you are aware, the Bay Area Integrated Regional Water Management Plan (BAIRWMP) group has been soliciting and evaluating proposals for an upcoming Department of Water Resources (DWR) Proposition 84 Round 2 grant submittal, for which projects have been developed in accordance with the 2013 update of the Bay Area Plan. Approximately $20 million is available to the region in this round.

For this process, 67 projects totaling approximately $110 million were submitted for consideration by the BAIRWMP Coordinating Committee (CC), which designated a Project Selection Committee (PSC) to develop and score various conceptual options for packaging together a successful proposal.

The CC unanimously decided on December 17, 2012 to pursue the following projects for submission in a Round 2 application based on the analysis and recommendations of the PSC.

Project (alphabetical)	**Amount**
Bayfront Canal Flood Management & Habitat Project	$1,135,000
Breuner Marsh Restoration and Access Project	$750,000
Building Climate Change Resiliency Along the Bay with Green Infrastructure and Treated Wastewater	$2,000,000
Conserving Our Watersheds	$600,000
East Bay Municipal Utility District East Bayshore Recycled Water Project Phase 1A	$1,000,000
Lagunitas Creek Watershed Sediment Reduction and Management Project	$630,000
Milliken Creek Flood Damage Reduction	$500,000
North Bay Water Reuse Program - Sonoma Valley Recycled Water Project - Phase 2	$1,020,000
Pescadero Water Supply Project	$700,000
Petaluma Flood Impact Reduction, Water & Habitat Quality, Recreation, Phase IV	$825,000
Regional Groundwater Project (San Bruno-Daly City-San Francisco)	$500,000
Regional Water Conservation ($500,000 to Santa Clara Valley Water District)	$2,700,000
Rheem Creek Restoration Project *	$750,000
Roseview Heights Mutual Water Tanks & Main Upgrades	$500,000
San Francisco International Airport Industrial Waste Treatment Plant and Reclaimed Water Facility	$750,000
San Jose Green Infrastructure	$2,000,000
Sausal Creek Restoration Project	$500,000
San Francisco Public Utilities Commission Watershed Green Infrastructure	$900,000
Students and Teachers Restoring a Watershed (STRAW)	$500,000
Upper York Dam Removal - St. Helena	$800,000
TOTAL (20 Projects) **	**$19,060,000**

* Rheem Creek will not be included unless collaboration confirmed with East Contra Costa County Region. If the Rheem Creek Project is not included, another project from the East Subregion will take its place.
** The total is less than $20 M to provide for administration and performance monitoring

Decision Process

The PSC pursued a process to evaluate seven options and select the combination of projects that would total less than $20 million and best meet the following factors identified by the PSC:

Factors

- Must meet DWR criteria for grants to assure a successful grant proposal:
  - Benefit/ Cost analysis (ability to provide detail for analysis)
  - Match (25% match or Dis-Advantaged Community waiver)
  - Readiness to proceed
- Fair and equitable allocation of funds throughout the Region, Sub-regions, and Functional Areas
- Maintain stakeholder engagement throughout the Sub-regions and Functional Areas
- Efficient use of resources (related to total number of projects)

Options

The PSC anticipated the need to develop different options that could be evaluated against the factors above. The options included the following with the results noted in italics.

A. Most Integrated/ DWR Criteria
Projects were rated based on level of integration (benefits to multiple IRWMP functional areas[1]) as well as DWR criteria for Technical Justification and Benefit/ Cost Analysis (included consideration of Regional projects).
Issues - top ranked projects did not include any South Sub-region projects and only 1 Regional project
B. Sub-regional Prioritization
Four sub-regions prioritized projects within their geographic areas based on long-term sub-regional targets.
Issues - too many projects to include in grant application and no regional projects
C. Functional Area Emphasis
Four functional areas prioritized projects based on $5 million allocations for each functional area
Issues – Sub-regional targets not met.
D. Climate Change Emphasis
8 projects were identified and ranked that specifically focused on Climate Change
Issues - Functional Area and Sub-region allocations were unbalanced –not pursued further.

In evaluating the options above, the PSC developed the following screening rules:

Rules

1) Cap- No project or entity to receive more than $2 million (Regional Conservation excepted since this is a program with multiple agencies involved) due to breadth and depth of submittals
2) Floor- No project less than $500,000 included (original floor in project request)
3) Planning Limit- No more than 5% ($1 million total) of full submittal
4) Proponent Ranking- Proponents with multiple submittals were asked to rank them and this information was considered in project selection
5) Combined Projects- If projects are separate under CEQA, or are not all within an option's priority funding range, they cannot be combined

---

[1] Bay Area IRWMP Functional Areas include: Water Supply and Quality; Wastewater and Recycling; Flood Protection and Stormwater; Habitat and Watersheds

E. Hybrid Options

E-1: Modified Option B (Sub-region Priorities) to include regional projects (STRAW and Regional Conservation) and incorporate some results of Option A.

E-2: Variation of E-1 that would allocate $1 million for Planning/Assessment projects. *Dropped given number of implementation projects and DWR focus on capital outlay*.

E-3: Modified Option A (Integration Option) to add funding for South and Regional projects and adjust amounts to stay below limit.

The PSC recommended Option E-1 to the Coordinating Committee as the option best meeting identified factors after reviewing common projects in all options.

A copy of the Options document prepared for the CC is attached. If you have questions about particular options or projects, please contact the appropriate IRWMP leads at:
http://bairwmp.org/subregions/contacts

We sincerely appreciate your participation in this process and regret that we could not accommodate more requests for funding. We value hearing about your experience in submitting and will look to incorporate feedback into future grant rounds. Please do not hesitate to contact us with comments and suggestions at Projects@bairwmp.org.

Sincerely,

Steven R. Ritchie
Assistant General Manager, Water
San Francisco Public Utilities Commission
Bay Area IRWMP Coordinating Committee Chair

2013 Bay Area Integrated Regional Water Management Plan

Finance Chapter

Table of Contents

Bay Area Integrated Regional Water Management Plan

Public Workshop #2

Project Selection, Financing and Collaboration

Monday, January 28, 2013

4:00 – 6:00 p.m.

StopWaste.org

1537 Webster Street, Oakland, CA

Summary of Workshop Participant Input

Communication challenges

- A workshop participant who is also a BAIRMWP project proponent commented that communication regarding submitting projects for the Proposition 84 Round 2 grant application was poor and that he was not receiving updates and information in a timely manner. Steve Ritchie, Chair of the BAIRWMP Coordination Committee (CC), indicated that the CC would follow up on this concern.

Funding Sources and Mechanisms

Following presentations provided by Carol Mahoney (Zone 7), Caitlin Sweeney (San Francisco Estuary Partnership), and Grant Schlereth (Arup) on financing sources and collaboration strategies (see BAIRWMP website for workshop presentations: www.bairwmp.org), workshop participants provided their own examples of funding mechanisms they have used and/or have found to be effective to fund water resource projects. These sources include:

- The California Financing Coordinating Committee hosts regular Funding Fairs that are open to the public and very helpful. The fairs provide opportunities for project proponents to obtain information about currently available infrastructure grant, loan and bond financing programs and options.
    - For more information, visit: http://www.cfcc.ca.gov/funding_fairs.htm.
- Small non-profit organizations are able to work with the Sonoma County Water Agency, which provides small grants for stakeholder engagement and localized involvement in making improvements to the water system. This has led to a number of successful habitat restoration projects.
- Participation in carbon markets for mitigation credits can potentially provide funding for water resource projects. The San Francisco Public Utilities Commission (SFPUC) is exploring this approach and the Point Reyes Bird Observatory is performing work in this area for grasslands and watersheds. In addition, smaller community based watershed groups are beginning to get involved in the carbon credit market. The Bay Area Watershed Network (BAWN) will be hosting a panel on carbon credits in February 2013 to discuss carbon credits and their potential applications.

    - For more information about the BAWN panel, visit: http://www.sfestuary.org/watershed-network.
- SFPUC provides funding for Alameda County Resource Conservation District staff to work on watershed restoration projects. This support provides the RCD with the resources it needs to implement projects; this has proved to be a very successful partnership.
- Estate planning for land trusts has allowed a number of conservation projects to take place. This is a strategy that should be considered, and it may be applicable for other types of projects as well.
- Santa Clara Valley Water District has a grant program that allows local non-profit organizations to participate in water resource projects. This funding source allows smaller organizations to implement smaller projects, as opposed to the larger infrastructure projects the BAIRMWP prioritizes. BAIRWMP should consider prioritizing funding the larger water resource agencies with funding programs similar to SCVWD because they allow smaller organizations to participate.
- The City of Livermore uses development fees to fund flood improvement projects. Developers also sometimes pay drainage fees to mitigate for stormwater runoff.
- Several local foundations, including the Lucile and David Packard Foundation and the Gordon and Betty Moore Foundation, fund watershed, wetlands and riparian projects.
- The San Francisco Bay Joint Venture funding database is a helpful resource. The database includes federal, state and local agency funding sources as well as private sources such as foundations and educational institutions.
    - For more information, visit: http://www.sfbayjv.org/funding-list.php.
- Non-profit organizations are very creative in identifying resources and finding ways of implementing projects. Some use large teams of volunteers for watershed projects, including Acterra in San Mateo and Santa Clara counties.

Partnership and Participation in BAIRMWP

- It would be helpful to make available a "cost-benefit consultant" to help project proponents, particularly non-profit organizations that often don't have the resources to do this, in this important aspect of the project applications
- To facilitate partnerships between larger public agencies and smaller organizations, it would be helpful if both sides could clearly articulate what they are looking for in a partner and what they aim to achieve. For example, if larger agencies could to clarify what kinds of projects they are prioritizing, the smaller organizations can then develop some ideas on how to create a mutually beneficial partnership. They might consider articulating/sharing this on a central website that is easily accessible.
- A relatively small number of projects included the 2013 BAIRWMP are being led by local cities. The Coordinating Committee should better understand the barriers to participation.
- DWR's requirements for disadvantaged community (DAC) projects to participate in the BAIRWMP, and the DAC boundaries, make it very challenging to participate. The process is complex and DACs have limited staff to work on applications and the intensive reporting and paperwork required.

SIGN-IN SHEET

Bay Area Integrated Regional Water Management Plan
Public Workshop #1
Monday, January 28, 2013, 4:00 – 6:00 p.m.
StopWaste.org, 1537 Webster Street, Oakland, CA

Name	Organization	Email	Phone
Joe Leach	City of Dixon	JLeach@CI.Dixon.CA.us	209-386-2201
Kevin Booker	Sonoma Valley CSD	kbooker@scwa.ca.gov	707 521-1865
Nico Procos	City of Palo Alto	nicolas.procos@cityofpaloalto.org	650. 329. 2214
Rainer Hoenicke	SFEI-ASC	rainer@sfei.org	510 - 746 - 7381
Roger Fry	CDM Smith	fryrg@cdmsmith	925-933-2900
Claire Elliott	Acterra	clairee@acterra.org	650-962-9876 ext 311
Jeff Rasmussen	EBRPD	jrasmussen@ebparks.org	510-544-2204
Yoriko Kishimoto	MROSD	ykishimoto@openspace.org	650-644-5084
Luisa Valiela	EPA	valiela.luisa@epa.gov	415-972-3400
Scott Dusterhoff	Stillwater Sciences	dusterhoff@stillwatersci.com	510-848-8098
Julie Lucido	City of Napa	jlucido@cityofnapa.org	707 257-9690
Grant Schleteth	Army	grant.schleteth@army.m[illegible]	415-954-0246
[illegible] Schreck	Bay Friendly	[illegible]@bayfriendly	415 847 9559
Colleen Haraden	Balance	charaden@balancehydro.com	510 520 5417

SIGN-IN SHEET

Bay Area Integrated Regional Water Management Plan
Public Workshop #1
Monday, January 28, 2013, 4:00 – 6:00 p.m.
StopWaste.org, 1537 Webster Street, Oakland, CA

Name	Organization	Email	Phone
Bret Swain	City of East Palo Alto	BSwain@CityofEPA.org	650 853 3159
Doug Moore	West Yost Assoc	dmoore@westyost.com	530-792-3275
Thomas Niesar	ACWD	Thomas.Niesar@ACWD.com	510-668-4210
Brian Mendenhall	SCVWD		408-630-3093
Carol Mahoney	Zone 7 water Agency		
Mark Boucher	Contra Costa Co. FC		
Mike Cowen	EBDA	[illegible]	510-278-5910
Chris Malan	ICARE	cmalan@myoneearth.org	707.322.8677 cell
Lucy Croy	NewFields	Lcroy@newfields.com	510-842-0540
Renee F. Webber	North Bay Water Reuse authority	you know	
Brad Sherwood	Sonoma CWA	Sherwood@Scwa.CA.Gov	707-547-1927
Jill Bicknell	SCVURPPP	jbicknell@eoainc.com	408 720-8811 x1
Trathen Heckman	Daily Acts	Trathen@dailyacts.org	707-789-9664

Name	Organization	Email	Phone
Carl Morrison			
Crystal Simons	Alameda Co. RCD	crystal.simons@ca.nacdnet.net	
Naomi Feger	SF Bay RWQCB	nfeger@waterboards.ca.gov	
I. BARANDIARAN	ARUP	IGNACIO.BARANDIARAN@ARUP.COM	
Harry Seraydarian			
Carol Mahoney			
Mary Grim	Contra Costa RCD	mary.grim@ca.nacdnet.net	
Erika Barraza	Carollo Engineers	ebarraza@carollo.com	925-932-1710
Nick Lin	City of Livermore	Yu-Jian.Lin@hotmail.com	415-837-8331
Pamela Lung	City of Livermore	pglung@cityoflivermore.org	925-960-4538
Dawn Argula	Alameda Co BOS #1	dawn.argula@att.net	925-551-6995

Name	Organization	Email	Phone
MATTHEW GRAUL	EAST BAY REGIONAL PARK DISTRICT	mgraul@ebparks.org	510 544-2327
Ben Wallace	Solano Land Trust	ben@solanolandtrust.org	707-432-0150 x203
Mitch Avalon	CCC FCD	mavalon@pw.cccounty.us	925-313-2203
Gilbert Yau	Belmont	gyau@belmont.gov	650 595 7467
Natalya Blumenfeld	Golden Gate National Parks Conservancy	NBlumenfeld@parksconservancy.org	415-561-3046
Robert Davis	Parsons	Robert.P.Davis@Parsons.com	415.519.7267
Kevin Lunde	San Francisco Bay RWQCB	klunde@waterboards.ca.gov	510 622-2431

Appendix E-8

Disadvantaged Community Outreach Materials

Bay Area Integrated Regional Water Management Plan

Projects Serving Disadvantaged Communities

Focus on Disadvantaged Communities

The San Francisco Bay Area Integrated Regional Water Management Plan (Bay Area IRWMP) is a planning process and document that identifies Bay Area water challenges and opportunities. It also encourages and describes how water resources management agencies and communities can work together to improve water supply reliability, protect water quality, manage flood protection, maintain public health standards, protect habitat and watershed resources, and enhance the overall health of San Francisco Bay.

Serving the water needs of low-income, disadvantaged communities (DACs) is a high priority for the people in the water agencies and non-profit organizations who are developing the Bay Area IRWMP. Water projects serving these communities are able to leverage the following advantages:

- The normally required 25% cost share may be waived for DAC projects.
- Eligible projects include both construction projects and *studies* to identify specific water needs that may lead to a construction project.

Eligible DAC Projects

An eligible DAC project needs to serve a DAC community's ""critical water supply or water quality need." Example projects may include (but are not limited to):

- Management of flood flows that threaten the habitability of dwellings
- Wastewater treatment necessary to abate or prevent surface or groundwater contamination
- Replacement of failing septic systems with a system that provides for the long-term wastewater treatment needs of the community.

Projects included in the Bay Area IRWMP become eligible for competitive state grants, but grants are not guaranteed.

Where are DACs in the Bay Area?

The California Department of Water Resources defines DACs as communities and neighborhoods with an annual median household income (MHI) less than 80 percent of the statewide average (or incomes less than $48,706). To understand where DACs are located in the Bay Area, visit the Bay Area IRWMP website (www.bairwmp.org) which hosts a series of DAC-specific maps.

How to Learn More

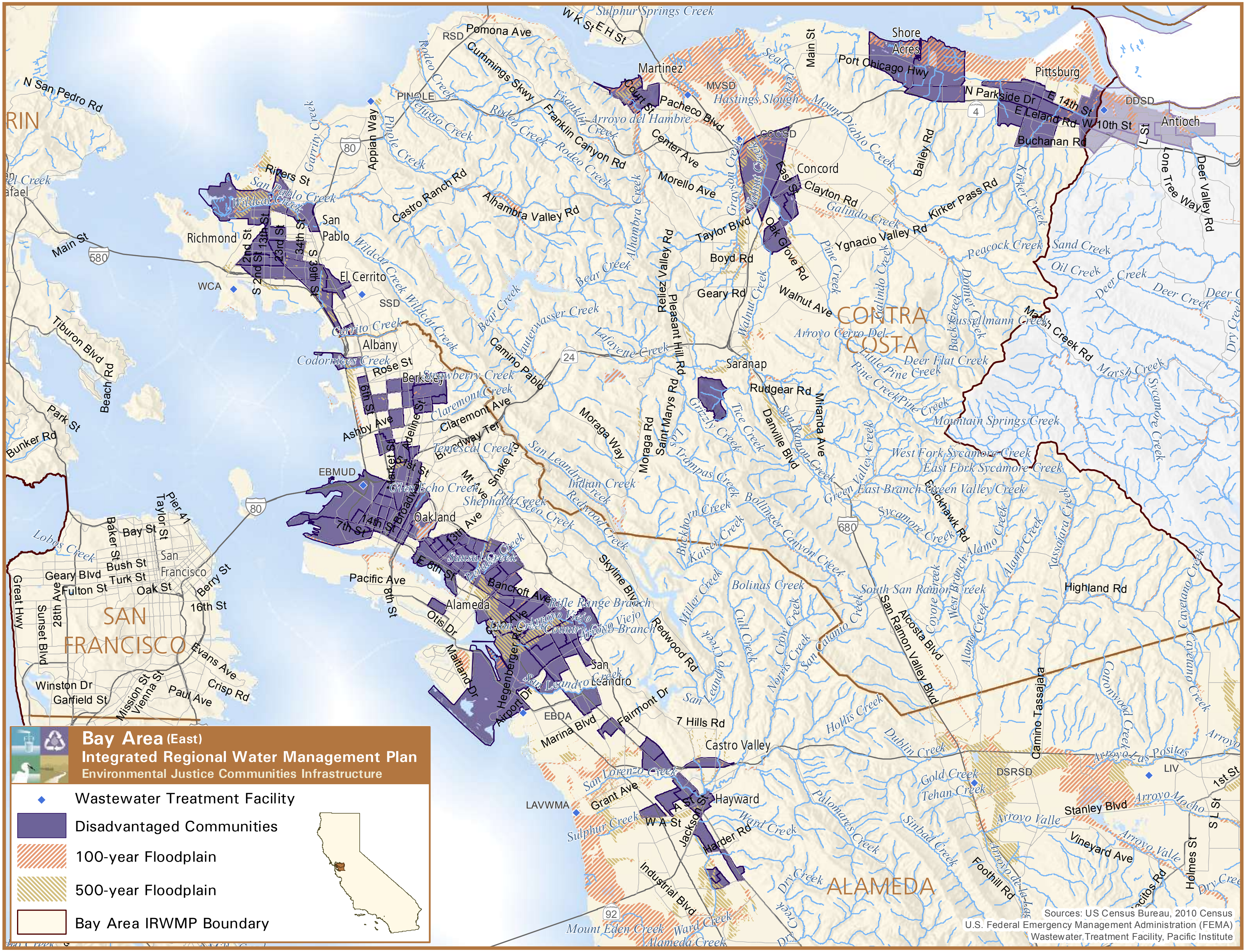
To learn more about the Bay Area IRWMP process, including how to submit a DAC project, please visit the project website at www.bairwmp.org. You can also contact one of the following subregional leads who can help guide you through the DAC eligibility determination and project submittal processes.

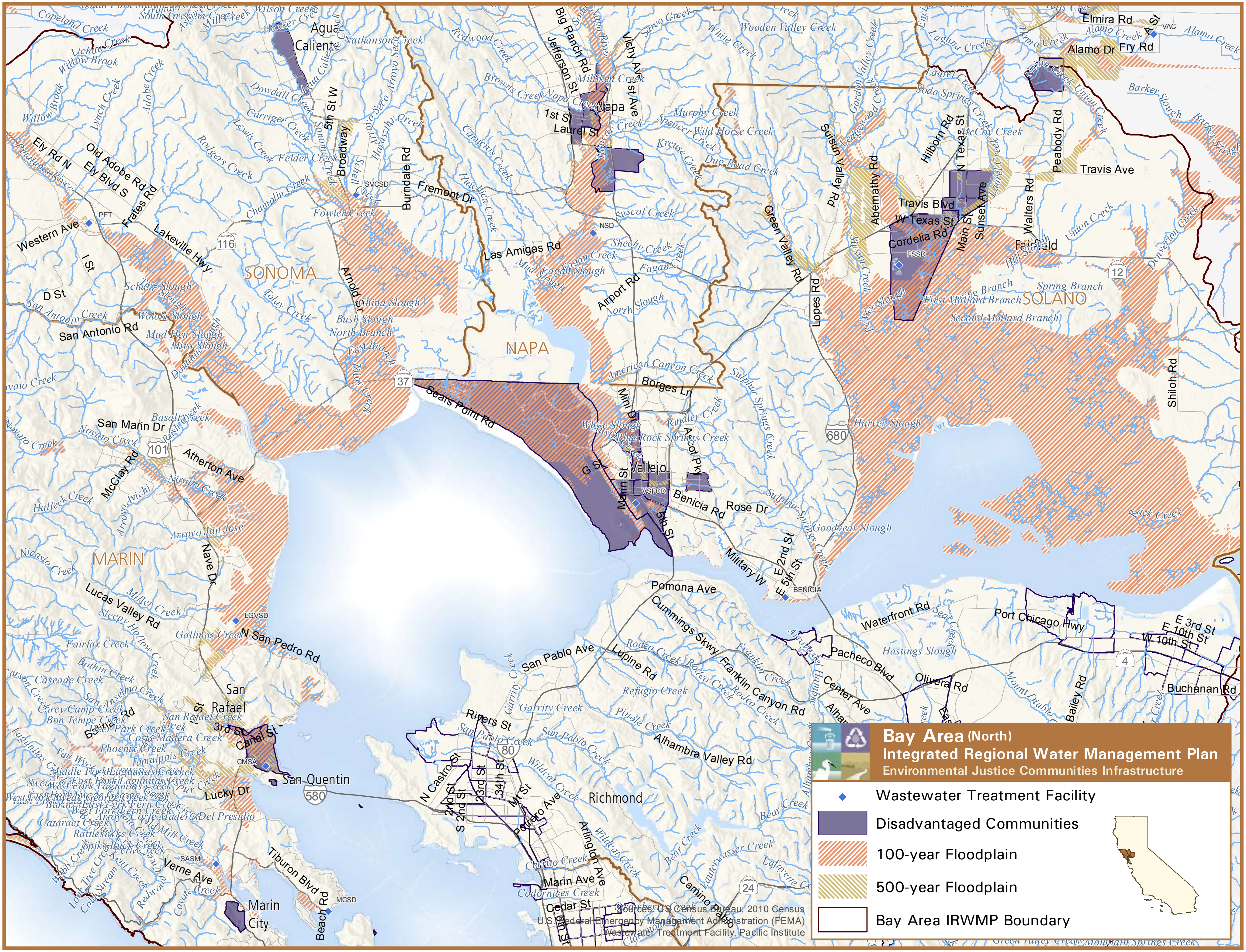
- North (Marin, Sonoma, Napa, Solano counties) – Harry Seraydarian: harryser@comcast.net
- East (Contra Costa, Alameda counties) – Mark Boucher: mbouc@pw.cccounty.us
- South (Santa Clara county) – Brian Mendenhall: BMendenhall@valleywater.org)
- West (San Francisco, San Mateo counties) – Cheryl Muñoz: cmunoz@sfwater.org

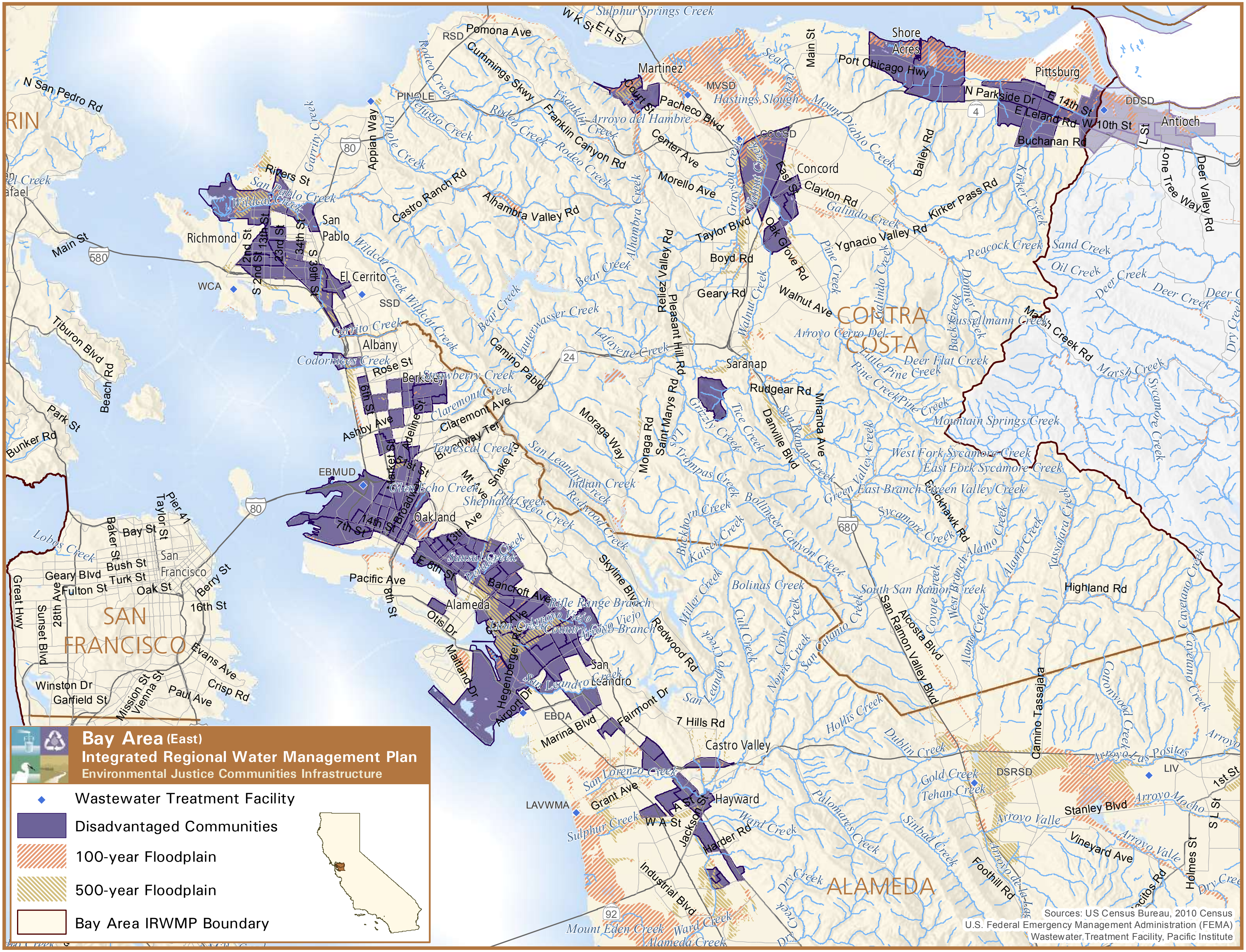
Project Submittal Deadline – September 1, 2012

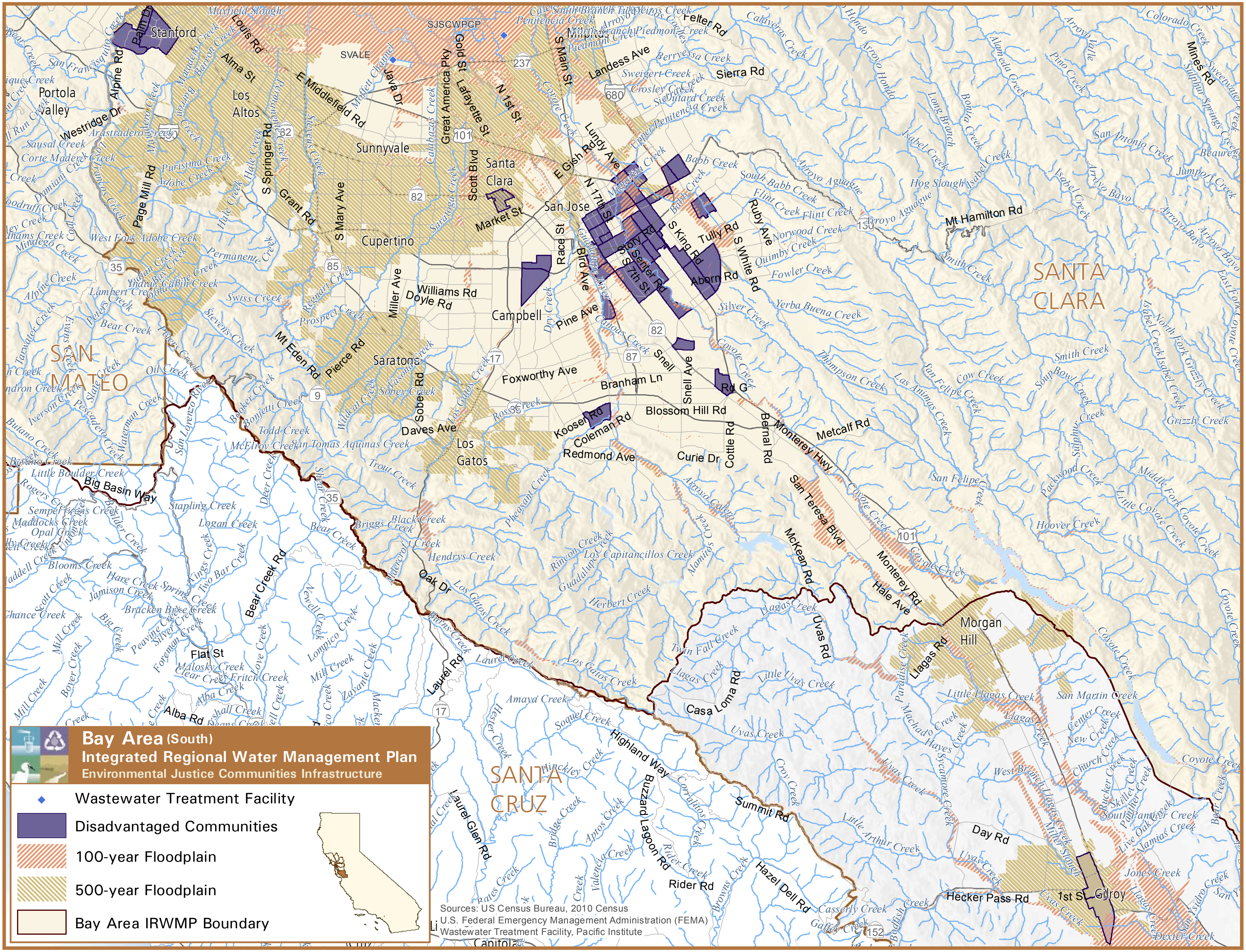
To be included in the Bay Area IRWMP, proposals must be submitted on the project website by September 1.

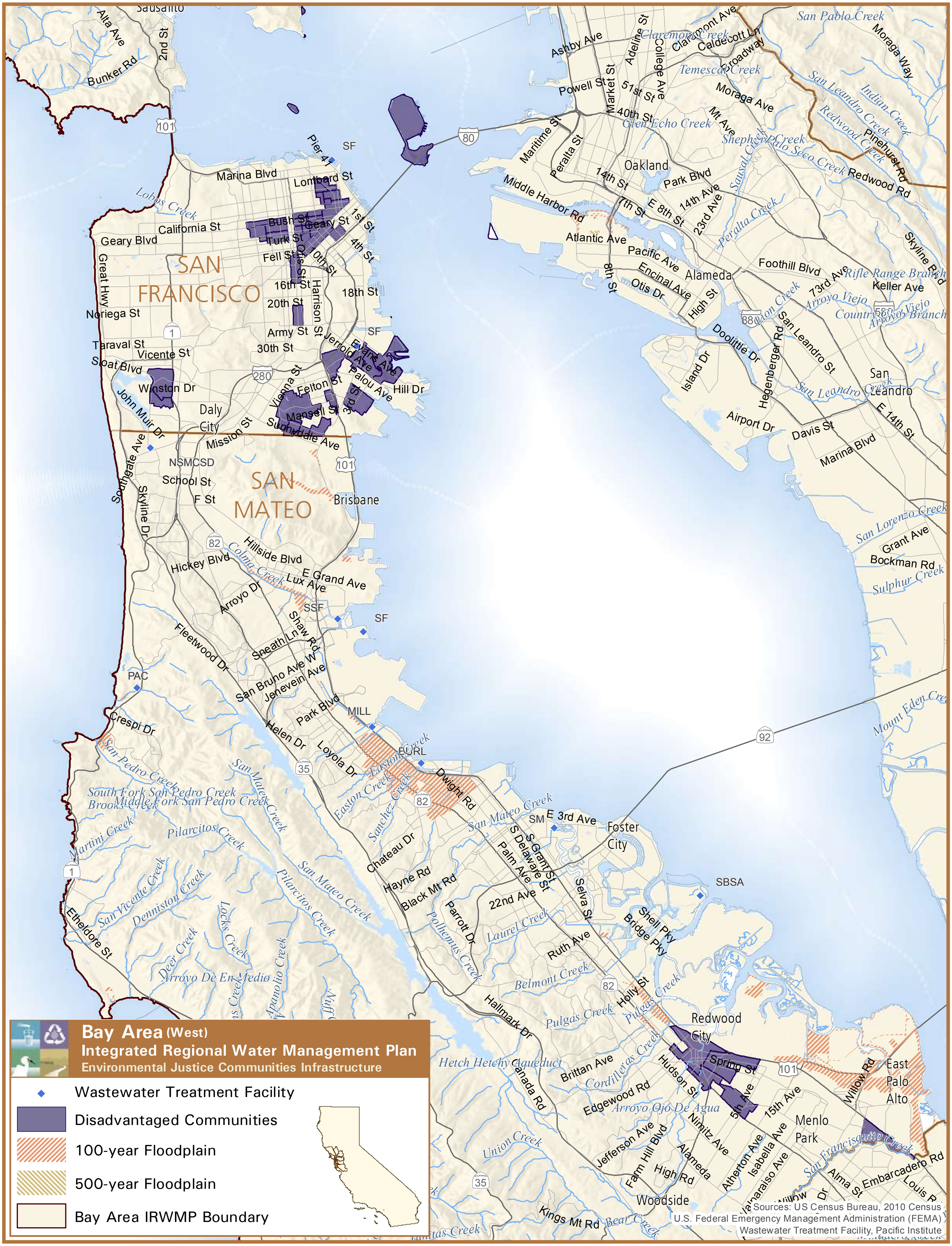
www.bairwmp.org


Bay Area (East)
Integrated Regional Water Management Plan
Environmental Justice Communities Infrastructure
Wastewater Treatment Facility
Disadvantaged Communities
100-year Floodplain
500-year Floodplain
Bay Area IRWMP Boundary
Sources: US Census Bureau, 2010 Census
U.S. Federal Emergency Management Administration (FEMA)
Wastewater Treatment Facility, Pacific Institute
CONTRA COSTA
ALAMEDA
SAN FRANCISCO
Richmond
San Pablo
El Cerrito
Albany
Berkeley
Oakland
Alameda
San Leandro
Castro Valley
Hayward
Martinez
Concord
Pittsburg
Antioch
Shore Acres
Saranap
RSD
PINOLE
MVSD
CCCSD
DDSD
WCA
SSD
EBMUD
EBDA
LAVWMA
DSRSD
LIV
Port Chicago Hwy
Pacheco Blvd
Clayton Rd
Ygnacio Valley Rd
Kirker Pass Rd
Camino Pablo
Skyline Blvd
Redwood Rd
San Ramon Valley Blvd
Foothill Rd
Stanley Blvd
Vineyard Ave
Wildcat Creek
San Pablo Creek
Walnut Creek
San Leandro Creek
San Lorenzo Creek
Alameda Creek


Bay Area (North)
Integrated Regional Water Management Plan
Environmental Justice Communities Infrastructure
Wastewater Treatment Facility
Disadvantaged Communities
100-year Floodplain
500-year Floodplain
Bay Area IRWMP Boundary
Sources: US Census Bureau, 2010 Census
U.S. Federal Emergency Management Administration (FEMA)
Wastewater Treatment Facility, Pacific Institute
SONOMA
NAPA
SOLANO
MARIN
Agua Caliente
Napa
Fairfield
Vallejo
San Rafael
San Quentin
Marin City
Richmond
BENICIA
VSFCD
FSSD
NSD
SVCSD
PET
LGVSD
CMSA
SASM
MCSD
VAC


Bay Area (East)
Integrated Regional Water Management Plan
Environmental Justice Communities Infrastructure
Wastewater Treatment Facility
Disadvantaged Communities
100-year Floodplain
500-year Floodplain
Bay Area IRWMP Boundary
Sources: US Census Bureau, 2010 Census
U.S. Federal Emergency Management Administration (FEMA)
Wastewater Treatment Facility, Pacific Institute
CONTRA COSTA
ALAMEDA
SAN FRANCISCO
Martinez
Pittsburg
Antioch
Concord
Richmond
San Pablo
El Cerrito
Albany
Berkeley
Oakland
Alameda
San Leandro
Castro Valley
Hayward
Saranap
Shore Acres
RSD
PINOLE
MVSD
CCCSD
DDSD
WCA
SSD
EBMUD
EBDA
LAVWMA
DSRSD
LIV


Bay Area (South)
Integrated Regional Water Management Plan
Environmental Justice Communities Infrastructure
Wastewater Treatment Facility
Disadvantaged Communities
100-year Floodplain
500-year Floodplain
Bay Area IRWMP Boundary
Sources: US Census Bureau, 2010 Census
U.S. Federal Emergency Management Administration (FEMA)
Wastewater Treatment Facility, Pacific Institute
SANTA CLARA
SAN MATEO
SANTA CRUZ
Stanford
Portola Valley
Los Altos
Sunnyvale
Santa Clara
San Jose
Cupertino
Campbell
Saratoga
Los Gatos
Milpitas
Morgan Hill
Gilroy
SJSCWPCP
SVALE


Bay Area (West)
Integrated Regional Water Management Plan
Environmental Justice Communities Infrastructure
Wastewater Treatment Facility
Disadvantaged Communities
100-year Floodplain
500-year Floodplain
Bay Area IRWMP Boundary
Sources: US Census Bureau, 2010 Census
U.S. Federal Emergency Management Administration (FEMA)
Wastewater Treatment Facility, Pacific Institute
SAN FRANCISCO
SAN MATEO
Oakland
Alameda
San Leandro
Daly City
Brisbane
Foster City
Redwood City
East Palo Alto
Menlo Park
Woodside
Sausalito
SF
NSMCSD
SSF
PAC
MILL
BURL
SM
SBSA

BAIRWMP Disadvantaged Community (DAC) Outreach Log

Date	Type	Contact	Description
2/14/2012	Email	Rosina Roibal, Bay Area Environmental Health Coalition	Email to Rosina re: outreach to EJ groups in Bay Area; Rosina sent notice to her listserv
2/17/2012	Phone call	Jesse Mills, SFEP	Phone call with Jesse to develop first generation DAC map
2/18/2012	Maps	Jesse Mills, SFEP	Developed first generation DAC map
2/21/2012	Phone call/criteria	Bruce Shaffer, DWR	Phone call with Bruce re: DAC eligibility criteria; provided list of questions for Bruce to vet internally
2/21/2012	Phone call	Maria Elena Kennedy, Greater LA IRWMP	Interview with Maria Elena re: DAC outreach strategies
2/21/2012	Email	Emily Alejandrino, DWR	Email to Emily (tribal liaison) re: IRWMP tribal outreach
3/23/2012	Phone call	Maria Elena Kennedy, Greater LA IRWMP	DAC outreach strategies
3/23/2012	Phone call	Tim Nelson, DWR tribal liaison	Phone call re: Bay Area tribal communities
3/28/2012	Email	Various	Sent emails/email exchange with various DAC contacts requesting interviews, including Peter Vorster (Bay Institute), Chuck Striplen (SFEI), Jennifer Clary (Clean Water Action), Meena Palaniappan (Pacific Institute), Marisa Raya (ABAG), Connie Galambos Malloy (Urban Habitat), Torri Estrada (EJCW), Debbie Davis (EJWC)
4/3/2012	Interview	Jennifer Clary, Clean Water Action	Interview with Jennifer to inform DAC findings assessment
4/4/2012	Email	Jennifer Clary, Clear Water Action; Karen Pierce, SF DPH	Email exchange with introduction to Karen
4/3/2012	Interview	Debbie Davis, Environmental Justice Coalition for Water (formerly)	Interview with Debbie to inform DAC findings assessment
4/9/2012	Interview	Karen Gaffney, North Coast IRWMP	Interview with Karen re: IRWMP DAC outreach strategies

4/10/2012	Interview	Melanie Denninger, State Coastal Conservancy	Interview with Melanie to inform DAC findings assessment
4/10/2012	Interview	Karen Pierce, SF Dept of Public Health	Interview with Karen to inform DAC findings assessment
4/16/2012	Engagement objectives	n/a	Developed DAC-specific engagement objectives for Plan Updarte
4/15/2012	Assessment	n/a	Developed summary of findings from DAC interviews
4/17/2012	Planning meeting	CC members	Convened and facilitated stakeholder engagement planning meeting; presented assessment findings and discussed DAC engagement strategy with group
4/24/2012	Email	Caitlin Sweeney, SFEP	Email with Caitlin re: following up with current DAC project sponsors to gauge their interest in submitting next phase projects for the Plan
4/27/2012	Phone call	Caitlin Sweeney, SFEP	Planning call with Caitlin re: coordinating with current DAC project sponsors
6/7/2012	Phone call	Marisa Raya, ABAG	Conversation with Marisa re: DAC projects and outreach to DACs
6/7/2012	Developed communication text	Caitlin Sweeney, SFEP	Drafted email text for Caitlin Sweeney to send to current DAC project sponsors re: idenitying projects for the 2013 Plan Update
6/7/2012	Email	Various	Caitlin Sweeney emailed current current DAC project sponsors re: identifying projects for the 2013 Plan Update
6/8/2012	Email	Harry Seraydarian	Email exchange with Harry re: a potential DAC contact - Kristen Schwind, Bay Localize
6/11/2012	Email/review	Caitlin Sweeney, others	Email exchange with Caitlin re: project proposal from the Watershed Project on Richmond Greenway
6/11/2012	Email/process design	Mark Boucher, Carol Mahoney	Email to Mark and Carol re: vetting DAC projects and establishing a process for guiding DAC project applicants through the submittal
6/12/2012	Email/process design	Mark Boucher, Carol Mahoney, Caitlin Sweeney	Email exchange re: vetting DAC projects and establishing a process for guiding DAC project applicants through the submittal process
6/12/2012	Phone call	Mark Shorett, ABAG	Phone call with Mark re: potential DAC projects
6/12/2012	Phone call	Ken MacNab, City of Calistoga	Phone conversation with Ken re: potential DAC projects in the City of Calistoga

6/12/2012	Phone call	Ted Daum, DWR	Phone conversation with Ted Daum re: establishing a process for vetting DAC projects with DWR
6/13/2012	Conversation	Caitlin Sweeney, SFEP, Kara Reyes, La Luz Center	In-person conversation re: Springs communities in Sonoma Valley and potential DAC project
6/27/2012	Email	Kevin Murray, San Francisquito Creek Joint Powers Authority	Email to Kevin re: a potential DAC project on San Francisquito Creek
6/27/2012	Phone call	Kristen Schwind, Bay Localize	Phone conversation with Kristen re: potential DAC projects and ngo's that serve DACs
6/27/2012	Email	Brent Butler, City of East Palo Alto	Email exchange with Brent re: the City of EPA submitting a DAC projects for the Plan Update
6/27/2012	Email	William Gibson, San Mateo County	Sent email to William re: potential DAC project
6/27/2012	Email	Matthew Snyder, City of San Francisco	Sent email to Matthrew re: potential DAC project
6/28/2012	Email	Various	Email sent to Frank Lopez (Urban Habitat), Amy Vanderwarker (CA Environmental Justice Alliance), Nile Malloy (Communities for a Better Environment), Ericka Erickson (Marin Grassroots) re: potential DAC
6/29/2012	Process	n/a	Developed process document (including roles) for providing DAC projects sponsors with guidance/assistance and vetting project ideas
6/29/2012	Planning	Outreach subcommittee	Held conference call with Outreach Subcommittee where K&W presented DAC project guidance/vetting process (process was
7/2/2012	Phone call/email	Cynthia D'Agosta, Committee for Green Foothills	Phone call and email exchange with Cynthia re: the Committee submitting a project for the Plan Update (they had a project in the 2006 Plan)
7/2/2012	Email/defining DAC requirements	Carl Morrison	Email exchange with Carl re: match waiver for DACs
7/3/2012	DAC maps	n/a	Finalized second generation DAC maps (total of 5), including region-wide map and 4 subregion maps
7/6/2012	Email	Caitlin Sweeney, SFEP	Email exchange with Caitlin outlining next steps in identifying DAC projects
7/13/2012	Website	n/a	Translate and post Workshop #1 Spanish-language notice and agenda

7/13/2012	Email	Master contact list including DAC-serving organizations	Workshop #1 notice (three emails prior to workshop and one follow-up)
7/13/2012	News release	Bay Area media	Media release for Workshop #1 sent to Spanish-, Vietnamese, and Chinese-language newspapers
7/20/2012	Email/website	Mark Boucher, David Siedband	Email to Mark and David re: making the DAC maps available on the BAIRWMP website and creating a dedicated DAC page
7/23/2012	Public workshop	Various	BAIRWMP public workshop, where project submittal advice was provided (total of 11 DAC representatives attended workshop)
7/24/2012	Email/phone	Harry Seraydarian	Phone call and email exchage with Harry re: a potential DAC project in
7/24/2012	Email	Marie Valmores, CC Water, Alyson Watson, City of Pittsburg	Email exchange with Marie and Alyson re: potential DAC project in Pittsburg
7/25/2012	Outreach materials	Various	Developed draft DAC-specific outreach flyer, sent to various PUT members for review
7/26/2012	Email	Walter Pease, City of Pittsburg, Alyson Watson, RMC	Email exchange with Walter and Alyson re: potential DAC project in Pittsburg
7/27/2012	Email/maps	Rebecca Tuden, City of Oakland	Sent Becky DAC map
7/27/2012	Outreach materials	n/a	Finalized DAC-specific outreach flyer
7/27/2012	Phone call	Phil Harrington, City of Berkeley	Phone call with Phil re: potential DAC project for City of Berkeley
7/27/2012	Email	Various	Email to FA leads, Outreach subcommittee members, and attendees of the July 23 CC meeting re: next steps in DAC project identification, including materials for them to conduct DAC outreach and process
7/30/2012	Website	n/a	DAC maps uploaded to website; DAC-specific page on website created; reviewed website and suggested edits to make material easier to find
7/30/2012	Email	FA leads	Sent emails to each FA lead requesting that they send notice to their membership groups re: DAC projects
7/30/2012	Email	Various DAC contacts	Sent email to DAC contacts who attended July 23 workshops (total of
7/31/2012	Email/data analysis	Carlos Martinez, City of East Palo Alto	Email to Carlos re: DAC census tracts in EPA. Analyzed data using DWR GIS tool to identify DAC census tracts for potential project

8/1/2012	Email	Kevin Murray, San Francisquito Creek Joint Powers Authority	Email exchange with Kevin re: potential DAC project for San Francisquito Creek
8/14/2012	Phone call	Harold Hedelman, Watershed Project	Phone call with Harold re: potential DAC project the Watershed Project is considering submitting
8/14/2012	Phone call	Chien Wong, Alameda County Flood	Phone call with Chien Wong re: potential DAC project
8/17/2012	Email/project concept	Ted Daum, DWR	Shared Watershed Project DAC project concept with Ted for comments/review
8/23/2012	Phone call	Caitlin Sweeney, SFEP	Phone call with Caitlin to clarify DAC eligibility requirements and discuss Watershed Project DAC project concept
8/23/2012	Phone call	Ted Daum, DWR	Phone call with Ted to clarify DAC eligibility requirements
8/27/2012	Phone call	Phil Harrington, City of Berkeley	Questions about DAC project eligibility and submitting DAC-benefitting Berkeley public works project on the website. Also referred to Caitlin Sweeney.
8/30/2012	Email blast	IRWMP listserv	Email to entire listserv re: clarification of DAC eligibility requirements
9/5/2012	Emails	Karen McBride, Rural Community Assistance Corporation (City of Pescadero)	Emails/phone calls re: eligibility of Pescadero DAC project, included Carole Foster (San Mateo County)
9/7/2012	Phone/emails	Kimra McAfee, Friends of Sausal Creek	Assistance re: DAC project, making sure it was submitted online successfully

Appendix E-9

Materials for Outreach to Bay Area Native American Tribes

Native American Tribes of the Bay Area

The following represents the Native American Tribes of the San Francisco Bay Area. Because of the boundaries of the Bay Area IRWMP jurisdiction, the tribes fall outside of the boundaries, with one significant exception – the Casino San Pablo in the East Bay, whose land and operations are owned and managed by the Lytton Band of Pomo Indians.

Sources: Chuck Striplen, San Francisco Estuary Institute; Karen Gaffney, North Coast IRWMP; Brian Campbell, EBMUD; tribal websites; DWR Water Plan

Location/population, contacts, IRWMP jurisdiction, issues, potential for IRWMP projects

Tribe	Tribal Lands/ Population	Contact Info	Jurisdiction	Issues/Capacity	Project Potential/ Partner
Lytton Band of Pomo Indians	Healdsburg. About 200-300 enrollees. Casino San Pablo in San Pablo is their reservation. They own 50 acres in Windsor and have wanted to develop it against local opposition.	Marjorie Mejia, Chairperson Lisa Miller, Tribal Administrator 1300 North Dutton Avenue Suite A Santa Rosa, CA 95401-7108	**Primarily North Coast IRWMP** per Karen Gaffney except for Casino San Pablo in Bay Area IRWMP		Casino San Pablo in San Pablo adjacent to a creek near the Bay.
Muwekma Ohlone Tribe		Alan Leventhal - Tribal Anthropologist aleventh@email.sjsu.edu 408-761-4516		Primary focus of most of their activity is in pursuing federal recognition and casino development	
Mishwal Wappo Tribe	Napa Valley/Alexander Valley. 340 living members.	Scott Gabaldon - Chairman scottg@MishewalWappoTribe.com 707-494-9159 Mishewal Wappo Tribe of Alexander Valley	**Not in BAIRWMP jurisdiction**	Primary focus of most of their activity is in pursuing federal recognition and casino development.	

Tribe	Tribal Lands/ Population	Contact Info	Jurisdiction	Issues/Capacity	Project Potential/ Partner
		P.O. Box 1086 Santa Rosa, CA 95402; Fax: 1 (707) 843-5006 http://www.mishewalwappotribe.com/		Chuck Striplen, SFEI, trying to work with them on environmental issues.	
Kashia Band of Pomo Indians of the Stewarts Point Rancheria	The Kashia Band's reservation is the Stewarts Point Rancheria. It occupies 40 acres in Sonoma County and 86 tribal members reside there. It conducts business from Santa Rosa.	3535 Industrial Drive, Suite B-2,, Santa Rosa, CA 95403 Nina Hapner - Environmental Director nina@stewartspoint.org 707-591-0580 x107 http://www.kashiapomo.blogspot.com/	**North Coast IRWMP** per Karen Gaffney		Construction potential – yes. Sonoma Co Water Agency (Grant Davis)
Dry Creek Rancheria (Pomo)	75 acres along Russian River between Healdsburg and Cloverdale. Operates River Rock Casino.	Dry Creek Rancheria Tom Keegan - Environmental Director TomK@drycreekrancheria.com 707-857-1810 x117 www.drycreekrancheria.com	**North Coast IRWMP** per Karen Gaffney The Tribe's waste water facility treats water to the highest standard, and the Rancheria recycles its treated water. The Department of Environmental Protection (DEP) was formed to protect the Dry Creek Rancheria's air, land and water from pollution and		Construction potential – yes. Sonoma Co Water Agency (Grant Davis) --River Rock Casino (creek restoration?)

Tribe	Tribal Lands/ Population	Contact Info	Jurisdiction	Issues/Capacity	Project Potential/ Partner
			to provide a healthy and safe environment for visitors, residents and future generations. Dry Creek Rancheria environmental work done by ESA.		
Federated Indians of Graton Rancheria	Graton consists of Coast Miwok and Southern Pomo – 1 acre/1 house in Graton in private ownership. Also, new casino complex on Laguna de Santa Rosa.	Devin Chatoian - Environmental Director Lorelle Ross - Vice Chair dchatoian@gratonrancheria.com 707-566-2288; Greg Sarris, Chairperson M Joann Adams, Tribal Administrator Gene Buvelot; 6400 Redwood Drive Suite 300 Rohnert Park, CA 94928-2341	**North Coast IRWMP** per Karen Gaffney		**Construction potential – yes.** Sonoma Co Water Agency (Grant Davis) New casino complex on Laguna de Santa Rosa.
Amah Mutsun Tribal Band	South Bay –	Jim Keller - Director of Conservation, or Chuck Striplen - Science Advisor way_institute@sbcglobal.net (831) 212-5912	**Pajaro IRWMP** per Chuck Striplen		

Last updated: 8/12/12

Bay Area Native American Tribe Outreach Log

Date	Type	Contact	Description
3/23/2012	Email	Tim Nelson, DWR tribal liaison	Received list and maps of tribes in Bay Area
3/23/2012	Phone call	Tim Nelson, DWR tribal liaison	Phone call re: Bay Area tribal communities
4/2/2012	Interview	Chuck Striplen, San Francisco Estuary Institute and Aman Matsun tribe member	One hour interview with Mr. Striplen by Pam Jones regarding Bay Area tribes/contacts, IRWMP jurisdictions, water interests/needs, tribal technical capacities
6/28/2012	Email	Chuck Striplen, San Francisco Estuary Institute	Received email from Mr. Striplen re: additional list of tribe contacts
6/28/2012	Email	Chuck Striplen, Aman Matsun tribe member	Email from Pam Jones to Mr. Striplen regarding follow-up on tribal contact list and development of plan
7/6/2012	Email	Chuck Striplen, San Francisco Estuary Institute	Email from Mr. Striplen regarding comments on the plan approach
7/18/2012	Email	Karen Gaffney, North Coast IRWMP; Brad Sherwood, Sonoma County Water Agency	Lettter for review of Tribal outreach approach and to determine SCWA potential to contact tribes
7/26/2012	Letter	California Native American Heritage Commission	Letter requesting assistance in developing outreach to Bay Area tribes for the BAIRWMP
8/6/2012	Email	Karen Gaffney, North Coast IRWMP; Brad Sherwood, Sonoma County Water Agency	Received response from Karen Gaffney regarding input on BAIRWMP tribal efforts
8/20/2012	Voice Mail	California Native American Heritage Commission	Message requesting input on tribal identification/contacts
8/6/2012	Email	Karen Gaffney, North Coast IRWMP; Brad Sherwood, Sonoma County Water Agency	Responded to Karen Gaffney's email of 8/6/2012 discussing BAIRWMP tribal efforts

Appendix F-1

Projects Added to the 2013 Bay Area IRWMP by the Coordinating Committee on May 28, 2014

Appendix F-1: Projects Added to the Plan

In anticipation of a third round of Proposition 84 funding, the Coordinating Committee in early 2014 solicited regional and subregional project concept proposals. The solicitation resulted in a total of 54 projects submitted, with the total amount sought for funding exceeding $420 million. These projects were then scored using 10 factors that had been developed for this concept proposal solicitation. Table F-1-1 lists the scoring factors and potential score for each factor. In some cases just a yes or no answer was all that was required.

Subsequent to the scoring, statewide drought legislation was passed and DWR essentially divided the third round in two parts with the first specifically addressing the drought. The Coordinating Committee then evaluated and rescored the submitted regional and subregional concept proposals as to how they would respond to the drought. The Bay Area regional factors in Table F-1-1 as well as scoring criteria developed after review of the DWR's Drought Solicitation Guidelines and Draft Proposal Solicitation Package (PSP) were key in selecting projects to include in the Drought Solicitation Proposal.

The eight projects listed in Table F-1-2 were ranked highly both because of Plan priorities and drought specific needs and are hereby added to the Plan. Submitted project concept proposals not evaluated for the Drought Round are being carried forward for evaluation under DWR's anticipated final Prop 84 IRWM round in 2015.

Table F-1-1: Project Scoring Factors

Factor	Criteria	Scoring (or yes or no)
1	In the Plan?	(Y/N)
	Goals/Objectives	1 to 3 points (Total of 200 points allocated among the 5 goals; 10 points per objective until 40 points maximum per goal [for flood goal, 40 points if all objectives addressed]) Tier into 3 categories: 1 – 1-66 of 200 2 – 67-123 of 200 3 – 124-200 of 200
2	Readiness to proceed	1 to 3 points 1 – Conceptual or early planning 2 – In CEQA or final design phase 3 – CEQA and all permitting complete – can start construct before April 2015
3	Provides 25% match?	(Y/N)
4	Provides at least two physical benefits?	(Y/N)
	Physical benefits	1 to 3 points 1 - Does not discuss benefits or evidence of minor benefits for project type 2 - Evidence of moderate benefits for project type 3 - Evidence of high level of benefit for project type
5	Benefit-Cost	1 to 3 points 1 - Not discussed or B/C below 1 2 - B/C between 1-3 3 - B/C above 3
6	Cash for consultant to prepare proposal?	(Y/N)
7	Collaboration with other entities	1 to 3 points 1 - Does not discuss or only narrow collaboration 2 - Moderate level of partners, some limitations to partnership 3 - Broad collaboration appropriate to project type
8	Degree of integrated benefits	1 to 4 points 1 - Benefits in only one FA or resource area 2 - Benefits 2 FAs or resource areas 3 - Benefits in 3 FAs or resource areas 4 - Benefits in 4 FAs or resource areas
9	Proposal indicates scalability?	(Y/N)
10	Regionality (for regional proposals only)	1 to 3 points 1 - Does not discuss or constrained to approx 1/3 of relevant part of region or less 2 - Brings benefits to a significant proportion of relevant region (up to 2/3) 3 - Benefits large portions in nearly all of relevant regions

Table F-1-2: Projects Added and Project IRWMP Factors Score

	Project	Total IRWMP Factors Score
1	Bay Area Regional Water Supply and Conservation Project	16.8 / 21
2	Bay Area Regional Recycled Water Project: • Calistoga Recycled Water Storage Facility • Continuous Recycled Water Production Facilities and Wolfe Road Recycled Water Pipeline Extension	16.7 / 21
3	Drought Response & Water Supply Reliability on the Central Coast	13.2 / 18
4	Enhancing and Balancing Beneficial Uses of Water Resources in the Pescadero-Butano Watershed	13.1 / 18
5	Lower Cherry Aqueduct Emergency Rehabilitation Project	12.3 / 21
6	MMWD WaterSMART Irrigation with AMI/AMR	11.5 / 18
7	Rinconada Water Treatment Plant Powdered Activated Carbon (PAC) Treatment for Drought Water Quality Conflicts	9.6 / 18
8	Zone 7 Water Supply Drought Preparedness Project	12.6 / 18

Appendix F-2

Projects Added to the 2013 Bay Area IRWMP by the Coordinating Committee on May 26, 2015

Appendix F-2: Projects Added to the Plan

The California Department of Water Resources (DWR) issued a Draft Implementation Grant Project Solicitation Package on March 12, 2015 which identified eligible projects and presented a draft scoring system for a fourth round of Proposition 84 funding, the 2015 IRWM Implementation Grant Solicitation. The Bay Area Coordinating Committee solicited regional and subregional project concept proposals via a spring solicitation. The solicitation resulted in a total of 45 project concepts submitted.

These 45 submitted project concepts were then reviewed and ranked by the Project Screening Committee (PSC), using the scoring matrix identified in the project solicitation. The matrix, presented in Table F-2-1, lists the scoring factors and potential score for each factor. In some cases just a yes or no answer was all that was required.

Numerous conceptual, hybrid, and feasible options for proposal composition were developed by the PSC in order to utilize the project scoring and ranking, and to adhere to established project selection principles, including: 1) Fair and equitable allocation of funds throughout the Region, Sub-regions, and Functional Areas; 2) Maintaining stakeholder engagement throughout the Sub-regions and Functional Areas; 3) Meeting DWR grant criteria are met, assuring a successful proposal; 4) Efficient use of resources (related to total number of projects in proposal).

The three projects listed in Table F-2-2 were ranked highly under the Bay Area Coordinating Committee's 2015 project solicitation and PSC review process, support Plan priorities and Bay Area project selection principles, and are hereby added to the Plan.

Table F-2-1: Project Scoring Factors

Factor	Criteria	Scoring (or yes or no)
1	In the Plan?	(Y/N)
	Goals/Objectives	1 to 3 points (Total of 200 points allocated among the 5 goals; 10 points per objective until 40 points maximum per goal [for flood goal, 40 points if all objectives addressed]) Tier into 3 categories: 1 – 1-66 of 200 2 – 67-123 of 200 3 – 124-200 of 200
2	Readiness to proceed	1 to 3 points 1 – Conceptual or early planning 2 – In CEQA or final design phase 3 – CEQA and all permitting complete – ready to proceed.
3	Provides 25% match?	(Y/N)
4	Provides two physical benefits?	(Y/N)
	Physical Benefits	1 to 6 points 1 - Does not discuss benefits or evidence of minor benefits for project type 3 - Evidence of moderate benefits for project type 6 - Evidence of high level of benefit for project type
5	Benefit-Cost	1 to 3 points 1 - Not discussed or B/C below 1 2 - B/C between 1-3 3 - B/C above 3
6	Cash for consultant to prepare proposal?	(Y/N)
7	Collaboration	1 to 3 points 1 - Does not discuss or only narrow collaboration 2 - Moderate level of partners, some limitations to partnership 3 - Broad collaboration appropriate to project type
8	Degree of integrated benefits	1 to 4 points 1 - Benefits in only one FA or resource area 2 - Benefits 2 FAs or resource areas 3 - Benefits in 3 FAs or resource areas 4 - Benefits in 4 FAs or resource areas
9	Proposal indicates scalability?	(Y/N)
10	Impact/Effect	1 to 3 points 1 - Does not discuss or impact constrained to approx 1/3 of relevant part of region or less; no relevance to regional priorities 2 - Brings benefits to a significant proportion of relevant region (up to 2/3); somewhat relevant to regional priorities 3 - Benefits large portions in nearly all of relevant region; highly relevant to regional priorities

Table F-2-2: Projects Added and Project IRWMP Factors Score

	Project	Total IRWMP Factors Score
1	Bay Area Regional Shoreline Resilience Program	22.86
2	Coastal San Mateo County Drought Relief Phase II	17.40
3	2020 Turf Replacement Project	16.00

Appendix G-1

Storm Water Resource Plans Added to the 2013 Bay Area IRWMP by the Coordinating Committee on April 25, 2016

Appendix G-1: Storm Water Resource Plans Added to the Plan

The California State Water Resources Control Board adopted the Final Proposition 1 Storm Water Grant Program Guidelines on December 15, 2015, which established the process and criteria for awarding grants for multi-benefit storm water management projects, through the development of a Storm Water Resource Plan. To be eligible for a Proposition 1 Storm Water Grant, each Bay Area applicant must first develop and submit their Storm Water Resource Plan, or functionally equivalent plan, to the Bay Area Integrated Regional Water Management Plan (BAIRWMP) Coordinating Committee for incorporation into the BAIRWMP.

The goals of the Storm Water Resource Plans are consistent with those of the BAIRWMP. As such, the Bay Area Coordinating Committee is in support of including Storm Water Resource Plans in the BAIRWMP, when the plans are complete.

The Storm Water Resource Plan listed below aligns with BAIRWMP priorities and protects Bay Area watersheds, and is hereby added to the 2013 BAIRWMP:

- City of San Pablo Wildcat Creek Restoration Plan

The following plans are under development and the Coordinating Committee anticipates accepting them into the BAIRWMP upon completion:

- Contra Costa Watersheds Storm Water Resource Plan

Appendix G-2

Storm Water Resource Plans Added to the 2013 Bay Area IRWMP by the Coordinating Committee on February 27, 2017

Appendix G-2: Storm Water Resource Plans Added to the Plan

The California State Water Resources Control Board adopted the Final Proposition 1 Storm Water Grant Program Guidelines on December 15, 2015, which established the process and criteria for awarding grants for multi-benefit storm water management projects, through the development of a Storm Water Resource Plan. To be eligible for a Proposition 1 Storm Water Grant, each Bay Area applicant must first develop and submit their Storm Water Resource Plan, or functionally equivalent plan, to the Bay Area Integrated Regional Water Management Plan (BAIRWMP) Coordinating Committee for incorporation into the BAIRWMP.

The goals of the Storm Water Resource Plans are consistent with those of the BAIRWMP. As such, the Bay Area Coordinating Committee is in support of including Storm Water Resource Plans in the BAIRWMP, when the plans are complete.

The Storm Water Resource Plan listed below aligns with BAIRWMP priorities and protects Bay Area watersheds, and is hereby added to the 2013 BAIRWMP:

- San Mateo County Stormwater Resource Plan

Appendix G-3

Storm Water Resource Plans Added to the 2013 Bay Area IRWMP by the Coordinating Committee on March 27, 2017

Appendix G-3: Storm Water Resource Plans Added to the Plan

The California State Water Resources Control Board adopted the Final Proposition 1 Storm Water Grant Program Guidelines on December 15, 2015, which established the process and criteria for awarding grants for multi-benefit storm water management projects, through the development of a Storm Water Resource Plan. To be eligible for a Proposition 1 Storm Water Grant, each Bay Area applicant must first develop and submit their Storm Water Resource Plan, or functionally equivalent plan, to the Bay Area Integrated Regional Water Management Plan (BAIRWMP) Coordinating Committee for incorporation into the BAIRWMP.

The goals of the Storm Water Resource Plans are consistent with those of the BAIRWMP. As such, the Bay Area Coordinating Committee is in support of including Storm Water Resource Plans in the BAIRWMP, when the plans are complete.

The Storm Water Resource Plan listed below aligns with BAIRWMP priorities and protects Bay Area watersheds, and is hereby added to the 2013 BAIRWMP:

- San Francisco Public Utilities Commission functional equivalent Stormwater Management Plan
- Daly City Vista Grande Drainage Basin functional equivalent Stormwater Resource Plan

Appendix G-4

Storm Water Resource Plans Added to the 2013 Bay Area IRWMP by the Coordinating Committee on May 21, 2018

Appendix G-4: Storm Water Resource Plans Added to the Plan

The California State Water Resources Control Board adopted the Final Proposition 1 Storm Water Grant Program Guidelines on December 15, 2015, which established the process and criteria for awarding grants for multi-benefit storm water management projects, through the development of a Storm Water Resource Plan. To be eligible for a Proposition 1 Storm Water Grant, each Bay Area applicant must first develop and submit their Storm Water Resource Plan, or functionally equivalent plan, to the Bay Area Integrated Regional Water Management Plan (BAIRWMP) Coordinating Committee for incorporation into the BAIRWMP.

The goals of the Storm Water Resource Plans are consistent with those of the BAIRWMP. As such, the Bay Area Coordinating Committee is in support of including Storm Water Resource Plans in the BAIRWMP, when the plans are complete.

The Storm Water Resource Plan listed below aligns with BAIRWMP priorities and protects Bay Area watersheds, and is hereby added to the 2013 BAIRWMP:

- Marin County functional equivalent Storm Water Resource Plan

Appendix G-5

Storm Water Resource Plans Added to the 2013 Bay Area IRWMP by the Coordinating Committee on October 22, 2018

Appendix G-5: Storm Water Resource Plans Added to the Plan

The California State Water Resources Control Board adopted the Final Proposition 1 Storm Water Grant Program Guidelines on December 15, 2015, which established the process and criteria for awarding grants for multi-benefit storm water management projects, through the development of a Storm Water Resource Plan. To be eligible for a Proposition 1 Storm Water Grant, each Bay Area applicant must first develop and submit their Storm Water Resource Plan, or functionally equivalent plan, to the Bay Area Integrated Regional Water Management Plan (BAIRWMP) Coordinating Committee for incorporation into the BAIRWMP.

The goals of the Storm Water Resource Plans are consistent with those of the BAIRWMP. As such, the Bay Area Coordinating Committee is in support of including Storm Water Resource Plans in the BAIRWMP, when the plans are complete.

The Storm Water Resource Plan listed below aligns with BAIRWMP priorities and protects Bay Area watersheds, and is hereby added to the 2013 BAIRWMP:

- Southern Sonoma County Stormwater Resource Plan

Appendix G-6

Storm Water Resource Plans Added to the 2013 Bay Area IRWMP by the Coordinating Committee on February 25, 2019

Appendix G-6: Storm Water Resource Plans Added to the Plan

The California State Water Resources Control Board adopted the Final Proposition 1 Storm Water Grant Program Guidelines on December 15, 2015, which established the process and criteria for awarding grants for multi-benefit storm water management projects, through the development of a Storm Water Resource Plan. To be eligible for a Proposition 1 Storm Water Grant, each Bay Area applicant must first develop and submit their Storm Water Resource Plan, or functionally equivalent plan, to the Bay Area Integrated Regional Water Management Plan (BAIRWMP) Coordinating Committee for incorporation into the BAIRWMP.

The goals of the Storm Water Resource Plans are consistent with those of the BAIRWMP. As such, the Bay Area Coordinating Committee is in support of including Storm Water Resource Plans in the BAIRWMP, when the plans are complete.

The Storm Water Resource Plan listed below aligns with BAIRWMP priorities and protects Bay Area watersheds, and is hereby added to the 2013 BAIRWMP:

- Santa Clara Basin Stormwater Resource Plan
- Contra Costa Watersheds Stormwater Resource Plan

Appendix G-7

Storm Water Resource Plans Added to the 2013 Bay Area IRWMP by the Coordinating Committee on July 22, 2019

Appendix G-7: Storm Water Resource Plans Added to the Plan

The California State Water Resources Control Board adopted the Final Proposition 1 Storm Water Grant Program Guidelines on December 15, 2015, which established the process and criteria for awarding grants for multi-benefit storm water management projects, through the development of a Storm Water Resource Plan. To be eligible for a Proposition 1 Storm Water Grant, each Bay Area applicant must first develop and submit their Storm Water Resource Plan, or functionally equivalent plan, to the Bay Area Integrated Regional Water Management Plan (BAIRWMP) Coordinating Committee for incorporation into the BAIRWMP.

The goals of the Storm Water Resource Plans are consistent with those of the BAIRWMP. As such, the Bay Area Coordinating Committee is in support of including Storm Water Resource Plans in the BAIRWMP, when the plans are complete.

The Storm Water Resource Plan listed below aligns with BAIRWMP priorities and protects Bay Area watersheds, and is hereby added to the 2013 BAIRWMP:

- Alameda Countywide Clean Water Program Stormwater Resource Plan

Appendix G-8

Storm Water Resource Plans Added to the 2013 Bay Area IRWMP by the Coordinating Committee on August 26, 2019

Appendix G-8: Storm Water Resource Plans Added to the Plan

The California State Water Resources Control Board adopted the Final Proposition 1 Storm Water Grant Program Guidelines on December 15, 2015, which established the process and criteria for awarding grants for multi-benefit storm water management projects, through the development of a Storm Water Resource Plan. To be eligible for a Proposition 1 Storm Water Grant, each Bay Area applicant must first develop and submit their Storm Water Resource Plan, or functionally equivalent plan, to the Bay Area Integrated Regional Water Management Plan (BAIRWMP) Coordinating Committee for incorporation into the BAIRWMP.

The goals of the Storm Water Resource Plans are consistent with those of the BAIRWMP. As such, the Bay Area Coordinating Committee is in support of including Storm Water Resource Plans in the BAIRWMP, when the plans are complete.

The Storm Water Resource Plan listed below aligns with BAIRWMP priorities and protects Bay Area watersheds, and is hereby added to the 2013 BAIRWMP:

- Santa Clara Basin Stormwater Resource Plan

CALIFORNIA
AIR RESOURCES BOARD

California's 2017 Climate Change Scoping Plan

The strategy for achieving California's 2030 greenhouse gas target

arb.ca.gov

November 2017

Contents

Decades of Leadership

From the first law to protect rivers from the impact of gold mining in 1884, to decades of work to fight smog, the Golden State has set the national – and international – standard for environmental protection. California pushes old boundaries, encounters new ones, and figures out ways to break through those as well. This is part of the reason why California has grown to become both the 6th largest economy in the world, and home to some of the world's strongest environmental protections. And, we have seen our programs and policies adopted by others as they seek to protect public health and the environment.

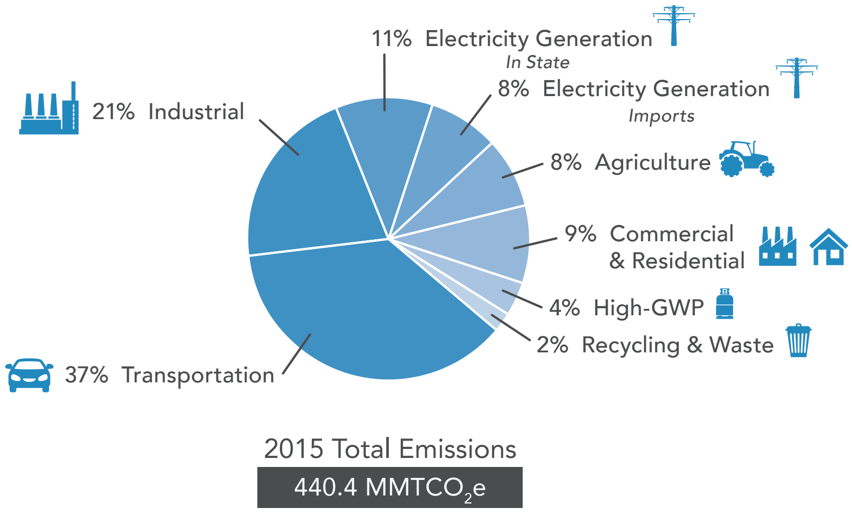
Governor Brown signs SB 32 recommitting California's efforts to curb climate change.

California's approach to climate change channels and continues this spirit of innovation, inclusion, and success. The 2030 target of 40 percent emissions reductions below 1990 levels guides this Scoping Plan, as the economy evolves to reduce greenhouse gas (GHG) emissions in every sector. It also demonstrates that we are doing our part in the global effort under the Paris Agreement to reduce GHGs and limit global temperature rise below 2 degrees Celsius in this century.

California's 2017 Climate Change Scoping Plan: The Strategy for Achieving California's 2030 Greenhouse Gas Target (Plan) builds on the state's successes to date, proposing to strengthen major programs that have been a hallmark of success, while further integrating efforts to reduce both GHGs and air pollution. California's climate efforts will:

- Lower GHG emissions on a trajectory to avoid the worst impacts of climate change;
- Support a clean energy economy which provides more opportunities for all Californians;
- Provide a more equitable future with good jobs and less pollution for all communities;
- Improve the health of all Californians by reducing air and water pollution and making it easier to bike and walk; and
- Make California an even better place to live, work, and play by improving our natural and working lands.

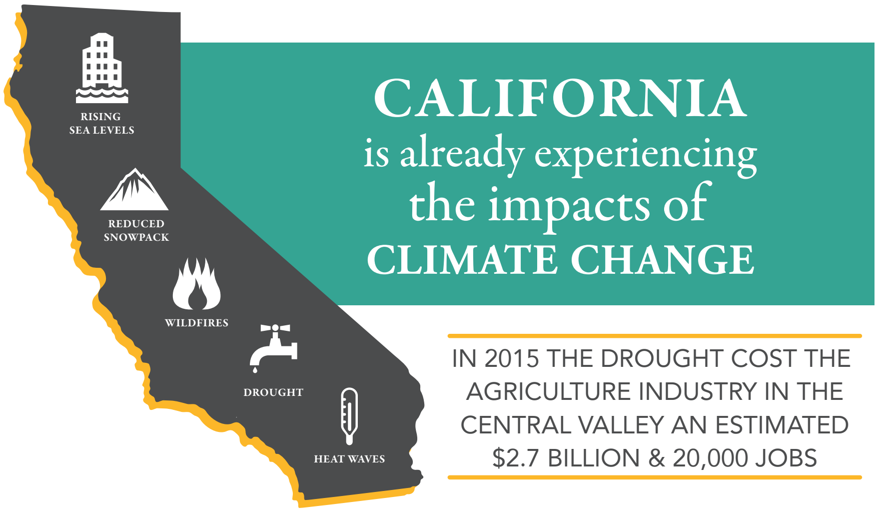
California Carbon Emissions by Scoping Plan Sector



The Climate Imperative – We Must Act

The evidence that the climate is changing is undeniable. As evidence mounts, the scientific record only becomes more definitive – and makes clear the need to take additional action now.

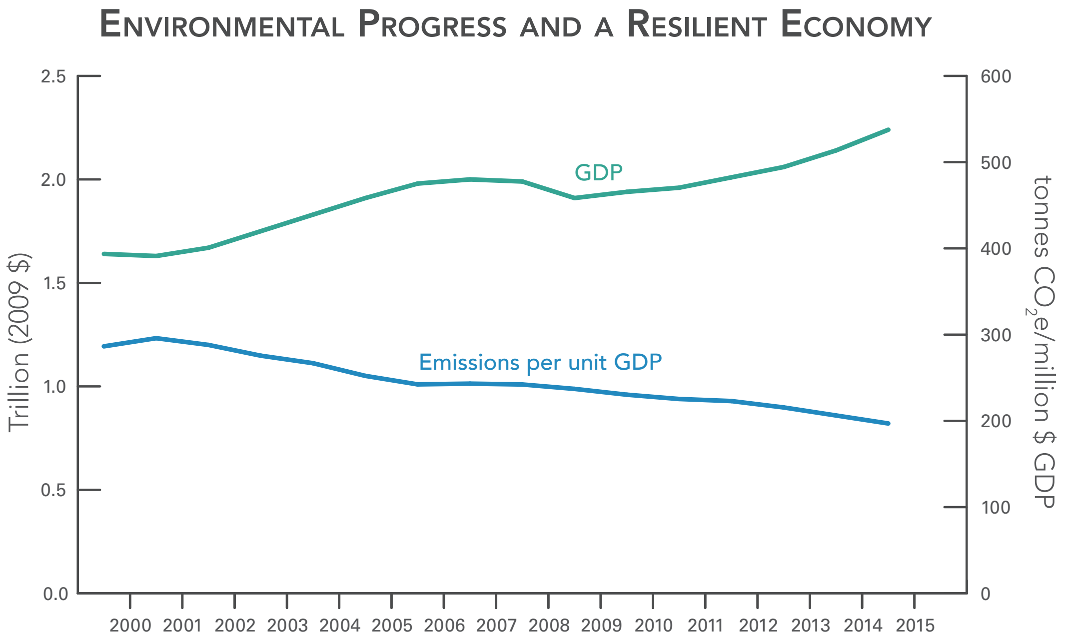
In California, as in the rest of the world, climate change is contributing to an escalation of serious problems, including raging wildfires, coastal erosion, disruption of water supply, threats to agriculture, spread of insect-borne diseases, and continuing health threats from air pollution. The drought that plagued California for years devastated the state's agricultural and rural communities, leaving some of them with no drinking water at all. In 2015 alone, the drought cost agriculture in the Central Valley an estimated $2.7 billion, and more than 20,000 jobs. Last winter, the drought was broken by record-breaking rains, which led to flooding that tore through freeways, threatened rural communities, and isolated coastal areas. This year, California experienced the deadliest wildfires in its history. Climate change is making events like these more frequent, more catastrophic and more costly. Climate change impacts all Californians, and the impacts are often disproportionately borne by the state's most vulnerable and disadvantaged populations.



IN 2015 THE DROUGHT COST THE AGRICULTURE INDUSTRY IN THE CENTRAL VALLEY AN ESTIMATED $2.7 BILLION & 20,000 JOBS

California is on Track – But There is More to Do

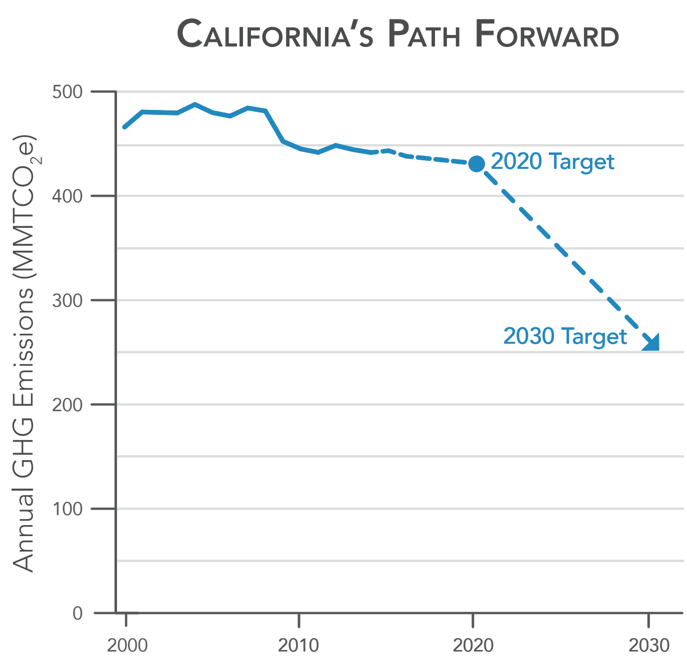
Although the California Global Warming Solutions Act of 2006 – also known as AB 32 – marked the beginning of an integrated climate change program, California has had programs to reduce GHG emissions for decades. The state's energy efficiency requirements, Renewable Portfolio Standard, and clean car standards have reduced air pollution and saved consumers money, while also lowering GHG emissions.



The California economy has grown while becoming less carbon intensive.

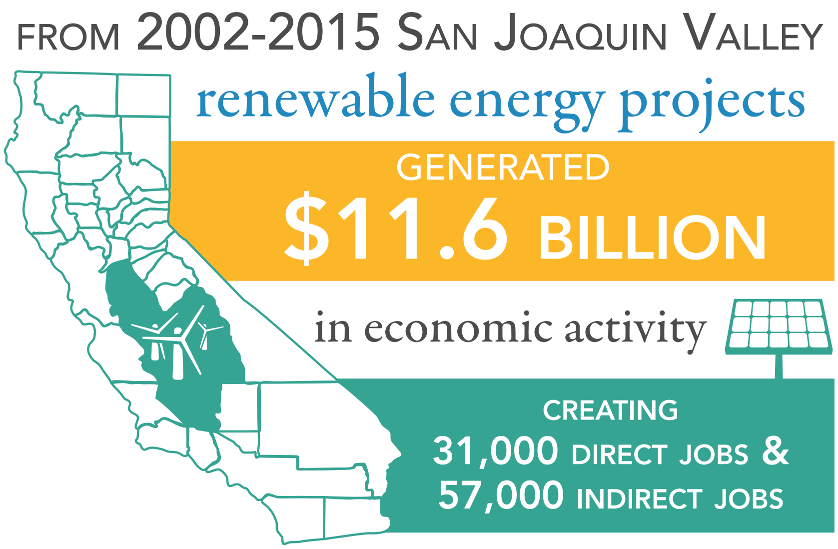
AB 32 set California's first GHG target called on the state to reduce emissions to 1990 levels by 2020. California is on track to exceed its 2020 climate target, while the economy continues to grow. Since the launch of many of the state's major climate programs, including Cap-and-Trade, economic growth in California has consistently outpaced economic growth in the rest of the country. The state's average annual growth rate has been double the national average – and ranks second in the country since Cap-and-Trade took effect in 2012. In short, California has succeeded in reducing GHG emissions while also developing a cleaner, resilient economy that uses less energy and generates less pollution.

Importantly, the State's 2020 and 2030 targets have not been set in isolation. They represent benchmarks, consistent with prevailing climate science, charting an appropriate trajectory forward that is in line with California's role in stabilizing global warming below dangerous thresholds. As we consider efforts to reduce emissions to meet the State's near-term requirements, we must do so with an eye toward reductions needed beyond 2030. The Paris Agreement – which calls for limiting global warming to well below 2 degrees Celsius and pursuing efforts to limit it to 1.5 degrees Celsius – frames our path forward.



California's Path to 2030

Executive Order B-30-15 and SB 32 extended the goals of AB 32 and set a 2030 goal of reducing emissions 40 percent from 2020 levels. This action keeps California on target to achieve the level of reductions scientists say is necessary to meet the Paris Agreement goals. This is an ambitious goal – calling on the State to double the rate of emissions reductions. Nevertheless, it is an achievable goal.



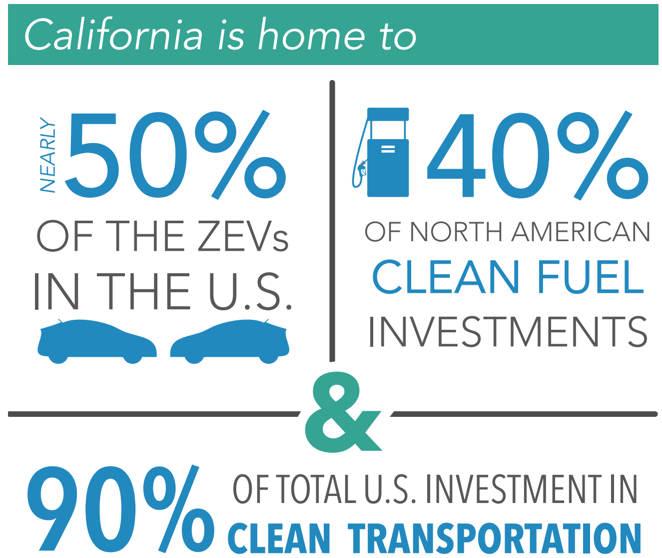
This Plan establishes a path that will get California to its 2030 target. Given our ambitious goals, this Plan is built on unprecedented outreach and coordination. Over 20 state agencies collaborated to produce the Plan, informed by 15 state agency-sponsored workshops and more than 500 public comments. The broad range of state agencies involved reflects the complex nature of addressing climate change, and the need to work across institutional boundaries and traditional economic sectors to effectively reduce GHG emissions. As part of the Plan development, alternative strategies were considered and evaluated, ranging from carbon taxes to individual facility caps to relying solely on sector-specific regulations. In addition, efforts were made to ensure that the Plan would benefit all Californians. To this end, the Environmental Justice Advisory Committee (EJAC), a Legislatively created advisory body, convened almost 20 community meetings throughout California to discuss the climate strategy, and held 19 meetings of its own to provide recommendations on the Plan.

This Plan draws from the experiences in developing and implementing previous plans to present a path to reaching California's 2030 GHG reduction target. The Plan is a package of economically viable and technologically feasible actions to not just keep California on track to achieve its 2030 target, but stay on track for a low- to zero-carbon economy by involving every part of the state. Every sector, every local government, every region, every resident is part of the solution. The Plan underscores that there is no single solution but rather a balanced mix of strategies to achieve the GHG target. This Plan highlights the fact that a balanced mix of strategies provides California with the greatest level of certainty in meeting the target at a low cost while also improving public health, investing in disadvantaged and low-income communities, protecting consumers, and supporting economic growth, jobs and energy diversity. Successful implementation of this Plan relies, in part, on long-term funding plans to inform future appropriations necessary to achieve California's long-term targets.

California's Climate Policy Portfolio

- Double building efficiency
- 50% renewable power
- More clean, renewable fuels
- Cleaner zero or near-zero emission cars, trucks, and buses
- Walkable/Bikeable communities with transit
- Cleaner freight and goods movement
- Slash potent "super-pollutants" from dairies, landfills and refrigerants
- Cap emissions from transportation, industry, natural gas, and electricity
- Invest in communities to reduce emissions

Create Inclusive Policies and Broad Support for Clean Technologies

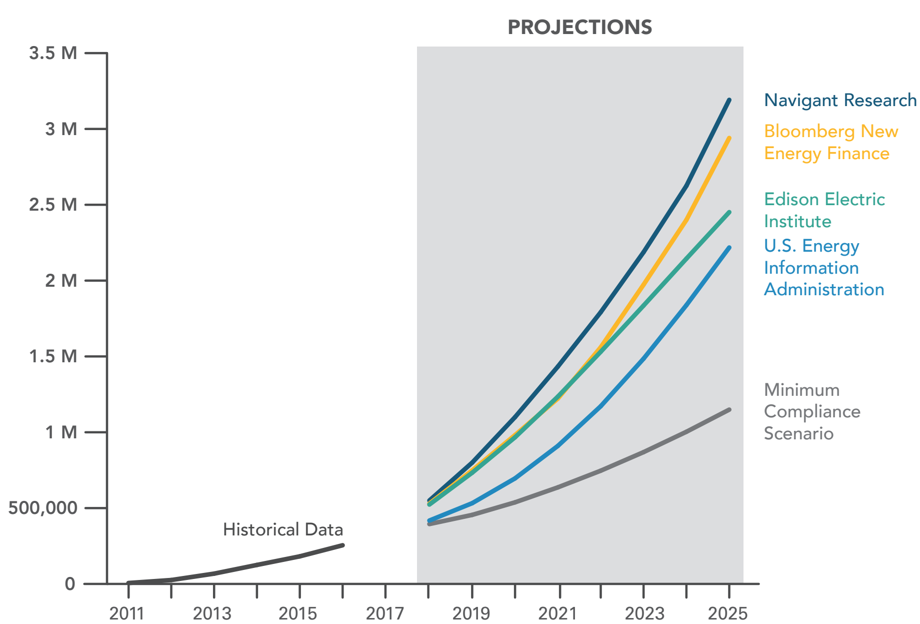


Remarkable progress over the past 10 years has put the global energy and transportation sector on a transformative path to cleaner energy. Far outpacing previous predictions, today solar and wind power are often less expensive than coal or natural gas, and they now comprise the majority of global investment in the power sector. Electric vehicle battery costs have tumbled even more quickly than solar costs, while performance has improved dramatically, and the auto industry is committed to an electric future.

California's policies have created markets for energy efficiency, energy storage, low carbon fuels, renewable power – including utility-scale and residential-scale solar – and zero-emission vehicles. Our companies are thriving, making those markets grow. California is home to nearly half of the zero-emission vehicles in the U.S., 40 percent of North American clean fuels investments, the world's best known electric car manufacturer, and the world's leading ride-sharing services. California is further advancing efficient land use policies that reduce auto dependency. Altogether, we're unleashing nonlinear transitions to clean energy and clean transportation technologies that will put California on the path to meeting our 2030 target and the goals of the Paris Agreement.

California policymaking has succeeded through thoughtful planning, bolstered by an open public process that solicits the best ideas from a wide array of sources, and by integrating effective regulation with targeted investments to provide broad market support for clean technologies. A key element of California's approach continues to be careful monitoring and reporting on the results of our programs and a willingness to make mid-course adjustments. As the State looks to 2030 and beyond, all sectors of the economy must benefit from these ideas to create a new and better future.

Cumulative California ZEV Sales Projections



Experience has shown clean technology and markets continue to outpace expectations.

Legislative Leadership on Climate

The California Legislature has shaped the State's climate change program, setting out clear policy objectives over the next decade:

- 40% reduction in GHG emissions by 2030;
- 50% renewable electricity;
- Double energy efficiency savings;
- Support for clean cars;
- Integrate land use, transit, and affordable housing to curb auto trips;
- Prioritize direct reductions;
- Identify air pollution, health, and social benefits of climate policies;
- Slash "super pollutants";
- Protect and manage natural and working lands;
- Invest in disadvantaged communities; and
- Strong support for Cap-and-Trade.

The benefits of innovative technologies need to reach all residents and businesses. Air pollution reductions and the associated health benefits should be targeted to communities where they are needed most. All Californians need access to clean transportation options that enable healthy communities to develop and thrive, including walking, cycling, transit, rail, and clean vehicle options.

Although GHG reductions can help to reduce harmful air pollution, California must concurrently employ other strategies to accelerate reductions of pollutants from large industrial sources that adversely impact communities. Newly passed AB 617 strengthens existing criteria and toxic air pollutant programs and our partnerships with local air districts to further reduce harmful air pollutants and protect communities. More fundamentally, AB 617 establishes a comprehensive statewide program – the first of its kind – to address air pollution where it matters most: in neighborhoods with the most heavily polluted air.

California's Goals

California's environmental justice and equity movement is establishing a blueprint for the nation and world. The State is pioneering targeted environmental and economic development programs to help those most in need. So far, half of all California Climate Investments, stemming from the State's Cap-and-Trade-Program, have been used to provide benefits in the 25 percent of California communities that are most disadvantaged by environmental and socio-economic burdens. By increasingly engaging with, and investing in, these communities – investing in technical assistance resources, holding listening sessions, improving our programs, and accelerating our efforts to bring the cleanest technologies to mass market – all California residents can have clean air to breathe, clean water to drink, and opportunities to participate in the cleaner economy.

Achieving Success in Equity and Access

- Continue to engage local organizations and invest in disadvantaged communities to ensure broad access to clean technologies;
- Ensure air pollution reductions happen where they are needed the most;
- Integrate across programs and agencies to ensure complementary policies provide maximum benefits to disadvantaged communities;
- Implement California Energy Commission and CARB recommendations to overcome barriers to clean energy and clean transportation options for low-income residents;
- Provide energy-efficient affordable housing near job centers and transit; and
- Implement AB 617 to dramatically improve air quality in local communities through targeted action plans.

Enhance Industrial Efficiency & Competitiveness

California leads the country in manufacturing and industrial efficiency. For every dollar spent on electricity, our manufacturers produce 55 percent more value than the national average. And the efficiency of California industry continues to grow at rates faster than the national average. High efficiency rates, coupled with the Cap-and-Trade Program's firm emission cap, allow economic activity to increase without corresponding increases in GHG emissions. In other words, the more California produces, the better it is for the planet. Maintaining and extending our successful programs – from the Cap-and-Trade Program and Low Carbon Fuel Standard to zero-emission, renewable energy and energy efficiency programs – will reduce GHGs, increase energy cost savings, offer businesses flexibility to reduce emissions at low cost and provide clear policy and market direction, and certainty, for business planning and investment. This will encourage continued research, evaluation, and deployment of innovative strategies and technology to further reduce emissions in the industrial sector through advances in energy efficiency and productivity, increased access to cleaner fuels, and carbon capture, utilization and storage.

Action on HFCs

Hydrofluorocarbons (HFCs) represent one of the biggest opportunities to reduce GHGs in the State through 2030 due to their high climate impacts, and in many cases, offer energy efficiency and financial savings, as well. The world recently agreed to phase down their use, but California has committed to move more quickly, in line with the scope of the opportunity for cost-effective emissions reductions in the State.

Achieving Success in Industrial Efficiency and Competitiveness

- Evaluate and implement policies and measures to continue reducing GHG, criteria, and toxic air contaminant emissions from sources such as refineries;
- Improve productivity and strengthen economic competitiveness by further improving energy efficiency and diversifying fuel supplies with low carbon alternatives;
- Prioritize procurement of goods that have lower carbon footprints
- Support and attract industry that produces goods needed to reduce GHGs; and
- Cut energy costs and GHG emissions by quickly transitioning to efficient HFC alternatives.

Prioritize Transportation Sustainability

California's transportation system underpins our economy. The extensive freight system moves trillions of dollars of goods each year and supports nearly one-third of the state economy and more than 5 million jobs. The way we plan our communities impacts everything from household budgets to infrastructure needs, productivity lost to congestion, protection of natural and working landscapes, and our overall health and well-being. And transportation is the largest source of GHG, criteria, and toxic diesel particulate matter emissions in the state.

RENEWABLE BIO DIESEL USE

has increased 7000% since 2011

California's ability to remain an economic powerhouse and environmental leader requires additional efforts to improve transportation sustainability with a comprehensive approach that includes regulation, incentives, and investment. This approach addresses a full range of transportation system improvements relating to efficient land use, affordable housing, infrastructure for cyclists and pedestrians, public transit, new vehicle technologies, fuels and freight. One example is the deployment of the nation's first high-speed rail system, which will include seamless connections to local transit.

The approach is working: California is home to nearly half of the country's zero-emission vehicles. Innovative alternative fuel producers and oil companies are bringing more low carbon fuels to market than required by the Low Carbon Fuel Standard. And, the State has committed to investing billions in zero-emission vehicles and infrastructure, land use planning, and active transportation options such as walking and biking. In fact, renewable fuels in the heavy-duty vehicle sector are displacing diesel fossil fuel as quickly as renewable power is replacing fossil fuels on the electricity grid. California's climate policies will also reduce fossil fuel use and decouple the state from volatile global oil prices. CARB's analyses show fossil fuel demand will decrease by more than 45 percent by 2030, which means Californians will be using less gasoline and diesel resulting in healthier air and cost-savings on transportation fuels. These benefits will be further amplified as we move away from light-duty combustion vehicles.

By re-doubling our efforts, California can make sure that markets tip quickly and definitively in the favor of electric cars, trucks, buses, and equipment, while increasing the use of clean, low carbon fuels where zero-emissions options are not yet available. Local transportation planning can make communities become healthier and more vibrant and connected – encouraging housing, walking, biking and transit policies that reduce GHGs and promote good quality of life. And, we can work to ensure that an efficient sustainable freight system continues to power our ever-growing economy.

Achieving Success in Transportation Sustainability

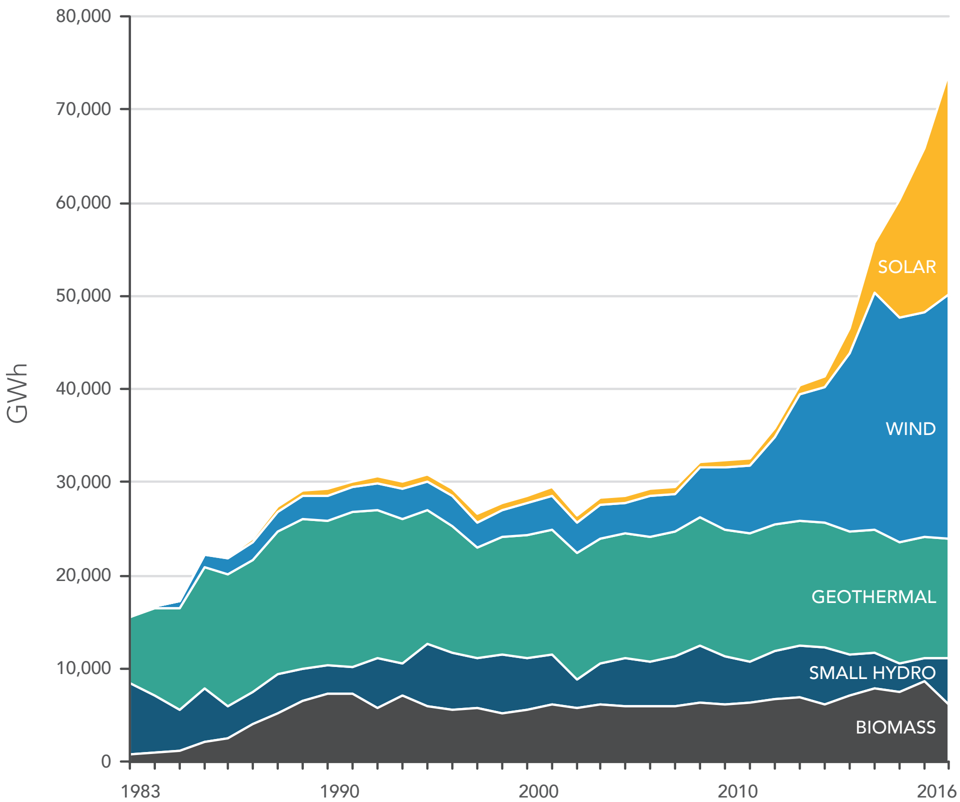
- Connect California's communities with a state-of-the-art high-speed rail system;
- Promote vibrant communities and landscapes through better planning efforts to curb vehicle-miles-traveled and increase walking, biking and transit;
- Build on the State's successful regulatory and incentive-based policies to quickly make clean cars, trucks, buses, and fuels definitive market winners;
- Coordinate agency activities to ensure that emerging automated and connected vehicle technologies reduce emissions; and
- Improve freight and goods movement efficiency and sustainability to enable California's continued economic growth.

Continue Leading on Clean Energy

California is well ahead of schedule in meeting its renewable energy targets. Wind and solar generation have grown exponentially in recent years, while hydroelectric, geothermal, and biomass have consistently contributed renewable power to our energy supply. Californians are the ones who will take action to meet energy efficiency targets, integrate renewable power through demand response, and drive demand for net zero energy buildings. This includes self-generation which also grew exponentially in recent years with installed solar totaling 2,000 megawatts (MW) in 2014 and 5,100 MW of the total statewide self-generation installed solar in 2015. By June 2017, solar installed in California was about 5,800 MW, far exceeding the State's goals.

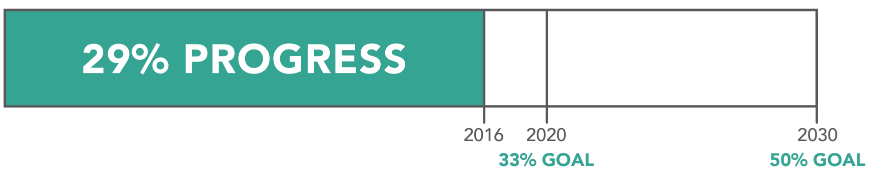
The Renewable Portfolio Standard, Carbon Pricing, and lower costs for renewable technology are delivering real environmental benefits.

Increasing Renewable Electricity Generation (in & out of state)



While at this time natural gas is an important energy source, we must move toward cleaner heating fuels and replicate the progress underway for electricity. As with electricity, this starts with efficiency and demand reduction, including building and appliance electrification where these advancements make sense. It calls for minimizing fugitive methane leaks throughout the system, including beyond California's borders where 90 percent of the natural gas used here originates. And, it includes using more renewable gas – a valuable in-state resource made from waste products – especially in the transportation sector. Replacing fossil fuels with renewable gas can reduce potent short-lived climate pollutants, and state policies should support this effort. Reducing demand for natural gas, and moving toward renewable natural gas, will help California achieve its 2030 climate target. However, switching from natural gas to electricity – where feasible and demonstrated to reduce GHGs – is needed to stay on track to achieve our long-term goals.

Reaching California's Clean Electricity Goals



The State's 3 largest investor-owned utilities are on track to achieve a 50% RPS by 2020.

Achieving Success in Clean Energy

- Effectively integrate at least 50 percent renewables as the primary source of power in the State through coordinated planning, additional deployments of energy storage, and grid regionalization;
- Utilize distributed resources and engage customers by making net zero energy buildings standard, implement Existing Buildings Energy Efficiency Action Plan to double existing building efficiency, and increase access to energy efficiency, renewable energy, and energy use data; and
- Reduce the use of heating fuels while concurrently making what is used cleaner by minimizing fugitive methane leaks, prioritizing natural gas efficiency and demand reduction, and enabling cost-effective access to renewable gas.

Put Waste Resources to Beneficial Use

Effectively managing waste streams is perhaps the most basic of environmental tenets. "Reduce, re-use, and recycle" is a mantra known even to elementary school students. For decades California law has reduced waste reaching landfills and recaptured value from waste streams through recycling and composting. California law requires reducing, recycling, or composting 75 percent of solid waste generated by 2020. The State also has specific goals for diverting organic waste, which decomposes in landfills to produce the super pollutant methane. State law also directs edible food to hungry families rather than having it discarded.

Capturing value from waste makes sense. As described in the Healthy Soils Initiative, compost from organic matter provides soil amendments to revitalize farmland, reduces irrigation and landscaping water demand, and potentially increases long-term carbon storage in rangelands. Organic matter can also provide a clean, renewable energy source in the form of bioenergy, biofuels, or renewable natural gas.

California should take ownership of its waste and adhere to a waste "loading order" that prioritizes waste reduction, re-use, and material recovery over landfilling. The State can take steps to reduce waste from packaging, which constitutes about one-quarter of California's waste stream. It can invest in and streamline in-state infrastructure development to support recycling, remanufacturing, composting, anaerobic digestion, and other beneficial uses of organic waste. And, it can help communities in their efforts to recover food for those in need.

Achieving Success in Putting Waste Resources to Beneficial Use

- Develop and implement programs, including edible food waste recovery, to divert organics from landfills and reduce methane emissions;
- Develop and implement a packaging reduction program; and
- Identify a sustainable funding mechanism to support waste management programs, including infrastructure development to support organics diversion.

Support Resilient Agricultural and Rural Economies and Natural and Working Lands

California's natural and working landscapes, like forests and farms, are home to the most diverse sources of food, fiber, and renewable energy in the country. They underpin the state's water supply and support clean air, wildlife habitat, and local and regional economies. They are also the frontiers of climate change. They are often the first to experience the impacts of climate change, and they hold the ultimate solution to addressing climate change and its impacts. In order to stabilize the climate, natural and working lands must play a key role.

Work to better quantify the carbon stored in natural and working lands is continuing, but given the long timelines to change landscapes, action must begin now to restore and conserve these lands. We should aim to manage our natural and working lands in California to reduce GHG emissions from business-as-usual by at least 15-20 million metric tons in 2030, to complement the measures described in this Plan.

Improved forest management on tribal lands has preserved almost 3 million metric tons of carbon in California and the revenues from the carbon offsets have been used to secure ownership of ancestral lands.

Natural and working lands can be better incorporated into California's climate change mitigation efforts by encouraging collaboration with local and regional organizations and increasing investment to protect, enhance, and innovate in our rural landscapes and communities. The State is partnering with tribes to preserve carbon, protect tribal forest lands and increase their land base. Transportation and land use planning should minimize the footprint of the built environment, while supporting and investing in efforts to restore, conserve and strengthen natural and working lands. California's forests should be healthy carbon sinks that minimize black carbon emissions where appropriate, supply new markets for woody waste and non-merchantable timber, and provide multiple ecosystem benefits. Rehabilitating and strengthening wetlands and tidal environments, and incorporating natural landscapes into urban environments will also help make natural and working lands part of the state's climate solution. Finally, California farmers can be a powerful force in the fight against climate change, in how they manage their lands, tend their crops, and husband their livestock.

Achieving Success in Supporting Resilient Agricultural and Rural Economies and Natural and Working Lands

- Protect, enhance and innovate on California's natural and working lands to ensure natural and working lands become a net carbon sink over the long-term;
- Develop and implement the Natural and Working Lands Implementation Plan to maintain these lands as a net carbon sink and avoid at least 15-20 metric tons of GHG emissions by 2030;
- Measure and monitor progress by completing CARB's Natural and Working Lands Inventory and implementing tracking and performance monitoring systems; and
- Unleash opportunity in the agricultural sector by improving manure management, boosting soil health, generating renewable power, electrifying operations, utilizing waste biomass, and increasing water, fertilizer, and energy use efficiency to reduce super pollutants.

Secure California's Water Supplies

Water is California's lifeblood. It sustains communities and drives the economy. An elaborate network of storage and delivery systems has enabled the state to prosper and grow. But this aging system was built for a previous time and is increasingly challenged by the realities of climate change and population growth.

The Water-Energy Nexus

- About 12% of the total energy used in the state is related to water, with 2% for conveyance, treatment and distribution, and 10% for end-customer uses like heating and cooling.
- The water-energy nexus provides opportunities for conservation of these natural resources as well as reduction of GHGs.

Producing, moving, heating and treating water demands significant energy and produces commensurately significant emissions. As California looks to the future, meeting new demands and sustaining prosperity requires increased water conservation and efficiency, improved coordination and management of various water supplies, greater understanding of the water-energy nexus, and deployment of new technologies in drinking water treatment, groundwater remediation and recharge, and potentially brackish and seawater desalination. State efforts must support systemic shifts toward conservation, efficiency, and renewable energy in the water sector.

Achieving Success in Securing California's Water Supplies

- Increase water savings by certifying innovative technologies for water conservation and developing and implementing new conservation targets, updated agricultural water management plans, and long term conservation regulations;
- Develop a voluntary registry for GHG emissions from energy use associated with water; and
- Continue to increase the use of renewable energy to operate the State Water Project.

Cleaning the Air and Public Health

The benefits of this Plan are broader than just climate change – implementation of the Plan will also help improve public health. The Plan incorporates freight and mobile source strategies which will deliver reductions in criteria and toxic air pollutants to improve air quality.

Climate Plan Provides Health Benefits in 2030

AVOIDED PREMATURE DEATHS	VALUE OF AVOIDED HEALTH IMPACTS	VALUE OF AVOIDED DAMAGES USING SOCIAL COST OF CARBON
~ 3,300	$1.2-1.8 billion	$1.9-11.2 billion

California continues to seek ways to improve implementation of its climate program and its ability to address the unique set of impacts facing the state's most pollution burdened communities. In addition, CARB's environmental justice efforts are intended to reach far beyond climate change. While this Plan provides a path for reducing GHG emissions in disadvantaged communities, it also includes new tools that will complement the Plan and lead to further air quality improvements.

In particular, implementation of AB 617 will improve air quality in local communities, in partnership with local air districts, using targeted investments in neighborhood-level air monitoring and the development of air pollution reduction action plans with strong enforcement programs. These plans will require pollution reductions from both mobile and stationary sources. Through these efforts, CARB anticipates, and will work for, increased data transparency and the adoption of new statewide air pollutant emission controls that will not only confer short-term benefits to those most in need of improvement, but which will ultimately benefit all Californians.

Under the leadership of CARB's first executive-level environmental justice liaison, the agency is also laying a roadmap to better serve California's environmental justice communities in the design and implementation across its broader programs.

Successful Example of Carbon Pricing and Investment

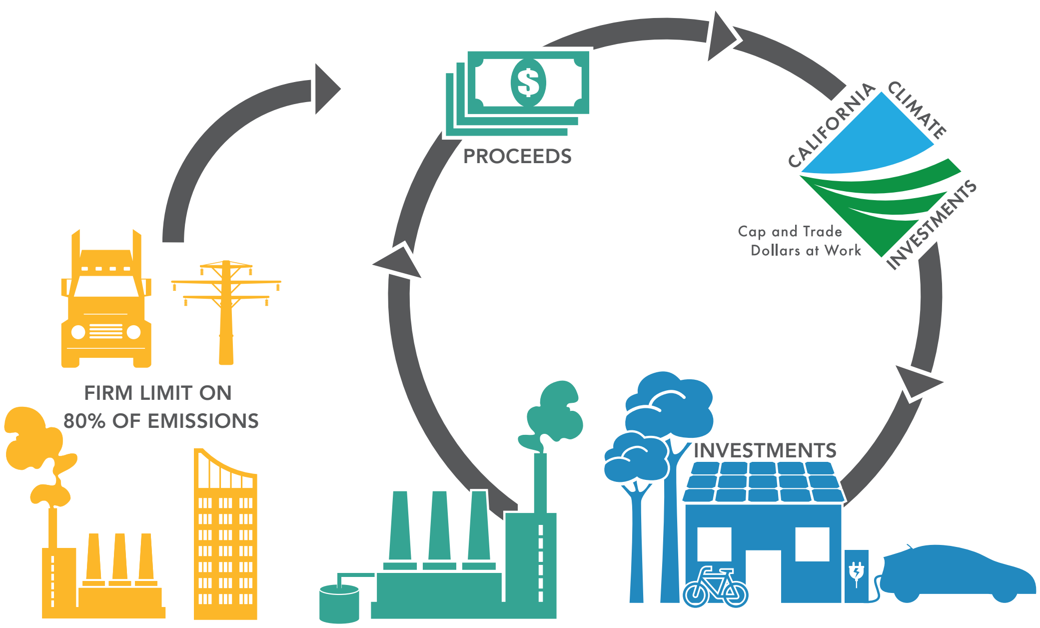
The Cap-and-Trade Program is fundamental to meeting California's long-range climate targets at low cost. The Cap-and-Trade Program includes GHG emissions from transportation, electricity, industrial, agricultural, waste, residential and commercial sources, and caps them while complementing the other measures needed to meet the 2030 GHG target. Altogether, the emissions covered by the Cap-and-Trade program total 80 percent of all GHG emissions in California. California's response to climate change has led to many innovative programs designed to reduce GHG emissions, including the Renewable Portfolio and Low Carbon Transportation Standards, but the Cap-and-Trade Program guarantees GHG emissions reductions through a strict overall emissions limit that decreases each year, while trading provides businesses with flexibility in their approach to reducing emissions. The Cap-and-Trade Program also generates revenue when the allowances to emit pollution are auctioned. Some of the revenue is returned directly to electricity ratepayers, and the rest is dedicated to reducing GHG emissions by making Legislatively directed investments in California with an emphasis on programs or projects that benefit disadvantaged and low-income communities.

Cap-and-Trade Program

- Firm, declining cap provides highest certainty to achieve 2030 target.
- Low cost GHG emission reductions minimize impact on consumers and economy.
- Flexibility for businesses
- Can be linked with similar programs worldwide.

Including the latest budget, approximately $5 billion has been appropriated to reduce GHG emissions, reduce air pollutant emissions where reductions are needed most, grow markets for clean technologies, and spur emissions reductions in sectors not covered by Cap-and-Trade. These investments are strengthening the economy and improving public health – especially in the areas of the state most burdened by pollution. So far, half of the $1.2 billion spent provides benefits to disadvantaged communities, and one-third of those investments were made directly in those communities.

California's Carbon Pricing & Investments Overview



California's Cap-and-Trade Program is the most comprehensive, effective, and well-designed carbon market on the planet. Today, the Program is linked with a similar program in Quebec and will link with a similar program in Ontario beginning in 2018. Nearly 40 countries and over 20 subnational entities – altogether representing nearly a quarter of global emissions – have developed, or are developing, emissions trading programs. Each of them looks to California and our linked Western Climate Initiative Partners as they design, implement, and refine their own programs.

Cap-and-Trade Dollars at Work (2017)

- Nearly 30,000 projects installing efficiency measures in homes
- 105,000+ rebates issued for zero-emission and plug-in hybrid vehicles
- 16,000+ acres of land preserved or restored
- 200+ transit agency projects funded, adding or expanding transit options
- 6,200+ trees planted in urban areas
- 1,100+ new affordable housing units under contract
- 50% of projects benefiting Disadvantaged Communities ($614M)
- 140,000+ total projects implemented

Fostering Global Action

Through the State's leadership in the Cap-and-Trade Program, innovative sector-specific policies that are reducing technology costs and GHG emissions, and community-scale engagement and investments to reduce GHGs and promote equity, California is playing a significant role in addressing global climate change.

Governor Brown has stated that climate change is the most important issue of our lifetime, and has promoted scientifically sound approaches to address climate change in California and beyond. He has participated in international climate discussions at the United Nations headquarters in New York, the United Nations Climate Change Conference in Paris, the Vatican, and the Climate Summit of the Americas in Canada – calling on other subnational and national leaders to join California in the fight against climate change. He has signed climate change agreements with leaders from Chile, China, the Czech Republic, Israel, Japan, Mexico, the Netherlands, other North American states and provinces, and Peru. He has joined an unprecedented alliance of heads of state, city and state leaders – convened by the World Bank Group and International Monetary Fund – to urge countries and companies around the globe to put a price on carbon. And California is a founding member of the International Zero Emission Vehicle (ZEV) Alliance, a coalition of national and subnational governments working to accelerate the adoption of ZEVs and make all new cars zero emissions. Delegations from around the world travel to Sacramento to meet with the architects and implementers of California's climate policies to learn how to successfully combine strong greenhouse gas policies with a strong economy.

Perhaps most significant is the Under2Coalition. It is a global climate pact – spearheaded by Governor Brown – among states, provinces, countries, and cities all committing to do their part to limit the increase in global average temperatures below the dangerous levels. Signatories commit to either reducing greenhouse gas emissions 80 to 95 percent below 1990 levels by 2050 or achieving a per capita annual emission target of less than 2 metric tons by 2050. More than 200 jurisdictions from 38 countries and six continents have now signed or endorsed the agreement. Together, members of the Under2Coalition represent more than 1.2 billion people and $28.8 trillion in GDP, equivalent to 39 percent of the global economy.

Unleashing the California Spirit

This Plan is a declaration of California's path forward. It builds on the State's successful approach to addressing climate change and harnesses the California spirit to propel a cleaner economy, while serving as an example for others.

But this Plan will not be successful on its own. Our collective, and individual, efforts must reach every sector of California's economy, and every community in the state. As California faces the challenge of climate change, it will succeed as it always has – through open, inclusive processes, through support of clean technology markets, and through a relentless pursuit of a healthy California for all.

There should be no doubt that California is united in understanding the need to act, and in the will to act. Investments in clean, low-carbon options will pay off – for the environment and the economy. Investments and training in education and workforce development for a lower carbon economy are a critical part of this transition.

This Plan is only the beginning. All of the measures in the Plan will be developed in their own public process, shaped not just by the vision of this Plan, but also by the best understanding of the technology, costs and impacts on communities – and by input from a broad range of stakeholders and perspectives with the recognition that achieving the 2030 target is a milestone on our way to the deeper GHG reductions needed to protect the environment and our way of life. The Plan also proposes developing a long-term funding plan to inform future appropriations necessary to achieve our long-term targets, which will send clear market and workforce development signals.

Climate change presents unprecedented challenges, but just as we have always done, Californians will tackle them with innovation, inclusion and ultimately, success.

Chapter 1

Introduction

Background

In November 2016, California Governor Edmund G. Brown affirmed California's role in the fight against climate change in the United States, noting, "We will protect the precious rights of our people and continue to confront the existential threat of our time–devastating climate change." By working to reduce the threat facing the State and setting an example, California continues to lead in the climate arena. This Scoping Plan for Achieving California's 2030 Greenhouse Gas Target (Scoping Plan or 2017 Scoping Plan) identifies how the State can reach our 2030 climate target to reduce greenhouse gas (GHG) emissions by 40 percent from 1990 levels, and substantially advance toward our 2050 climate goal to reduce GHG emissions by 80 percent below 1990 levels. By selecting and pursuing a sustainable and clean economy path for 2030, the State will continue to successfully execute existing programs, demonstrate the coupling of economic growth and environmental progress, and enhance new opportunities for engagement within the State to address and prepare for climate change.

This Scoping Plan builds on and integrates efforts already underway to reduce the State's GHG, criteria pollutant, and toxic air contaminant emissions. Successful implementation of existing programs has put California on track to achieve the 2020 target. Programs such as the Low Carbon Fuel Standard and Renewables Portfolio Standard are delivering cleaner fuels and energy, the Advanced Clean Cars Program has put more than a quarter million clean vehicles on the road, and the Sustainable Freight Action Plan will result in efficient and cleaner systems to move goods throughout the State. Enhancing and implementing these ongoing efforts puts California on the path to achieving the 2030 target. This Scoping Plan relies on these, and other, foundational programs paired with an extended, more stringent Cap-and-Trade Program, to deliver climate, air quality, and other benefits.

In developing this Scoping Plan, it is paramount that we continue to build on California's success by taking effective actions. We must rapidly produce real results to avoid the most catastrophic impacts of climate change. The Scoping Plan identifies policies based on solid science and identifies additional research needs, while also recognizing the need for flexibility in the face of a changing climate. Ongoing research to better understand systems where our knowledge is weaker will allow for additional opportunities to set targets and identify actionable policies. Further, a long-term funding plan to inform future appropriations is critical to achieve our long-term targets, which will send clear market and workforce development signals.

Climate Legislation and Directives

California has made progress on addressing climate change during periods of both Republican and Democratic national and State administrations. California's governors and legislature prioritize public health and the environment. A series of executive orders and laws have generated policies and actions across State government, among local and regional governments, and within industry. These policies also have encouraged collaboration with federal agencies and spurred partnerships with many jurisdictions beyond California's borders. Moving forward, California will continue its pursuit of collaborations and advocacy for action to address climate change. The following list provides a summary of major climate legislation and executive orders that have shaped California's climate programs.

Assembly Bill 32 (AB 32) (Nuñez, Chapter 488, Statutes of 2006), the California Global Warming Solutions Act of 2006.

- Cut the State's GHG emissions to 1990 levels by 2020 with maintained and continued reductions post 2020.
- First comprehensive climate bill in California, a defining moment in the State's long history of environmental stewardship.

- Secured the State's role as a national and global leader in reducing GHGs.

Pursuant to AB 32, the California Air Resources Board (CARB or Board) prepared and adopted the initial Scoping Plan to "*identify and make recommendations on direct emissions reductions measures, alternative compliance mechanisms, market-based compliance mechanisms, and potential monetary and non-monetary incentives*" in order to achieve the 2020 goal, and to achieve "*the maximum technologically feasible and cost-effective GHG emissions reductions*" by 2020 and maintain and continue reductions beyond 2020. AB 32 requires CARB to update the Scoping Plan at least every five years.

Executive Order B-30-15

In his January 2015 inaugural address, Governor Brown identified actions in five key climate change strategy "pillars" necessary to meet California's ambitious climate change goals. These five pillars are:

- Reducing today's petroleum use in cars and trucks by up to 50 percent.
- Increasing from one-third to 50 percent our electricity derived from renewable sources.
- Doubling the efficiency savings achieved at existing buildings and making heating fuels cleaner.
- Reducing the release of methane, black carbon, and other short-lived climate pollutants.
- Managing farm and rangelands, forests, and wetlands so they can store carbon.

Consistent with these goals, Governor Brown signed Executive Order B-30-15 in April 2015:

- Establishing a California GHG reduction target of 40 percent below 1990 levels by 2030.
- Calling on CARB, in coordination with sister agencies, to update the AB 32 Climate Change Scoping Plan to incorporate the 2030 target.
- Building out the "sixth pillar" of the Governor's strategy–to safeguard California in the face of a changing climate–highlighting the need to prioritize actions to reduce GHG emissions and build resilience in the face of a changing climate.

Senate Bill 350 (SB 350) (De Leon, Chapter 547, Statutes of 2015), Golden State Standards

- Required the State to set GHG reduction planning targets through Integrated Resource Planning in the electricity sector as a whole and among individual utilities and other electricity providers (collectively known as load serving entities).
- Codified an increase in the Renewables Portfolio Standard (RPS) to 50 percent by 2030[1] and doubled the energy savings required in electricity and natural gas end uses as discussed in the Governor's inaugural address.

Senate Bill 32 (SB 32) (Pavley, Chapter 249, Statutes of 2016), California Global Warming Solutions Act of 2016: emissions limit and Assembly Bill 197 (AB 197) (E. Garcia, Chapter 250, Statutes of 2016), State Air Resources Board: greenhouse gases: regulations.

SB 32 affirms the importance of addressing climate change by codifying into statute the GHG emissions reductions target of at least 40 percent below 1990 levels by 2030 contained in Governor Brown's Executive Order B-30-15. The 2030 target reflects the same science that informs the agreement reached in Paris by the 2015 Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC), aimed at keeping the global temperature increase below 2 degrees Celsius (°C). The California 2030 target represents the most ambitious GHG reduction goal for North America. Based on the emissions reductions directed by SB 32, the annual 2030 statewide target emissions level for California is 260 million metric tons of carbon dioxide equivalent ($MMTCO_2e$).

The companion bill to SB 32, AB 197, provides additional direction to CARB on the following areas related to the adoption of strategies to reduce GHG emissions.

- Requires annual posting of GHG, criteria, and toxic air contaminant data throughout the State, organized by local and sub-county level for stationary sources and by at least a county level for mobile sources.
- Requires CARB, when adopting rules and regulations to achieve emissions reductions

1 *http://www.cpuc.ca.gov/renewables/*

and to protect the State's most affected and disadvantaged communities, to consider the social costs of GHG emissions and prioritize both of the following:
    - Emissions reductions rules and regulations that result in direct GHG emissions reductions at large stationary sources of GHG emissions and direct emissions reductions from mobile sources.
    - Emissions reductions rules and regulations that result in direct GHG emissions reductions from sources other than those listed above.
- Directs CARB, in the development of each scoping plan, to identify for each emissions reduction measure:
    - The range of projected GHG emissions reductions that result from the measure.
    - The range of projected air pollution reductions that result from the measure.
    - The cost-effectiveness, including avoided social costs, of the measure.

CARB has begun the process to implement the provisions of AB 197. For instance, CARB is already posting GHG, criteria pollutant and toxic air contaminant data. CARB also incorporated air emissions data into a visualization tool in December 2016 in response to direction in AB 197 to provide easier access to this data.[2]

Senate Bill 1383 (SB 1383) (Lara, Chapter 395, Statutes of 2016), Short-lived climate pollutants: methane emissions: dairy and livestock: organic waste: landfills

- Requires the development, adoption, and implementation of a Short-Lived Climate Pollutant Strategy.[3, 4]
- Includes the following specific goals for 2030 from 2013 levels:
    - 40 percent reduction in methane.
    - 40 percent reduction in hydrofluorocarbon gases.
    - 50 percent reduction in anthropogenic black carbon.[5]

Short-lived climate pollutants (SLCPs), such as black carbon, fluorinated gases, and methane, are powerful climate forcers that have a dramatic and detrimental effect on air quality, public health, and climate change. These pollutants create a warming influence on the climate that is many times more potent than that of carbon dioxide. In March 2017, the Board adopted the Short-Lived Climate Pollutant Reduction Strategy (SLCP Strategy) establishing a path to decrease GHG emissions and displace fossil-based natural gas use. Strategies include avoiding landfill methane emissions by reducing the disposal of organics through edible food recovery, composting, in-vessel digestion, and other processes; and recovering methane from wastewater treatment facilities, and manure methane at dairies, and using the methane as a renewable source of natural gas to fuel vehicles or generate electricity. The SLCP Strategy also identifies steps to reduce natural gas leaks from oil and gas wells, pipelines, valves, and pumps to improve safety, avoid energy losses, and reduce methane emissions associated with natural gas use. Lastly, the SLCP Strategy also identifies measures that can reduce hydrofluorocarbon (HFC) emissions at national and international levels, in addition to State-level action that includes an incentive program to encourage the use of low-Global Warming Potential (GWP) refrigerants, and limitations on the use of high-GWP refrigerants in new refrigeration and air-conditioning equipment.

Assembly Bill 1504 (AB 1504) (Skinner, Chapter 534, Statutes of 2010): Forest resources: carbon sequestration

- Requires the Board of Forestry and Fire Protection to adopt district forest practice rules and regulations in accordance with specified policies to, among other things, assure the continuous growing and harvesting of commercial forest tree species.
- Requires the Board of Forestry and Fire Protection to ensure that its rules and regulations that govern the harvesting of commercial forest tree species consider the capacity of forest resources to sequester carbon dioxide emissions sufficient to meet or exceed the sequestration target of 5 million metric tons of carbon dioxide annually, as established in the first AB 32 Climate Change Scoping Plan.

2 CARB. 2016. CARB's Emission Inventory Activities. *www.arb.ca.gov/ei/ei.htm*
3 CARB. Reducing Short-Lived Climate Pollutants in California. *www.arb.ca.gov/cc/shortlived/shortlived.htm*
4 Senate Bill No. 605. *leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB605*
5 Senate Bill No.1383. *leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB1383*

Senate Bill 1386 (SB 1386) (Wolk, Chapter 545, Statutes of 2016): Resource conservation, natural and working lands

- Declares it the policy of the State that protection and management of natural and working lands, as defined, is an important strategy in meeting the State's GHG reduction goals.
- Requires State agencies to consider protection and management of natural and working lands in establishing policies and grant criteria, and in making expenditures, and "implement this requirement in conjunction with the State's other strategies to meet its greenhouse gas emissions reduction goals."

Assembly Bill 398 (AB 398) (E. Garcia, Chapter 135, Statutes of 2017): California Global Warming Solutions Act of 2006: market-based compliance mechanisms: fire prevention fees: sales and use tax manufacturing exemption

- Clarifies the role of the State's Cap-and-Trade Program from January 1, 2021, through December 31, 2030, continuing elements of the current program, but requiring CARB to make some post-2020 refinements.
- Establishes a Compliance Offsets Protocol Task Force to provide guidance to CARB in approving new offset protocols that increase projects with direct, in-state environmental benefits.
- Establishes the Independent Emissions Market Advisory Committee to report annually on the environmental and economic performance of the Cap-and-Trade Program and other climate policies.
- Identifies legislative priorities for allocating auction revenue proceeds, to include but not be limited to: air toxic and criteria air pollutants from stationary and mobile sources; low- and zero-carbon transportation alternatives; sustainable agricultural practices that promote transition to clean technology, water efficiency, and improved air quality; healthy forests and urban greening; short-lived climate pollutants; climate adaptation and resiliency; and climate and clean energy research.

In addition, AB 398 requires CARB to designate the Cap-and-Trade Program as the mechanism for reducing GHG emissions from petroleum refineries and oil and gas production facilities in this update to the Scoping Plan. With respect to local air districts, AB 398 states that it does not limit or expand the district's existing authority, including the authority to regulate criteria pollutants and toxic air contaminants, except that it prohibits an air district from adopting or implementing a rule for the specific purpose of reducing emissions of carbon dioxide from stationary sources that are subject to the Cap-and-Trade Program.

Assembly Bill 617 (AB 617) (C. Garcia, Chapter 136, Statutes of 2017): Nonvehicular air pollution: criteria air pollutants and toxic air contaminants.

This bill was passed as a companion to AB 398 (E. Garcia, 2017) to strengthen air quality monitoring and reduce air pollution at a community level, in communities affected by a high cumulative burden of exposure to pollution. CARB is required to prepare a monitoring plan by October 1, 2018, that assesses the State's current air monitoring network with recommendations for a set of high-priority locations around the State to deploy community focused air monitoring systems. Local air districts must deploy air monitoring systems in the selected high priority locations by July 1, 2019. Thereafter, CARB will evaluate and select additional locations for community air monitoring on an annual basis. The air districts must also deploy air monitoring systems within one year of CARB's selection of the high-priority locations. In addition to the monitoring plan, the bill requires CARB to develop a statewide strategy to reduce criteria pollutants and toxic air contaminants (TACs) in communities affected by high cumulative exposure burdens through approved community emissions reduction programs developed by local air districts, in partnership with residents in the affected communities; requires CARB to establish a uniform system of annual reporting of criteria pollutants and TACs for the existing statewide air monitoring network; and expedites implementation of best available retrofit control technology in non-attainment areas.

Tables summarizing the legislation described in this section, along with other climate related legislation and programs are included in Appendix H and organized by sector.

Initial Scoping Plan and First Update to the Scoping Plan

The Initial Scoping Plan[6] in 2008 presented the first economy-wide approach to reducing emissions and highlighted the value of combining both carbon pricing with other complementary programs to meet California's 2020 GHG emissions target while ensuring progress in all sectors. The coordinated set of policies in the Initial Scoping Plan employed strategies tailored to specific needs, including market-based compliance mechanisms, performance standards, technology requirements, and voluntary reductions. The Initial Scoping Plan also described a conceptual design for a cap-and-trade program that included eventual linkage to other cap-and-trade programs to form a larger regional trading program.

AB 32 requires CARB to update the scoping plan at least every five years. The First Update to the Scoping Plan[7] (First Update), approved in 2014, presented an update on the program and its progress toward meeting the 2020 limit. It also developed the first vision for long-term progress beyond 2020. In doing so, the First Update laid the groundwork for the goals set forth in Executive Orders S-3-05[8] and B-16-2012[9]. It also identified the need for a 2030 mid-term target to establish a continuum of actions to maintain and continue reductions, rather than only focusing on targets for 2020 or 2050.

Building on California's Environmental Legacy

California's successful climate policies and programs have already delivered emissions reductions resulting from cleaner, more fuel-efficient cars and zero emission vehicles (ZEVs), low carbon fuels, increased renewable energy, and greater waste diversion from landfills; water conservation; improved forest management; and improved energy efficiency of homes and businesses. Beyond GHG reductions, these policies and programs also provide an array of benefits including improved public health, green jobs, and more clean energy choices. The 2030 GHG emissions reduction target in SB 32 will ensure that the State maintains this momentum beyond 2020, mindful of the State's population growth and needs. This Scoping Plan identifies a path to simultaneously make progress on the State's climate goals as well as complement other efforts such as the State Implementation Plans (SIPs) and community emissions reduction programs to help improve air quality in all parts of the State.

California's future climate strategy will require continued contributions from all sectors of the economy, including enhanced focus on zero- and near-zero emission (ZE/NZE) vehicle technologies; continued investment in renewables, such as solar roofs, wind, and other types of distributed generation; greater use of low carbon fuels; integrated land conservation and development strategies; coordinated efforts to reduce emissions of short-lived climate pollutants (methane, black carbon, and fluorinated gases); and an increased focus on integrated land use planning to support livable, transit-connected communities and conservation of agricultural and other lands. Requirements for GHG reductions at stationary sources complement efforts of local air pollution control and air quality management districts (air districts) to tighten criteria and toxics air pollution emission limits on a broad spectrum of industrial sources, including in disadvantaged communities historically located adjacent to large stationary sources. Finally, meeting the State's climate, public health, and environmental goals will entail understanding, quantifying, and addressing emissions impacts from land use decisions at all governmental levels.

Purpose of the 2017 Scoping Plan

This Scoping Plan incorporates, coordinates, and leverages many existing and ongoing efforts and identifies new policies and actions to accomplish the State's climate goals. Chapter 2 of this document includes a description of a suite of specific actions to meet the State's 2030 GHG limit. In addition, Chapter 4 provides a broader description of the many actions and proposals being explored across the sectors, including the natural resources sector, to achieve the State's mid and long-term climate goals.

Guided by legislative direction, the actions identified in this Scoping Plan reduce overall GHG emissions in California and deliver policy signals that will continue to drive investment and certainty in a low carbon

---

6 CARB. Initial AB 32 Climate Change Scoping Plan. Available at: *www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf*

7 CARB. First Update to the AB 32 Scoping Plan. Available at: *www.arb.ca.gov/cc/scopingplan/document/updatedscopingplan2013.htm*

8 *www.gov.ca.gov/news.php?id=1861*

9 *www.gov.ca.gov/news.php?id=17472*

economy. This Scoping Plan builds upon the successful framework established by the Initial Scoping Plan and First Update, while identifying new, technologically feasible, and cost-effective strategies to ensure that California meets its GHG reduction targets in a way that promotes and rewards innovation, continues to foster economic growth, and delivers improvements to the environment and public health, including in disadvantaged communities. The Plan includes policies to require direct GHG reductions at some of the State's largest stationary sources and mobile sources. These policies include the use of lower GHG fuels, efficiency regulations, and the Cap-and-Trade Program, which constrains and reduces emissions at covered sources.

Process for Developing the 2017 Scoping Plan

This Scoping Plan was developed in coordination with State agencies, through engagement with the Legislature, and with open and transparent opportunities for stakeholders and the public to engage in workshops and other meetings. Development also included careful consideration of, and coordination with, other State agency plans and regulations, including the Cap-and-Trade Program, Low Carbon Fuel Standard (LCFS), State Implementation Plan, California Sustainable Freight Action Plan, California Transportation Plan 2040, Forest Carbon Plan, and the Short-Lived Climate Pollutant Strategy, among others.

To inform this Scoping Plan, CARB, in collaboration with the Governor's Office and other State agencies, solicited comments and feedback from affected stakeholders, including the public, and the Environmental Justice Advisory Committee (EJAC or Committee). The process to update the 2017 Scoping Plan began with the Governor's Office Pillar Symposia, which included over a dozen public workshops, and featured a series of Committee and environmental justice community meetings.[10]

One key message conveyed to CARB during engagement with the legislature, EJAC, and environmental justice communities was the need to emphasize reductions at large stationary sources, with a particular focus on multi-pollutant strategies for these sources to reduce GHGs and harmful criteria and toxic air pollutants that result in localized health impacts, especially in disadvantaged communities. Other consistent feedback for CARB included the need for built and natural infrastructure improvements that enhance quality of life, increase access to safe and viable transportation options, and improve physical activity and related health outcomes.

Updated Climate Science Supports the Need for More Action

Climate scientists agree that global warming and other shifts in the climate system observed over the past century are caused by human activities. These recorded changes are occurring at an unprecedented rate.[11] According to new research, unabated GHG emissions could allow sea levels to rise up to ten feet by the end of this century–an outcome that could devastate coastal communities in California and around the world.[12]

California is already feeling the effects of climate change, and projections show that these effects will continue and worsen over the coming centuries. The impacts of climate change have been documented by the Office of Environmental Health Hazard Assessment (OEHHA) in the Indicators of Climate Change Report, which details the following changes that are occurring already:[13]

- A recorded increase in annual average temperatures, as well as increases in daily minimum and maximum temperatures.
- An increase in the occurrence of extreme events, including wildfire and heat waves.
- A reduction in spring runoff volumes, as a result of declining snowpack.
- A decrease in winter chill hours, necessary for the production of high-value fruit and nut crops.
- Changes in the timing and location of species sightings, including migration upslope of flora and fauna, and earlier appearance of Central Valley butterflies.

10 *www.arb.ca.gov/cc/scopingplan/scopingplan.htm*

11 Cook, J., et al. 2016. Consensus on consensus: A synthesis of consensus estimates on human-caused global warming. Environmental Research Letters 11:048002 doi:10.1088/1748-9326/11/4/048002. *iopscience.iop.org/article/10.1088/1748-9326/11/4/048002*.

12 California Ocean Protection Council. 2017. Rising Seas in California: An Update On Sea-Level Rise Science. *www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf*

13 Office of Environmental Health Hazard Assessment, Indicators of Climate Change (website): *oehha.ca.gov/climate-change/document/indicators-climate-change-california*

In addition to these trends, the State's current conditions point to a changing climate. California's recent historic drought incited land subsidence, pest invasions that killed over 100 million trees, and water shortages throughout the State. Recent scientific studies show that such extreme drought conditions are more likely to occur under a changing climate.[14,15] The total statewide economic cost of the 2013–2014 drought was estimated at $2.2 billion, with a total loss of 17,100 jobs.[16] In the Central Valley, the drought cost California agriculture about $2.7 billion and more than 20,000 jobs in 2015, which highlights the critical need for developing drought resilience.[17] Drought affects other sectors as well. An analysis of the amount of water consumed in meeting California's energy needs between 1990 and 2012 shows that while California's energy policies have supported climate mitigation efforts, the performance of these policies have increased vulnerability to climate impacts, especially greater hydrologic uncertainty.[18]

Several publications carefully examined the potential role of climate change in the recent California drought. One study examined both precipitation and runoff in the Sacramento and San Joaquin River basins, and found that 10 of the past 14 years between 2000 and 2014 have been below normal, and recent years have been the driest and hottest in the full instrumental record from 1895 through November 2014.[19] In another study, the authors show that the increasing co-occurrence of dry years with warm years raises the risk of drought, highlighting the critical role of elevated temperatures in altering water availability and increasing overall drought intensity and impact.[20] Generally, there is growing risk of unprecedented drought in the western United States driven primarily by rising temperatures, regardless of whether or not there is a clear precipitation trend.[21]

According to the U.S. Forest Service report, National Insect and Disease Forest Risk Assessment, 2013–2027,[22] California is at risk of losing 12 percent of the total area of forests and woodlands in the State due to insects and disease, or over 5.7 million acres. Some species are expected to lose significant amounts of their total basal area (e.g., whitebark pine is projected to lose 60 percent of its basal area; and lodgepole pine is projected to lose 40 percent). While future climate change is not modeled within the risk assessment, and current drought conditions are not accounted for in these estimates, the projected climate changes over a 15 year period (2013-2027) are expected to significantly increase the number of acres at risk, and will increase the risk from already highly destructive pests such as the mountain pine beetle. Extensive tree mortality is already prevalent in California. The western pine beetle and other bark beetles have killed a majority of the ponderosa pine in the foothills of the central and southern Sierra Nevada Mountains. A recent aerial survey by the U.S. Forest Service identified more than 100 million dead trees in California.[23] As there is usually a lag time between drought years and tree mortality, we are now beginning to see a sharp rise in mortality from the past four years of drought. In response to the very high levels of tree mortality, Governor Brown issued an Emergency Proclamation on October 30, 2015, that directed state agencies to identify and take action to reduce wildfire risk through the removal and use of the dead trees.

---

14 Diffenbaugh, N., D. L. Swain, and D. Touma. 2015. Anthropogenic Warming has Increased Drought Risk in California. Proceedings of the National Academy of Sciences 112(13): 3931–3936.

15 Cayan, D., T. Das, D. W. Pierce, T. P. Barnett, M. Tyree, and A. Gershunov. 2010. Future Dryness in the Southwest US and Hydrology of the Early 21st Century Drought. Proceedings of the National Academy of Sciences 107(50): 21272–21276.

16 Howitt, R., J. Medellin-Azuara, D. MacEwan, J. Lund, and D. Summer. 2014. Economic Impacts of 2014 Drought on California Agriculture. *watershed.ucdavis.edu/files/biblio/DroughtReport_23July2014_0.pdf*.

17 Williams, A. P., et al. 2015. Contribution of anthropogenic warming to California drought during 2012–2014. Geophysical Research Letters *http://onlinelibrary.wiley.com/doi/10.1002/2015GL064924/abstract*.

18 Fulton, J., and H. Cooley. 2015. The water footprint of California's energy system, 1990–2012 Environmental Science & Technology 49(6):3314–3321. *pubs.acs.org/doi/abs/10.1021/es505034x*.

19 Mann, M. E., and P. H. Gleick. 2015. Climate change and California drought in the 21st century. Proceedings of the National Academy of Sciences of the United States of America, 112(13):3858–3859. *doi.org/10.1073/pnas.1503667112*.

20 Diffenbaugh, N. S., D. L. Swain, and D. Touma. 2015. Anthropogenic warming has increased drought risk in California. Proceedings of the National Academy of Sciences of the United States of America. 10.1073/pnas.1422385112. *www.pnas.org/content/112/13/3931.full.pdf*

21 Cook, B. I., T. R. Ault, and J. E. Smerdon. 2015. Unprecedented 21st century drought risk in the American Southwest and Central Plains. Science Advances 1(1), e1400082, doi:10.1126/sciadv.1400082.

22 Krist, F.J. Jr., J.R. Ellenwood, M.E. Woods, A.J. McMahan, J.P. Cowardin, D.E. Ryerson, F.J. Sapio, M.O. Zweifler, S.A. Romero. 2014. FHTET 2013 – 2027 National Insect & and Disease Forest Risk Assessment. FHTET-14-01 January 2014. Available at: *http://www.fs.fed.us/foresthealth/technology/pdfs/2012_RiskMap_Report_web.pdf*

23 USDA. 2016. New Aerial Survey Identifies More Than 100 Million Dead Trees in California. *www.usda.gov/wps/portal/usda/usdahome?contentid=2016/11/0246.xml&contentidonly=true*

Climate Impacts at the Community Level

The California Energy Commission Cal-Adapt tool provides information about future climate conditions to help better understand how climate will impact local communities.

cal-adapt.org

A warming climate also causes sea level to rise; first, by warming the oceans which causes the water to expand, and second, by melting land ice which transfers water to the ocean. Even if storms do not become more intense or frequent, sea level rise itself will magnify the adverse impact of any storm surge and high waves on the California coast. Some observational studies report that the largest waves are already getting higher and winds are getting stronger.[24] Further, as temperatures warm and GHG concentrations increase more carbon dioxide dissolves in the ocean, making it more acidic. More acidic ocean water affects a wide variety of marine species, including species that people rely on for food. Recent projections indicate that if no significant GHG mitigation efforts are taken, the San Francisco Bay Area may experience sea level rise between 1.6 to 3.4 feet, and in an extreme scenario involving the rapid loss of the Antarctic ice sheet, sea levels along California's coastline could rise up to 10 feet by 2100.[25] This change is likely to have substantial ecological and economic consequences in California and worldwide.[26]

While more intense dry periods are anticipated under warmer conditions, extremes on the wet end of the spectrum are also expected to increase due to more frequent warm, wet atmospheric river events and a higher proportion of precipitation falling as rain instead of snow. In recent years, atmospheric rivers have also been recognized as the cause of the large majority of major floods in rivers all along the U.S. West Coast and as the source of 30-50 percent of all precipitation in the same region.[27] These extreme precipitation events, together with the rising snowline, often cause devastating floods in major river basins (e.g., California's Russian River). It was estimated that the top 50 observed floods in the U.S. Pacific Northwest were due to atmospheric rivers.[28] Looking ahead, the frequency and severity of atmospheric rivers on the U.S. West Coast will increase due to higher atmospheric water vapor that occurs with rising temperature, leading to more frequent flooding.[29, 30]

Climate change can drive extreme weather events such as coastal storm surges, drought, wildfires, floods, and heat waves, and disrupt environmental systems including our forests and oceans. As GHG emissions continue to accumulate and climate disruption grows, such destructive events will become more frequent. Several recent studies project increased precipitation within hurricanes over ocean regions.[31, 32] The primary physical mechanism for this increase is higher water vapor in the warmer atmosphere, which enhances moisture convergence in a storm for a given circulation strength. Since hurricanes are responsible for many of the most extreme precipitation events, such events are likely to become more extreme. Anthropogenic warming by

---

24 National Research Council of the National Academy of Sciences. 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. National Academies Press.

25 California Ocean Protection Council. 2017. Rising Seas in California: An Update On Sea-Level Rise Science. *www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf*

26 Chan, F., et al. 2016. The West Coast Ocean Acidification and Hypoxia Science Panel: Major Findings, Recommendations, and Actions. California Ocean Science Trust, Oakland, California, USA.

27 Dettinger, M. D. 2013. Atmospheric rivers as drought busters on the U.S. West Coast. Journal of Hydrometeorology 14:1721 1732, doi:10.1175/JHM-D-13-02.1. *journals.ametsoc.org/doi/abs/10.1175/JHM-D-13-02.1*.

28 Warner, M. D., C. F. Mass, and E. P. Salath´e. 2012. Wintertime extreme precipitation events along the Pacific Northwest coast: Climatology and synoptic evolution. Monthly Weather Review 140:2021–43. *http://journals.ametsoc.org/doi/abs/10.1175/MWR-D-11-00197.1*.

29 Hagos, S. M., L. R. Leung, J.-H. Yoon, J. Lu, and Y. Gao, 2016: A projection of changes in landfalling atmospheric river frequency and extreme precipitation over western North America from the Large Ensemble CESM simulations. Geophysical Research Letters, 43 (3), 357-1363, *http://onlinelibrary.wiley.com/doi/10.1002/2015GL067392/epdf*.

30 Payne, A. E., and G. Magnusdottir, 2015: An evaluation of atmospheric rivers over the North Pacific in CMIP5 and their response to warming under RCP 8.5. Journal of Geophysical Research: Atmospheres, 120 (21), 11,173-111,190, *http://onlinelibrary.wiley.com/doi/10.1002/2015JD023586/epdf*.

31 Easterling, D.R., K.E. Kunkel, M.F. Wehner, and L. Sun, 2016: Detection and attribution of climate extremes in the observed record. Weather and Climate Extremes, 11, 17-27. *http://dx.doi.org/10.1016/j.wace.2016.01.001*.

32 NAS, 2016: Attribution of Extreme Weather Events in the Context of Climate Change. The National Academies Press, Washington, DC, 186 pp. *http://dx.doi.org/10.17226/21852*.

the end of the 21st century will likely cause tropical cyclones globally to become more intense on average. This change implies an even larger percentage increase in the destructive potential per storm, assuming no changes in storm size.[33,34] Thus, the historical record, which once set our expectations for the traditional range of weather and other natural events, is becoming an increasingly unreliable predictor of the conditions we will face in the future. Consequently, the best available science must drive effective climate policy.

California is committed to further supporting new research on ways to mitigate climate change and how to understand its ongoing and projected impacts. California's Fourth Climate Change Assessment and Indicators of Change Report will further update our understanding of the many impacts from climate change in a way that directly informs State agencies' efforts to safeguard the State's people, economy, and environment.[35, 36]

Together, historical data, current conditions, and future projections provide a picture of California's changing climate, with two important messages:

- Change is already being experienced and documented across California, and some of these changes have been directly linked to changing climatic conditions.
- Even with the uncertainty in future climate conditions, every scenario estimates further change in future conditions.

It is critical that California continue to take steps to reduce GHG emissions in order to avoid the worst of the projected impacts of climate change. At the same time, the State is taking steps to make the State more resilient to ongoing and projected climate impacts as laid out by the Safeguarding California Plan.[37] The Safeguarding California Plan is being updated in 2017 to present new policy recommendations and provide a roadmap of all the actions and next steps that state government is taking to adapt to the ongoing and inevitable effects of climate change. The Draft Safeguarding California Plan[38] is available and will be finalized after workshops and public comments. California's continuing efforts are vital steps toward minimizing the impact of GHG emissions and a three-pronged approach of reducing emissions, preparing for impacts, and conducting cutting-edge research can serve as a model for action.

California's Greenhouse Gas Emissions and the 2030 Target

Progress Toward Achieving the 2020 Limit

AB 32 directs CARB to develop and track GHG emissions and progress toward the 2020 statewide GHG target. California is on track to achieve the target while also reducing criteria pollutants and toxic air contaminants and supporting economic growth. As shown in Figure 1, in 2015, total GHG emissions decreased by 1.5 $MMTCO_2e$ compared to 2014, representing an overall decrease of 10 percent since peak levels in 2004. The 2015 GHG Emission Inventory and a description of the methodology updates can be accessed at: *www.arb.ca.gov/cc/inventory/inventory.htm*.

Per California Health and Safety Code section 38505, CARB monitors and regulates seven GHGs to reduce emissions: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and nitrogen trifluoride (NF_3). The fluorinated gases are also referred to as "high global warming potential gases" (high-GWP gases). California's annual statewide GHG emission inventory has historically been the primary tool for tracking GHG emissions trends. Figure 1 provides the GHG inventory trend. Additional information on the methodology for the GHG inventory can also be found at: *www.arb.ca.gov/cc/inventory/data/data.htm*.

33 Sobel, A.H., S.J. Camargo, T.M. Hall, C.-Y. Lee, M.K. Tippett, and A.A. Wing, 2016: Human influence on tropical cyclone intensity. Science, 353, 242-246.

34 Kossin, J. P., K. A. Emanuel, and S. J. Camargo, 2016: Past and projected changes in western North Pacific tropical cyclone exposure. Journal of Climate, 29 (16), 5725-5739, *https://doi.org/10.1175/JCLI-D-16-0076.1*.

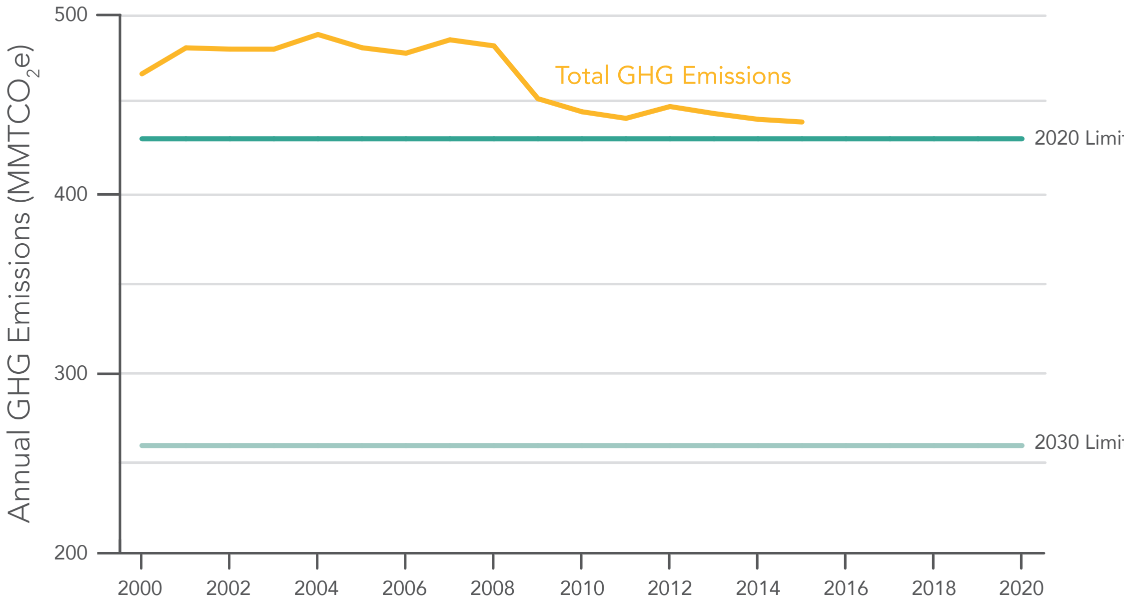
35 California's Fourth Climate Change Assessment. *http://resources.ca.gov/climate/safeguarding/research/*

36 Office of Environmental Health Hazard Assessment, Indicators of Climate Change (website): *https://oehha.ca.gov/climate-change/document/indicators-climate-change-california*

37 California Natural Resources Agency. 2017. Safeguarding California. *http://resources.ca.gov/climate/safeguarding/*

38 *http://resources.ca.gov/climate/safeguarding/*

Figure 1: California GHG Inventory Trend



Carbon dioxide is the primary GHG emitted in California, accounting for 84 percent of total GHG emissions in 2015, as shown in Figure 2 below. Figure 3 illustrates that transportation, primarily on-road travel, is the single largest source of CO_2 emissions in the State. Upstream transportation emissions from the refinery and oil and gas sectors are categorized as CO_2 emissions from industrial sources and constitute about 50 percent of the industrial source emissions. When these emissions sources are attributed to the transportation sector, the emissions from that sector amount to approximately half of statewide GHG emissions. In addition to transportation, electricity production, and industrial and residential sources also are important contributors to CO_2 emissions.

Figures 2 and 3 show State GHG emission contributions by GHG and sector based on the 2015 GHG Emission Inventory. Emissions in Figure 3 are depicted by Scoping Plan sector, which includes separate categories for high-GWP and recycling/waste emissions that are otherwise typically included within other economic sectors.

Figure 2: Emissions by GHG

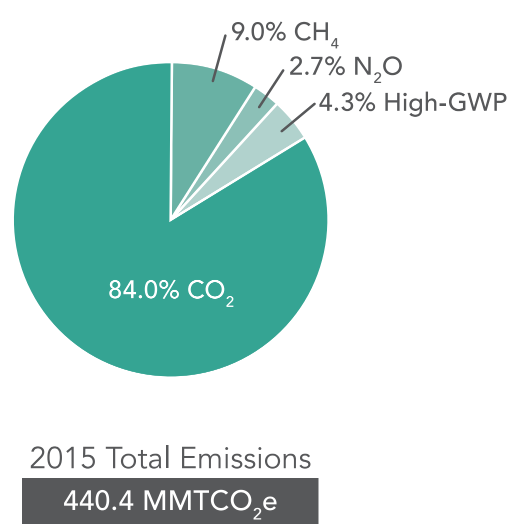
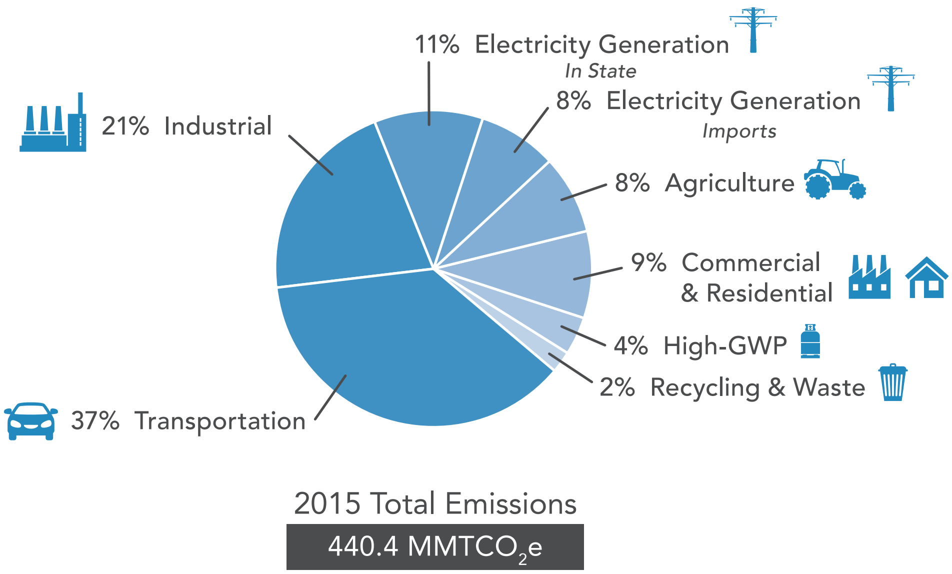
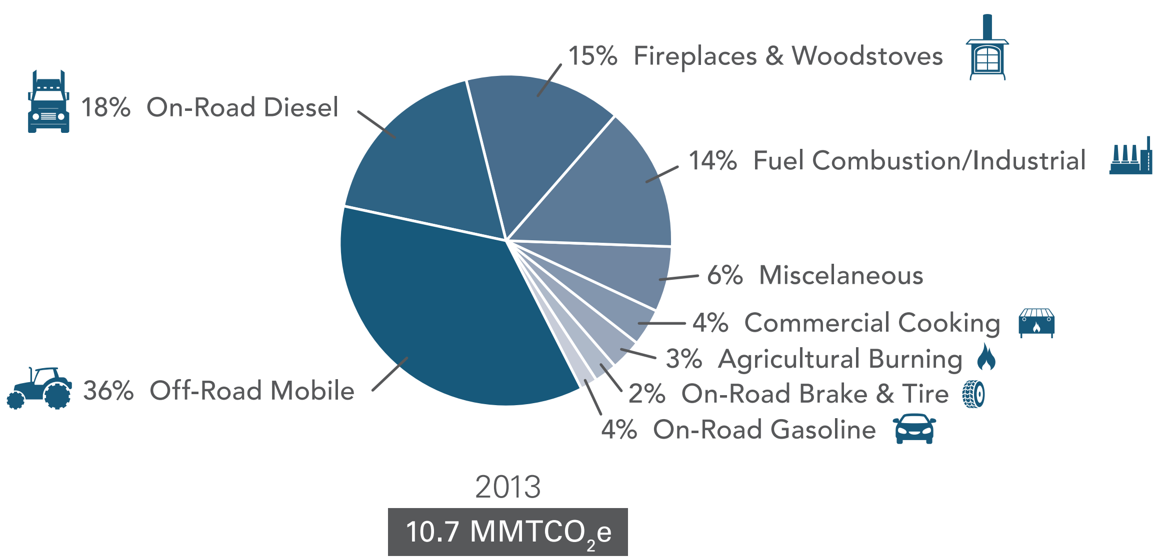


FIGURE 3: EMISSIONS BY SCOPING PLAN SECTOR



In addition, CARB has developed a statewide emission inventory for black carbon in support of the SLCP Strategy, which is reported in two categories: non-forestry (anthropogenic) sources and forestry sources.[39] The black carbon inventory will help support implementation of the SLCP Strategy, but is not part of the State's GHG Inventory that tracks progress towards the State's climate targets. The State's major anthropogenic sources of black carbon include off-road transportation, on-road transportation, residential wood burning, fuel combustion, and industrial processes (Figure 4). The forestry category includes non-agricultural prescribed burning and wildfire emissions.

FIGURE 4: CALIFORNIA 2013 ANTHROPOGENIC BLACK CARBON EMISSION SOURCES*



*Using 100-year GWP

The exchange of CO_2 between the atmosphere and California's natural and working lands sector is currently unquantified and therefore, excluded from the State's GHG Inventory. A natural and working lands carbon inventory is essential for monitoring land-based activities that may increase or decrease carbon sequestration over time. CARB staff is working to develop a comprehensive inventory of GHG fluxes from all of California's

39 Per SB 1383, the SLCP Strategy only addresses anthropogenic black carbon.

natural and working lands using the Intergovernmental Panel on Climate Change (IPCC) design principles. CARB released the Natural and Working Lands Inventory with the 2030 Target Scoping Plan Update Discussion Draft.[40] This inventory provides an estimate of GHG emissions reductions and changes in carbon stock from some carbon pools in agricultural and natural and working lands. The CARB Natural and Working Lands Inventory includes an inventory of carbon stocks, stock-change (and by extension GHG flux associated with stock-change) with some attribution by disturbance process for the analysis period 2001-2010. Disturbance processes include activities such as conversion from one land category to a different category, fire, and harvest. The CARB Natural and Working Lands Inventory covers varieties of forests and woodlands, grasslands, and wetlands (biomass-stock-change only). The Inventory includes default carbon densities for croplands and urban/developed lands to facilitate stock-change estimation for natural lands that convert to cropland, natural lands that convert to developed lands, and for croplands that convert to developed lands.

Greenhouse Gas Emissions Tracking

As described above, California maintains an economy-wide GHG inventory for the State that is consistent with IPCC practices to allow for comparison of statewide GHG emissions with those at the national level and with other international GHG inventories. Statewide GHG emissions calculations use many data sources, including data from other State and federal agencies. However, the primary source of data comes from reports submitted to CARB through the Regulation for the Mandatory Reporting of GHG Emissions (MRR). MRR requires facilities and entities with more than 10,000 metric tons of carbon dioxide equivalent ($MTCO_2e$) of combustion and process emissions, all facilities belonging to certain industries, and all electric power entities to submit an annual GHG emissions data report directly to CARB. Reports from facilities and entities that emit more than 25,000 $MTCO_2e$ are verified by a CARB-accredited third-party verification body. More information on MRR emissions reports can be found at: *www.arb.ca.gov/cc/reporti\ng/ghg-rep/reported-data/ghg-reports.htm.*

All data sources used to develop the GHG Emission Inventory are listed in inventory supporting documentation at: *www.arb.ca.gov/cc/inventory/data/data.htm.*

Other State agencies, nonprofit organizations, and research institutions are developing and testing methodologies and models to quantify GHG fluxes from California's natural and working lands. CARB's ongoing work on the Natural and Working Lands Inventory will serve as one source of data to gauge the scope of GHG reduction potential from California's natural and working lands and monitor progress over time. CARB will evaluate other data sources and methodologies to validate or support the CARB inventory or project-scale tracking. Interagency work is also underway to integrate and account for the land use and management impacts of development, transportation, housing, and energy policies.

Greenhouse gas mitigation action may cross geographic borders as part of international and subnational collaboration, or as a natural result of implementation of regional policies. In addition to the State's existing GHG inventory, CARB has begun exploring how to build an accounting framework that also utilizes existing program data to better reflect the broader benefits of our policies that may be happening outside of the State. For GHG reductions outside of the State to be attributed to our programs, those reductions must be real and quantifiable, without any double counting, including claims to those reductions by other jurisdictions. CARB is collaborating with other jurisdictions to ensure GHG accounting rules are consistent with international best practices. Robust accounting rules will instill confidence in the reductions claimed and maintain support for joint action across jurisdictions. Consistency and transparency are critical as we work together with other jurisdictions on our parallel paths to achieve our GHG targets.

California's Approach to Addressing Climate Change

Integrated Systems

The State's climate goals require a comprehensive approach that integrates and builds upon multiple ongoing State efforts. As we address future mobility, we identify how existing efforts – such as the California Sustainable Freight Action Plan, Mobile Source Strategy, California Transportation Plan 2040, High-Speed

40 CARB. 2016. California Greenhouse Gas Inventory - Forests and Other Lands. *www.arb.ca.gov/cc/inventory/sectors/forest/forest.htm*

Rail,[41] urban planning, housing, and goals for enhancement of the natural environment – can complement each other while providing multiple environmental benefits, including air quality and climate benefits. The collective consideration of these efforts illuminates the synergies and conflicts between policies. For example, land disturbance due to increased renewables through utility scale wind and solar and transmission can release GHGs from soil and disturb grasslands and rangelands that have the potential to sequester carbon. Further, policies that support sustainable land use not only reduce vehicle miles traveled (VMT) and its related emissions, but may also avoid land disturbance that could result in GHG emissions or loss of sequestration potential in the natural environment. Identifying these types of trade-offs, and designing policies and implementation strategies to support goals across all sectors, will require ongoing efforts at the local, regional, and State level to ensure that sustainable action across both the built and natural environments help to achieve the State's long-term climate goals.

Promoting Resilient Economic Growth

California's strategic vision for achieving at least a 40 percent reduction in GHG emissions by 2030 is based on the principle that economic prosperity and environmental sustainability can be achieved together. Policies, strategies, plans and regulations to reduce GHG emissions help California businesses compete in a global economy and spur new investments, business creation, and jobs to support a clean energy economy. California's portfolio-based climate strategy can achieve great success when accompanied by consistent and rigorous GHG monitoring and reporting, a robust public process, and an effective enforcement program for the few that attempt to evade rules. The transition to a low-carbon future can strengthen California's economy and infrastructure and produce other important environmental benefits such as reductions in criteria pollutants and toxic air contaminants, especially in California's most vulnerable communities.

Actions that are presented in this Scoping Plan provide economic opportunities for the future, but progress toward our goals is already evident today. For example, in 2015, California added more than 20,000 new jobs in the solar sector. This was more than half of the new jobs in this industry across the nation. Employment in the clean economy grew by 20 percent between 2002 and 2012, which included the period of economic recession around 2008.[42] Shifting to clean, local, and efficient uses of energy reinvests our energy expenditures in our local economies and reduces risks to our statewide economy associated with exposure to volatile global and national oil and gas commodity prices. Indeed, a clean economy is a resilient economy.

Successfully driving economic transition will require cleaner and more efficient technologies, policies and incentives that recognize and reward innovation, and prioritizing low carbon investments. Enacting policies and incentives at multiple jurisdictional levels further ensures the advancement of land use and natural resource management objectives for GHG mitigation, climate adaptation, and other co-benefits. Intentional synergistic linkages between technological advances and resource stewardship can result in sustainable development. The development and implementation of Sustainable Communities Strategies (SCSs) pursuant to Senate Bill (SB) 375, which link transportation, housing, and climate policy, are designed to reduce per capita GHG emissions while improving air quality and expanding transportation and housing options. This Scoping Plan identifies additional ways, beyond SB 375, to promote the technologies and infrastructure required to meet our collective climate goals, while also presenting the vision for California's continuing efforts to foster a sustainable, clean energy economy.

Increasing Carbon Sequestration in Natural and Working Lands

California's natural and working lands make the State a global leader in agriculture, a U.S. leader in forest products, and a global biodiversity hotspot. These lands support clean air, wildlife and pollinator habitat, rural economies, and are critical components of California's water infrastructure. Keeping these lands and waters intact and at high levels of ecological function (including resilient carbon sequestration) is necessary for the well-being and security of Californians in 2030, 2050, and beyond. Forests, rangelands, farms,

41 California's High-Speed Rail is part of the International Union of Railways (UIC) and California signed the Railway Climate Responsibility Pledge, which was commended by the Secretary of the UN Framework Convention on Climate Change as part of achieving global 2050 targets.

42 California Business Alliance for a Clean Economy. 2015. Clean Energy and Climate Change Summary of Recent Analyses for California. *clean-economy.org/wp-content/uploads/2015/01/Clean-Energy-Climate-Change-Analyses_January2015.pdf*

wetlands, riparian areas, deserts, coastal areas, and the ocean store substantial carbon in biomass and soils.

Natural and working lands are a key sector in the State's climate change strategy. Storing carbon in trees, other vegetation, soils, and aquatic sediment is an effective way to remove carbon dioxide from the atmosphere. This Scoping Plan describes policies and programs that prioritize protection and enhancement of California's landscapes, including urban landscapes, and identifies next steps to ensure management actions are taken to increase the sequestration potential of those resources. We cannot ignore the relationships between energy, transportation, and natural working lands sectors or the adverse impacts that climate change is having on the environment itself. We must consider important trade-offs in developing the State's climate strategy by understanding the near and long-term impacts of various policy scenarios and actions on our State and local communities.

Improving Public Health

The State's drive to improve air quality and promote community health and well-being as we address climate change remains a priority, as it has for almost 50 years. The State is committed to addressing public health issues, including addressing chronic and infectious diseases, promoting mental health, and protecting communities from exposure to harmful air pollutants and toxins. Several of the strategies included in this Plan were primarily developed to help California achieve federal and State ambient air quality standards for air pollutants with direct health impacts, but they will also deliver GHG reductions. Likewise, some climate strategies, such as GHG reduction measures that decrease diesel combustion from mobile sources, produce air quality co-benefits in the form of concurrent reductions in criteria pollutants and toxic air contaminants.

Climate change itself is already affecting the health of our communities and is exacerbating existing health inequities. Those facing the greatest health burdens include low-income individuals and households, the very young and the very old, communities of color, and those who have been marginalized or discriminated against based on gender or race/ethnicity.[43] Economic factors, such as income, poverty, and wealth, are among the strongest determinants of health. Addressing climate change presents an important opportunity to improve public health for all of California's residents and to further our work toward making our State the healthiest in the nation.

The major provisions of AB 617 (C. Garcia, 2017), to be completed by 2020, will ensure that as the State seeks to advance climate policy to meet the 2030 target, we will also act locally to improve neighborhood air quality. AB 617 requires strengthening and expanding community level air monitoring; expediting equipment retrofits at large industrial sources that are located in areas that are in nonattainment for the federal and State ambient air quality standards; requiring development of a statewide strategy to further reduce criteria pollutants and toxic air contaminants in communities faced with high cumulative exposure levels; and local air district-developed community emissions reductions plans that identify emissions reductions targets, measures, implementation schedules, and enforcement plans for these affected communities. By identifying and addressing the disproportionate impacts felt today and by planning, designing, and implementing actions for a sustainable future that considers both climate and air quality objectives, we can be part of the solution to make public health inequities an issue of the past.

Environmental Justice

Fair and equitable climate action requires addressing the inequities that create and intensify community vulnerabilities. The capacity for resilience in the face of climate change is driven by living conditions and the forces that shape them. These include, but are not limited to, access to services such as health care, healthy foods, air and water, and safe spaces for physical activity; income; education; housing; transportation; environmental quality; and good health status. Strategies to alleviate poverty, increase access to economic opportunities, improve living conditions, and reduce health and social inequities will result in more climate-resilient communities. The transition to a low carbon California economy provides an opportunity to not only reduce GHG emissions, but also to reduce emissions of criteria pollutants and air toxins, and to create a healthier environment for all of California's residents, especially those living in the State's most disadvantaged communities. Policies designed to facilitate this transition and state-wide, regional, and local reductions,

43 California Department of Public Health (CDPH). 2015. The Portrait of Promise: The California Statewide Draft Plan to Promote Health and Mental Health Equity. A Report to the Legislature and the People of California by the Office of Health Equity. Sacramento, CA: California Department of Public Health, Office of Health Equity.

must also be appropriately tailored to address the unique characteristics of economically distressed communities throughout the State's diverse geographic regions, including both rural and highly-urbanized areas. Equity considerations must likewise be part of the deliberate and thoughtful process in the design and implementation of all policies and measures included in the Scoping Plan. And CARB must ensure that its ongoing engagement with environmental justice communities will continue beyond the development of the Scoping Plan and be included in all aspects of its various air pollution programs. Additional detail on CARB's efforts to achieve these goals is provided in Chapter 5.

It is critical that communities of color, low-income communities, or both, receive the benefits of the cleaner economy growing in California, including its environmental and economic benefits. Currently, low-income customers enrolled in the California Alternate Rates for Energy (CARE) Program or the Family Electric Rate Assistance (FERA) Program are also eligible to receive a rebate under the California Climate Credit, or a credit on residential and small business electricity bills resulting from the sale of allowances received by investor-owned utilities as part of the Cap-and-Trade Program. SB 1018 (Committee on Budget and Fiscal Review, Chapter 39, Statutes of 2012) and other implementing legislation requires that Cap-and-Trade Program auction monies deposited into the Greenhouse Gas Reduction Fund (GGRF) be used to further the purposes of AB 32 and facilitate reduction of GHG emissions. Investments made with these funds not only reduce GHG emissions, but also provide other environmental, health, and economic benefits including, fostering job creation by promoting in-state GHG emissions reduction projects carried out by California workers and businesses.

Environmental Justice Advisory Committee

Martha Dina Argüello	Physicians for Social Responsibility	Los Angeles
Colin Bailey	The Environmental Justice Coalition for Water	Sacramento
Gisele Fong	End Oil	Los Angeles
Tom Frantz	Association of Irritated Residents	Central Valley
Katie Valenzuela Garcia (Served until May 2017)	Oak Park Neighborhood Association	Sacramento
Sekita Grant (Served until June 2017)	The Greenlining Institute	Statewide
Kevin Hamilton	Central California Asthma Collaborative	Central Valley
Rey León	Valley LEAP	Central Valley
Luis Olmedo	Comité Civico Del Valle	Salton Sea Region
Kemba Shakur	Urban Releaf	Bay Area
Mari Rose Taruc	Asian Pacific Environmental Network	Bay Area
Eleanor Torres	The Incredible Edible Community Garden	Inland Empire
Monica Wilson	Global Alliance for Incinerator Alternatives	Bay Area

Further, SB 535 (De Leon, Chapter 830, Statutes of 2012) and AB 1550 (Gomez, Chapter 369, Statutes of 2016) direct State and local agencies to make significant investments using GGRF monies to assist California's most vulnerable communities. Under SB 535 (de León, Chapter 830, Statutes of 2012), a minimum of 25 percent of the total investments were required to benefit disadvantaged communities; of that, a minimum of 10 percent were required to be located within and provide benefits to those communities. Based on cumulative data reported by agencies as of March 2016, the State is exceeding these targets. Indeed, 50 percent of the $1.2 billion dollars spent on California Climate Investments projects provided benefits to disadvantaged communities; and 34 percent of this funding was used on projects located directly in disadvantaged communities.[44]

Environmental Justice Advisory Committee

AB 32 calls for CARB to convene an Environmental Justice Advisory Committee (EJAC), to advise the Board in developing the Scoping Plan, and any other pertinent matter in implementing AB 32. It requires that the Committee be comprised of representatives from communities in the State with the most significant exposure to air pollution, including, but not limited to, communities with minority populations or low-income

44 *www.arb.ca.gov/cc/capandtrade/auctionproceeds/cci_annual_report_2017.pdf*

populations, or both. CARB consulted 13 environmental justice and disadvantaged community representatives for the 2017 Scoping Plan process, starting with the first Committee meeting in December 2015. In February and April 2017, members of the California Air Resources Board held joint public meetings with the EJAC to discuss options for addressing environmental justice and disadvantaged community concerns in the Scoping Plan. The full schedule of Committee meetings and meeting materials is available on CARB's website.[45]

Starting in July 2016, the Committee hosted a robust community engagement process, conducting 19 community meetings throughout the State. To enhance this community engagement, CARB staff coordinated with staff from local government agencies and sister State agencies. At the community meetings, staff from State and local agencies participated in extensive, topic-specific "world café" discussions with local groups and individuals. The extensive dialogue between the EJAC, State agencies, and local agencies provided community residents the opportunity to share concerns and provide input on ways California can meet its 2030 GHG target while addressing a number of environmental and equity issues.

Environmental Justice Advisory Committee Recommendations

The Committee's recommendations for the Scoping Plan were informed by comments received at community meetings described above and Committee member expertise. Recommendations were provided for the sector focus areas, overarching environmental justice policy, and California Climate Investments. The Committee also sorted their recommendations into five themes: partnership with environmental justice communities, equity, economic opportunity, coordination, and long-term vision. Finally, the Committee provided direction that their recommendations are intended "to be read and implemented holistically and not independently of each other." The EJAC's recommendations, in their entirety, are included in Appendix A and available at *www.arb.ca.gov/cc/ejac/meetings/04262017/ejac-sp-recommendations033017.pdf*.

The Committee's overarching recommendations for partnership with environmental justice communities, equity, coordination, economic opportunity, and long-term vision include the following recommendations:

- Encourage long-term community engagement, a culture shift in California, and neighborhood-level solutions to promote the implementation of the State's climate plans, using strategies identified by the Committee.
- Improve the balance of reducing GHGs and compliance costs with other AB 32 goals of improving air quality in environmental justice communities while maximizing benefits for all Californians.
- Consider public health impacts and equity when examining issues in any sector and have CARB conduct an equity analysis on the Scoping Plan and each sector, with guidance from the Committee.
- Develop metrics to ensure actions are meeting targets and develop contingency plans for mitigation and adjustment if emissions increases occur as programs are implemented.
- Develop a statewide community-based air monitoring network to support regulatory efforts and monitor neighborhood scale pollution in disadvantaged communities.
- Coordinate strategies between State, federal, and local agencies for strong, enforceable, evidence-based policies to prevent and address sprawl with equity at the center.
- Maximize the accessibility of safe jobs, incentives, and economic benefits for Californians and the development of a just transition for workers and communities in and around polluting industries.
- Prioritize improving air quality in environmental justice communities and analyze scenarios at a neighborhood scale for all California communities.
- Ensure that AB 32 economic reviewers come from various areas around the State to represent insights on economic challenges and opportunities from those regions.
- Do not limit the Scoping Plan to examining interventions and impacts until 2030, or even 2050. Plan and analyze on a longer-term scale to prevent short-sighted mistakes and reach the long-term vision, as actions today and for the next 30 years will have impacts for seven generations.
- The Scoping Plan must prioritize GHG reductions and investments in California environmental justice communities first, before other California communities; and the innovation of new technologies or strategies to reach even deeper emissions cuts, whenever possible.
- Convene the Committee beyond the Scoping Plan development process.

The Committee's key Energy sector recommendations include:

- Developing aggressive energy goals toward 100 percent renewable energy by 2030, including a vision for a clean energy economy, and prioritizing actions in disadvantaged communities.

45 *www.arb.ca.gov/cc/ejac/ejac.htm*

- Setting goals for green buildings.
- Enforcing GHG reduction targets for existing buildings, and providing upgrades that enable buildings to use renewable energy technologies and water capture.
- Prioritizing and supporting community-owned technologies, such as community-owned solar, for environmental justice communities.

Key Water sector recommendations include:

- Encouraging water conservation and recycling.
- Prioritizing safe drinking water for all.

The Committee's key Industry sector recommendations include:

- Prioritizing direct emissions reductions in environmental justice communities.
- Replacing the Cap-and-Trade Program with a carbon tax or fee and dividend program.
- Eliminating offsets and the allocation of free allowances if the Cap-and-Trade Program continues.
- Analyze where GHG emissions are increasing and identify strategies to prevent and reduce such emissions in environmental justice communities.
- Committing to reductions in petroleum use.

The Committee's key Transportation sector recommendations include:

- Increasing access to affordable, reliable, clean, and safe mobility options in disadvantaged communities.
- Community-engaged land use planning.
- Maximizing electrification.
- Restricting sprawl and examining transportation regionally.
- Considering the development of green transportation hubs that integrate urban greening with transportation options and implement the recommendations of the SB 350 studies.

The Committee's key Natural and Working Lands, Agriculture, and Waste sector recommendations include:

- Reducing waste and mandating that local jurisdictions manage the waste they create.
- Returning carbon to the soil.
- Not burning biomass or considering it a renewable resource.
- Supporting healthy soils as a critical element to land and waste management.
- Integrating urban forestry within local communities.
- Exploring ways to allow and streamline the process for cultural and prescribed burning for land management and to prevent large-scale wildfires.
- Including an annual reduction of 5 million metric tons of CO_2e from natural and working lands.

The Committee's recommendations for California Climate Investments include:

- Ensuring near-term technologies do not adversely impact communities and long-term investments move toward zero emissions.
- Requiring GGRF projects to be transformative for disadvantaged communities as defined by each community.
- Eliminating funding for AB 32 regulated entities.
- Providing technical assistance to environmental justice communities so they can better access funding and resources.
- Prioritizing projects identified by communities and ensuring all applicants have policies to protect against displacement or gentrification.

In April 2017, EJAC members provided a refined list of priority changes for the Scoping Plan from the full list of EJAC recommendations. CARB staff responded to each priority recommendation, describing additions to the Scoping Plan or suggested next steps for recommendations beyond the level of detail in the Plan. Appendix A includes the Priority EJAC Recommendations with CARB Responses and full list of EJAC Recommendations.

More information about the Committee and its recommendations on the previous Scoping Plans and this Scoping Plan is located at: *www.arb.ca.gov/ejac*.

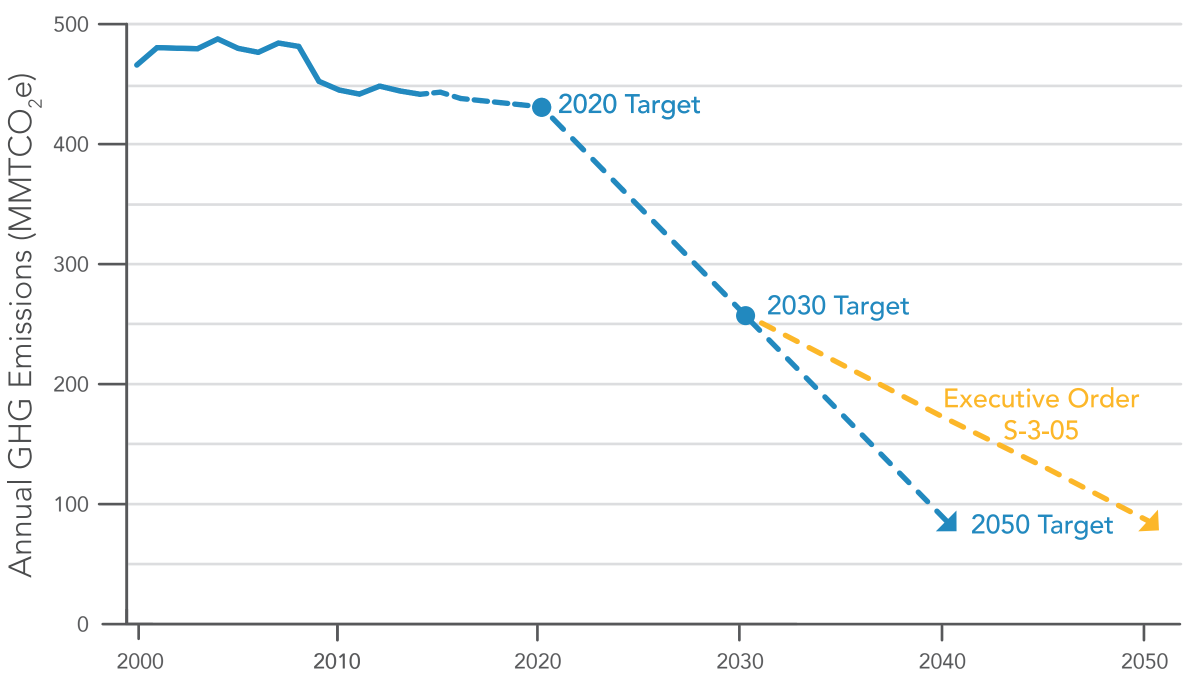
Setting the Path to 2050

The State's 2020 and 2030 targets have not been set in isolation. They represent benchmarks, consistent with prevailing climate science, charting an appropriate trajectory forward that is in-line with California's role in stabilizing global warming below dangerous thresholds. As we consider efforts to reduce emissions to meet the State's near-term requirements, we must do so with an eye toward reductions needed beyond 2030, as well. The Paris Agreement – which calls for limiting global warming to well below 2 degrees Celsius and aiming to limit it below a 1.5 degrees Celsius – frames our path forward.

While the Scoping Plan charts the path to achieving the 2030 GHG emissions reduction target, we also need momentum to propel us to the 2050 statewide GHG target (80 percent below 1990 levels). In developing this Scoping Plan, we considered what policies are needed to meet our mid-term and long-term goals. For example, though Zero Net Carbon Buildings are not feasible at this time and more work needs to be done in this area, they will be necessary to achieve the 2050 target. To that end, work must begin now to review and evaluate research in this area, establish a planning horizon for targets, and identify implementation mechanisms. Concurrently, we must consider and implement policies that not only deliver critical reductions in 2030 and continue to help support the State's long-term climate objectives, but that also deliver other health, environmental and economic benefits. We should not just be planning to put 1.5 million ZEVs on the road by 2025 or 4.2 million on the road by 2030 – but rather, we should be comprehensively facilitating the market-wide transition to electric drive that we need to see materialize as soon as possible. This means that we need to be working towards making all fuels low carbon as quickly as possible, even as we incrementally ramp up volume requirements through the Low Carbon Fuel Standard. And it means that we need to support the broad array of actions and strategies identified in Chapter 4, and new ones that may emerge – to keep us on track to achieve deeper GHG reductions to protect the environment and our way of life. As with all investments, the approach taken must balance risk, reward, longevity, and timing.

Figure 5 illustrates the potential GHG reductions that are possible by making consistent progress between 2020 and 2050, versus an approach that begins with the 2030 target and then makes progress toward the 2050 level included in Executive Order S-3-05. Depending on our success in achieving the 2030 target, taking a consistent approach may be possible. It would achieve the 2050 target earlier, and together with similar actions globally, would have a greater chance of preventing global warming of 2°C. The strategy for achieving the 2050 target should leave open the possibility for both paths. Note that Figure 5 does not include emissions or sequestration potential from the natural and working lands sector or black carbon.

Figure 5: Plotting California's Path Forward



Intergovernmental Collaboration

Federal, state, Tribal, and local action can be complementary. We have seen federal action through the Clean Air Act, regulations for GHG emissions from passenger cars and trucks, development of the Clean Power Plan to limit GHGs from power plants, and the advancement of methane rules for oil and gas production. We have also seen recent federal efforts to delay or reverse some of these actions. As we have done in the past, California, working with other climate leaders, can take steps to advance more ambitious federal action and protect the ability of states to move forward to address climate change. Both collaboration and advocacy will mark the road ahead. However, to the extent that California cannot implement policies or measures included in the Scoping Plan because of the lack of federal action, we will develop alternative measures to achieve the reductions from the same sectors to ensure we meet our GHG reduction targets.

Regional, Tribal, and local governments and agencies are critical leaders in reducing emissions through actions that reduce demand for electricity, transportation fuels, and natural gas, and improved natural and working lands management. Many local governments already employ efforts to reduce GHG emissions beyond those required by the State. For example, many cities and counties improve their municipal operations by upgrading vehicle fleets, retrofitting government buildings and streetlights, purchasing greener products, and implementing waste-reduction policies. In addition, they may adopt more sustainable codes, standards, and general plan improvements to reduce their community's footprints and emissions. Many Tribes within and outside of California have engaged in consultations with CARB to develop robust carbon offset projects under California's Cap-and-Trade Program, in particular forest projects. In fact, Tribal forest projects represent a significant percentage of offset credits issued under the Program. These consultations and carbon sequestration projects are in addition to other Tribal climate-related efforts. The State will provide a supportive framework to advance these and other local efforts, while also recognizing the need to build on, and export, this success to other regional, Tribal, and local governments throughout California and beyond.

Local actions are critical for implementation of California's ambitious climate agenda. State policies, programs, and actions–such as many of those identified throughout this Scoping Plan–can help to support, incentivize, and accelerate local actions to achieve mutual goals for more sustainable and resilient communities. Local municipal code changes, zoning changes, or policy directions that apply broadly to the community within the general plan or climate action plan area can promote the deployment of renewable, zero emission, and low carbon technologies such as zero net energy buildings, renewable fuel production facilities, and zero emission charging stations. Local decision-making has an especially important role in achieving reductions of GHG emissions generated from transportation. Over the last 60 years, development patterns have led to sprawling suburban neighborhoods, a vast highway system, growth in automobile ownership, and under-prioritization of infrastructure for public transit and active transportation. Local decisions about these policies today can establish a more sustainable built environment for the future.

International Efforts

California is not alone in its efforts to address climate change at the international level to reduce global GHG emissions. The agreement reached in Paris by the 2015 Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC), aimed at keeping the global temperature rise below 2°C, is spurring worldwide action to reduce GHGs and support decarbonization across the global economy. In recent years, subnational governments have emerged to take on a prominent role. With the establishment of the Under 2 Memorandum of Understanding (MOU),[46,47] the Governors' Climate and Forests Task Force,[48] and the Western Climate Initiative,[49] among other partnership initiatives, subnational jurisdictions from the around the world are collaborating and leading on how best to address climate change.

46 Under 2 MOU website: *under2mou.org/*

47 One of the Brown Administration's priorities is to highlight California's climate leadership on the subnational level, and to ensure that subnational activity is recognized at the international level. In the year preceding the Paris negotiations, the Governor's Office recruited subnational jurisdictions to sign onto the Memorandum of Understanding on Subnational Global Climate Leadership (Under 2 MOU), which brings together states and regions willing to commit to reducing their GHG emissions by 80 to 95 percent, or to limit emissions to 2 metric tons CO_2-equivalent per capita, by 2050. The governor led a California delegation to the Paris negotiations to highlight our successful climate programs and to champion subnational action and international cooperation on meeting the challenge of reducing GHG emissions. As of October 2017, 188 jurisdictions representing more than 1.2 billion people and more than one-third of the global economy had joined California in the Under 2 MOU.

48 Governors' Climate and Forests Task Force website: *www.gcftaskforce.org/*

49 Western Climate Initiative website: *www.wci-inc.org/*

From its inception, AB 32 recognized the importance of California's climate leadership and engagement with other jurisdictions, and directed CARB to consult with the federal government and other nations to identify the most effective strategies and methods to reduce GHGs, manage GHG control programs, and facilitate the development of integrated and cost-effective regional, national, and international GHG reduction programs. California undertook a two-pronged approach: first, we assessed our State-specific circumstances to develop measures that would apply specifically in California; and second, we assessed which measures might lend themselves, through careful design and collaboration with other interested jurisdictions, toward linked or collaborative GHG reduction programs. Under the Clean Air Act, California has a special role as an innovator and leader in the area of motor vehicle emission regulations, which allows our State to adopt motor vehicle emission standards that are stricter than federal requirements. Partners around the country and the world emulate these motor vehicle standards, leading to widespread health benefits. Similarly, by enacting a comprehensive climate strategy that appeals to national and international partners, California can help lead the world in tackling climate change.

Today, the State's Cap-and-Trade Program is linked with Québec's program and scheduled to link with Ontario's emissions trading system on January 1, 2018. Low carbon fuel mandates similar to California's LCFS have been adopted by the United States Environmental Protection Agency (U.S. EPA) and by other jurisdictions including Oregon, British Columbia, the European Union, and the United Kingdom. Over two-dozen states have a renewables portfolio standard. California is a member of the Pacific Coast Collaborative with British Columbia, Oregon, and Washington, who collaborate on issues such as energy and sustainable resource management, among others.[50] California continues to discuss carbon pricing through a cap-and-trade program with international delegations. We have seen design features of the State's Cap-and-Trade Program incorporated into other emerging and existing programs, such as the European Union Emissions Trading System, the Regional Greenhouse Gas Initiative, China's emerging national trading program, and Mexico's emerging pilot emission trading program.

Recognizing the need to address the substantial GHG emissions caused by the deforestation and degradation of tropical and other forests, California worked with a group of subnational governments to form the Governors' Climate and Forests Task Force (GCF) in 2008.[51] The GCF is currently comprised of 38 different subnational jurisdictions– including states and provinces in Brazil, Colombia, Ecuador, Indonesia, Ivory Coast, Mexico, Nigeria, Peru, Spain, and the United States–that are contemplating or enacting programs for low-emissions rural development and reduced emissions from deforestation and land use. GCF members continue to engage in discussions to share information and experiences about the design of such programs and how the programs could potentially interact with carbon markets. Ongoing engagement between California and its GCF partners, as well as ongoing discussions with other stakeholders, continues to provide lessons on how such programs could complement California's climate programs.[52]

Further, California's High-Speed Rail is part of the International Union of Railways (UIC), and California has signed the Railway Climate Responsibility Pledge, which was commended by the Secretary of the UNFCCC as part of achieving the global 2050 targets. This initiative is to demonstrate that rail transport is part of the solution for sustainable and carbon free mobility.

California will continue to engage in multi-lateral forums that develop the policy foundation and technical infrastructure for GHG regulations in multiple jurisdictions through entities such as the International Carbon Action Partnership (ICAP), established by California and other partners in 2007. Members of the ICAP that have already implemented or are actively pursuing market-based GHG programs[53] share experiences and knowledge. California also participates in the Partnership for Market Readiness (PMR), a multilateral World Bank initiative that brings together more than 30 developed and developing countries to share experiences and build capacity for climate change mitigation efforts, particularly those implemented using market instruments.[54] In November 2014, CARB became a Technical Partner of the PMR, and CARB staff members have provided technical information on the design and implementation of the Cap-and-Trade Program at several PMR meetings.

50 Pacific Coast Collaborative website: *pacificcoastcollaborative.org/*

51 Governors' Climate and Forests Task Force Website: *www.gcftaskforce.org/*

52 Continued collaboration on efforts to reduce emissions from tropical deforestation and to evaluate sector-based offset programs, such as the jurisdictional program in Acre, Brazil, further demonstrates California's ongoing climate leadership and fosters partnerships on mutually beneficial low emissions development initiatives, including measures to encourage sustainable supply chain efforts by public and private entities.

53 International Carbon Action Partnership website: *icapcarbonaction.com/*

54 Partnership for Market Readiness website: *www.thepmr.org/*

Many foreign jurisdictions seek out California's expertise because of our history of success in addressing air pollution and climate change. California also benefits from these interactions. Expanding global action to fight air pollution and climate change expands markets for clean technology. This can bolster business for companies in California developing clean energy products and services and help to bring down the cost of those products globally and in California. Additionally, innovative policies and lessons learned from our partners' jurisdictions can help to inform future climate policies in California.

Governor Brown's focus on subnational collaborations on climate change and air quality has strengthened and deepened California's existing international relationships and forged new ones. These relationships are a critical component of reducing emissions of GHGs and other pollutants worldwide. As we move forward, CARB and other State agencies will continue to communicate and collaborate with international partners to find the most cost-effective ways to improve air quality, fight climate change, and share California's experience and expertise in reducing air pollution and GHGs while growing a strong economy. To highlight the State's resolve and support of other governments committed to action and tackling the threat of the global warming, on July 6, 2017, Governor Brown announced a major initiative to host world leaders at a Global Climate Action Summit planned for September 2018 in San Francisco.

Chapter 2

The Scoping Plan Scenario

This chapter describes the State strategy for meeting the 2030 GHG target (also called the Scoping Plan Scenario), along with a short description of the four alternative scenarios, which were evaluated but ultimately rejected when compared against statutory and policy criteria and priorities that the State's comprehensive climate action must deliver. All scenarios are set against the business-as-usual (BAU or Reference Scenario) scenario–what would GHG emissions look like if we did nothing beyond the existing policies that are required and already in place to achieve the 2020 limit. BAU includes the existing renewables requirements, advanced clean cars, the 10 percent reduction in carbon intensity Low Carbon Fuel Standard, and the SB 375 program for sustainable communities, among others. However, it does not include a range of new policies or measures that have been developed or put into statute over the past two years.

The Reference Scenario (BAU) shows continuing, but modest, reductions followed by a later rise of GHG emissions as the economy and population grow. The comprehensive analysis of all five alternatives indicates that the Scoping Plan Scenario–continuing the Cap-and-Trade Program–is the best choice to achieve the State's climate and clean air goals. It also protects public health, provides a solid foundation for continued economic growth, and supports California's quality of life.

All of the alternative scenarios briefly described in this chapter are the product of the Scoping Plan development process and were informed by public input, including that from EJAC, as well as Board and legislative direction over the course of two years. The scenarios all include a range of additional measures developed or required by legislation over the past two years with 2030 as their target date and include: extending the LCFS to an 18 percent reduction in carbon intensity beyond 2020, and the requirements of SB 350 to increase renewables to 50 percent and to double energy efficiency savings. They also all include the Mobile Source Strategy targets for more zero emission vehicles and much cleaner trucks and transit, the Sustainable Freight Action Plan to improve freight efficiency and transition to zero emission freight handling technologies, and the requirements under SB 1383 to reduce anthropogenic black carbon 50 percent and hydrofluorocarbon and methane emissions by 40 percent below 2013 levels by 2030. The recent adoption of AB 398 into State law on July 25, 2017, clarifies the role of the Cap-and-Trade Program through December 31, 2030.

Work is still underway on how to quantify the GHG emissions within the natural and working lands sector. As such, the analyses in this chapter do not include any estimates from this sector. Additional information on the current efforts to better understand GHG emissions fluxes and model the actions needed to support the goal of net carbon sequestration in natural and working lands can be found in Chapter 4. Even absent quantification data, the importance of this sector in achieving the State's climate goals should be considered in conjunction with any efforts to reduce GHG emissions in the energy and industrial sectors.

During the development of the Scoping Plan, stakeholders suggested alternative scenarios to achieve the 2030 target. While countless scenarios could potentially be developed and evaluated, the four below were considered, as they were most often included in comments by stakeholders and they bracket the range of potential scenarios. Several of these alternative scenarios were also evaluated in the Initial AB 32 Scoping Plan in 2008 (All Regulations, Carbon Tax).[55] Since the adoption of the Initial AB 32 Scoping Plan, some of the alternative scenarios have been implemented or contemplated by other jurisdictions, which has helped in the analysis and the development of this Scoping Plan. This section provides a brief description of the alternatives. A full description of the alternatives and staff's AB 197 and policy analyses are included in Appendix G.

55 CARB. 2009. Initial AB 32 Climate Change Scoping Plan Document. *www.arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm*

Scoping Plan Scenario: Ongoing and statutorily required programs and continuing the Cap-and-Trade Program. This scenario was modified from the January 2017 Proposed Scoping Plan to reflect AB 398, including removal of the 20 percent refinery measure.

Alternative 1: No Cap-and-Trade. Includes additional activities in a wide variety of sectors, such as specific required reductions for all large GHG sources, and more extensive requirements for renewable energy. Industrial sources would be regulated through command and control strategies.

Alternative 2: Carbon Tax. A carbon tax to put a price, but not limit, on carbon, instead of the Cap-and-Trade Program.

Alternative 3: All Cap-and-Trade. This alternative is the same as the Scoping Plan Scenario, while maintaining the LCFS at a 10 percent reduction in carbon intensity past 2020.

Alternative 4: Cap-and-Tax. This would place a declining cap on individual industrial facilities, and individual natural gas and fuel suppliers, while also requiring them to pay a tax on each metric ton of GHGs emitted.

Since the statutory direction on meeting a 2030 GHG target is clear, the issue of certainty of reductions is paramount. These alternatives vary greatly as to the certainty of meeting the target. The declining mass emissions cap under a cap-and-trade program provides certain and measurable reductions over time; a carbon tax, meanwhile, establishes some carbon price certainty, but does not provide an assurance on reductions and instead assumes that some degree of reductions will occur if costs are high enough to alter behavior.

There are also other considerations: to what extent does an alternative meet the target, but also deliver clean air benefits, prioritize reductions at large stationary sources, and allow for continued investment in disadvantaged communities? What is the cost of an alternative and what will be the impact on California consumers? Does an alternative allow for California to link with other jurisdictions, and support the Clean Power Plan[56] and other federal and international climate programs? Does an alternative provide for flexibility for regulated entities, and a cost-effective approach to reduce greenhouse gases?

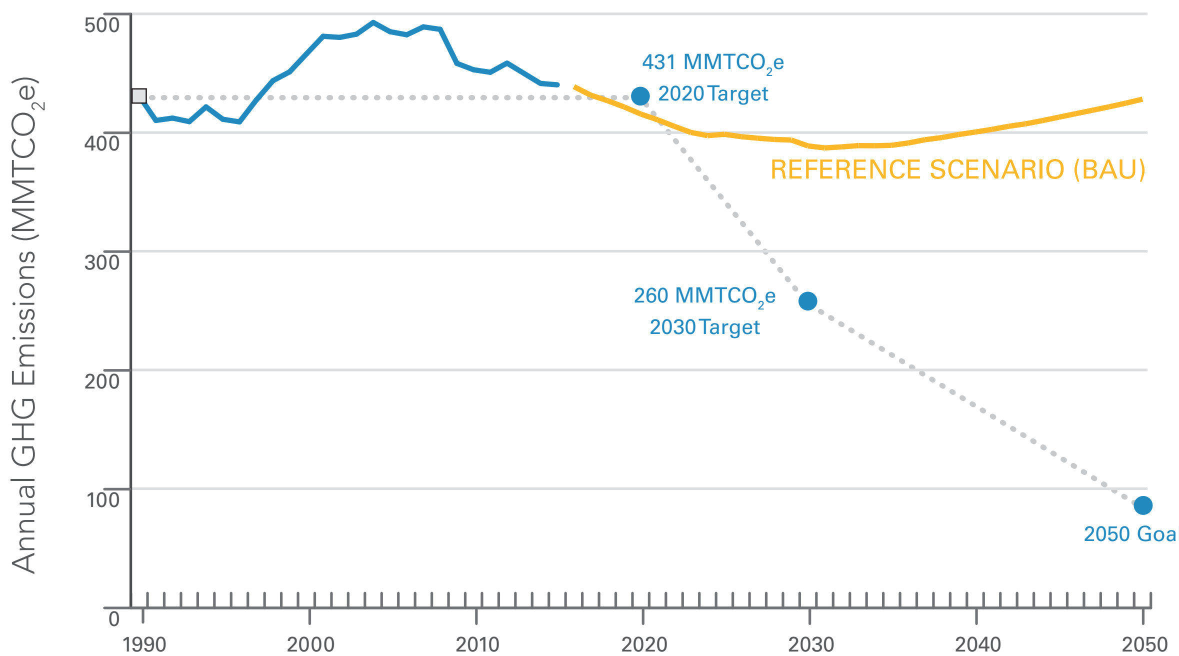
The Scoping Plan Scenario provides a portfolio of policies and measures that balances this combination of objectives, including the highest certainty to achieve the 2030 target, while protecting the California economy and consumers. A more detailed analyses of the alternatives is provided in Appendix G.

Scoping Plan Scenario

The development of the Scoping Plan began by first modeling a Reference Scenario (BAU). The Reference Scenario is the forecasted statewide GHG emissions through 2030 with existing policies and programs, but without any further action to reduce GHGs. Figure 6 provides the modeling results for a Reference Scenario for this Scoping Plan. The graph shows the State is expected to reduce emissions below the 2020 statewide GHG target, but additional effort will be needed to maintain and continue GHG reductions to meet the mid- (2030) and long-term (2050) targets. Figure 6 depicts a linear, straight-line path to the 2030 target. It should be noted that in any year, GHG emissions may be higher or lower than the straight line. That is to be expected as periods of economic recession or increased economic activity, annual variations in hydropower, and many other factors may influence a single or several years of GHG emissions in the State. CARB's annual GHG reporting and inventory will provide data on progress towards achieving the 2030 target. More details about the modeling for the Reference Scenario can be found in Appendix D.

56 Although the Clean Power Plan is being challenged in legal and administrative processes, its requirements reflect U.S. EPA's statutory obligation to regulate greenhouse gases from the power sector. Thus it, and other federal programs, are a key consideration for Scoping Plan development.

Figure 6: 2017 Scoping Plan Reference Scenario



The Scoping Plan Scenario is summarized in Table 1. As shown in the table, most of the measures are identified as "known commitments" (marked with "*"), meaning that they are existing programs or required by statute. These commitments are not part of the Reference Scenario (BAU) in Figure 6 since their passage and implementation is related to meeting the Governor's climate pillars, the 2030 climate target, or other long-term climate and air quality objectives. In addition to the known commitments, the Scoping Plan Scenario includes a post-2020 Cap-and-Trade Program.

Table 1: Scoping Plan Scenario

Policy	Primary Objective	Highlights	Implementation Time Frame
SB 350[57]*	Reduce GHG emissions in the electricity sector through the implementation of the 50 percent RPS, doubling of energy savings, and other actions as appropriate to achieve GHG emissions reductions planning targets in the Integrated Resource Plan (IRP) process.	• Load-serving entities file plans to achieve GHG emissions reductions planning targets while ensuring reliability and meeting the State's other policy goals cost-effectively. • 50 percent RPS. • Doubling of energy efficiency savings in natural gas and electricity end uses statewide.	2030
Low Carbon Fuel Standard (LCFS)*	Transition to cleaner/less-polluting fuels that have a lower carbon footprint.	• At least 18 percent reduction in carbon intensity, as included in the Mobile Source Strategy.	2030
Mobile Source Strategy (Cleaner Technology and Fuels [CTF] Scenario)[58]*	Reduce GHGs and other pollutants from the transportation sector through transition to zero-emission and low-emission vehicles, cleaner transit systems and reduction of vehicle miles traveled.	• 1.5 million zero emission vehicles (ZEV), including plug-in hybrid electric, battery-electric, and hydrogen fuel cell vehicles by 2025 and 4.2 million ZEVs by 2030. • Continue ramp up of GHG stringency for all light-duty vehicles beyond 2025. • Reductions in GHGs from medium-duty and heavy-duty vehicles via the Phase 2 Medium and Heavy-Duty GHG Standards. • Innovative Clean Transit: Transition to a suite of innovative clean transit options. Assumed 20 percent of new urban buses purchased beginning in 2018 will be zero emission buses with the penetration of zero-emission technology ramped up to 100 percent of new bus sales in 2030. Also, new natural gas buses, starting in 2018, and diesel buses, starting in 2020, meet the optional heavy-duty low-NO_x standard. • Last Mile Delivery: New regulation that would result in the use of low NO_x or cleaner engines and the deployment of increasing numbers of zero-emission trucks primarily for class 3-7 last mile delivery trucks in California. This measure assumes ZEVs comprise 2.5 percent of new Class 3–7 truck sales in local fleets starting in 2020, increasing to 10 percent in 2025. • Reduction in vehicle miles traveled (VMT), to be achieved in part by continued implementation of SB 375 and regional Sustainable Community Strategies; forthcoming statewide implementation of SB 743; and potential additional VMT reduction strategies not specified in the Mobile Source Strategy, but included in the document "Potential VMT Reduction Strategies for Discussion" in Appendix C.[59]	Various
SB 1383*	Approve and Implement Short-Lived Climate Pollutant strategy[60] to reduce highly potent GHGs	• 40 percent reduction in methane and hydrofluorocarbon (HFC) emissions below 2013 levels by 2030. • 50 percent reduction in anthropogenic black carbon emissions below 2013 levels by 2030.	2030
California Sustainable Freight Action Plan[61]*	Improve freight efficiency, transition to zero emission technologies, and increase competitiveness of California's freight system.	• Improve freight system efficiency by 25 percent by 2030. • Deploy over 100,000 freight vehicles and equipment capable of zero emission operation and maximize both zero and near-zero emission freight vehicles and equipment powered by renewable energy by 2030.	2030
Post-2020 Cap-and-Trade Program	Reduce GHGs across largest GHG emissions sources	• Continue the existing Cap-and-Trade Program with declining caps to ensure the State's 2030 target is achieved.	
* These measures and policies are referred to as "known commitments."			

57 SB 350 Clean Energy and Pollution Reduction Act of 2015 (De León, Chapter 547, Statutes of 2015). *leginfo.legislature.ca.gov/faces/billNavClient.xhtml?billid=201520160SB350* This policy also includes increased demand response and PV.
58 CARB. 2016. 2016 Mobile Source Strategy. *www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf*
59 CARB. Potential State-Level Strategies to Advance Sustainable, Equitable Communities and Reduce Vehicle Miles of Travel (VMT)--for Discussion. *www.arb.ca.gov/cc/scopingplan/meetings/091316/Potential%20VMT%20Measures%20For%20Discussion_9.13.16.pdf*
60 CARB. 2016. Reducing Short-Lived Climate Pollutants in California. *www.arb.ca.gov/cc/shortlived/shortlived.htm*
61 State of California. California Sustainable Freight Action Plan website. *www.casustainablefreight.org/*

Table 2 summarizes the results of the modeling for the Reference Scenario and known commitments. Per SB 32, the 2030 limit is 260 $MMTCO_2e$. That is a limit on total GHG emissions in a single year. At approximately 389 $MMTCO_2e$, the Reference Scenario is expected to exceed the 2030 limit by about 129 $MMTCO_2e$.

Table 2 also compares the Reference Scenario 2030 emissions estimate of 389 $MMTCO_2e$ to the 2030 target of 260 $MMTCO_2e$ and the level of 2030 emissions with the known commitments, estimated to be 320 $MMTCO_2e$. And, in the context of a linear path to achieve the 2030 target, there is also a need to achieve cumulative emissions reductions of 621 $MMTCO_2e$ from 2021 to 2030 to reach the 2030 limit. While there is no statutory limit on cumulative emissions, the analysis considers and presents some results in cumulative form for several reasons. It should be recognized that policies and measures may perform differently over time. For example, in early years, a policy or measure may be slow to be deployed, but over time it has greater impact. If you were to look at its performance in 2021 versus 2030, you would see that it may not seem important and may not deliver significant reductions in the early years, but is critical for later years as it results in greater reductions over time. Further, once GHGs are emitted into the atmosphere, they can have long lifetimes that contribute to global warming for decades. Policies that reduce both cumulative GHG emissions and achieve the single-year 2030 target provide the most effective path to reducing climate change impacts. A cumulative construct provides a more complete way to evaluate the effectiveness of any measure over time, instead of just considering a snapshot for a single year.

Table 2: 2030 Modeling GHG Results for the Reference Scenario and Known Commitments

Modeling Scenario	2030 GHG Emissions ($MMTCO_2e$)	Cumulative GHG Reductions 2021–2030 ($MMTCO_2e$)	Cumulative Gap to 2030 Target ($MMTCO_2e$)
Reference Scenario (Business-as-Usual)	389	n/a	621
Known Commitments	320	385	236

As noted above, the known commitments are expected to result in emissions that are 60 $MMTCO_2e$ above the target in 2030, and have a cumulative emissions reduction gap of about 236 $MMTCO_2e$. This means the known commitments do not decline fast enough to achieve the 2030 target. The remaining 236 $MMTCO_2e$ of estimated GHG emissions reductions would not be achieved unless further action is taken to reduce GHGs. Consequently, for the Scoping Plan Scenario, the Post-2020 Cap-and-Trade Program would need to deliver 236 $MMTCO_2e$ cumulative GHG emissions reductions from 2021 through 2030. If the estimated GHG reductions from the known commitments are not realized due to delays in implementation or technology deployment, the post-2020 Cap-and-Trade Program would deliver the additional GHG reductions in the sectors it covers to ensure the 2030 target is achieved. Figure 7 illustrates the cumulative emissions reductions contributions of the known commitments and the Cap-and-Trade Program from 2021 to 2030.

Post-2020 Cap-and-Trade Program with Declining Caps

This measure would continue the Cap-and-Trade Program post-2020 pursuant to legislative direction in AB 398. The program is up and running and has a five-year-long record of auctions and successful compliance. In the face of a growing economy, dry winters, and the closing of a nuclear plant, it is delivering GHG reductions. This is not to say that California should continue on this road simply because the Cap-and-Trade Program is already in place. The analyses in this chapter, and the economic analysis in Chapter 3, clearly demonstrate that continuing the Cap-and-Trade Program through 2030 will provide the most secure, reliable, and feasible clean energy future for California–one that will continue to deliver crucial investments to improve the quality of life and the environment in disadvantaged communities.

Under this measure, funds would also continue to be deposited into the Greenhouse Gas Reduction Fund (GGRF) to support projects that fulfill the goals of AB 32, with AB 398 identifying a list of priorities for the Legislature to consider for future appropriations from GGRF. Investment of the Cap-and-Trade Program proceeds furthers the goals of AB 32 by reducing GHG emissions, providing net GHG sequestration, providing co-benefits, investing in disadvantaged communities and low-income communities, and supporting the long-term, transformative efforts needed to improve public and environmental health and develop a clean energy economy. These investments support programs and projects that deliver major economic, environmental, and public health benefits for Californians. Importantly, prioritized investments in disadvantaged communities are providing a multitude of meaningful benefits to these communities some of which include increased affordable housing opportunities, reduced transit and transportation costs, access to cleaner vehicles, improved mobility options and air quality, job creation, energy cost savings, and greener and more vibrant communities.

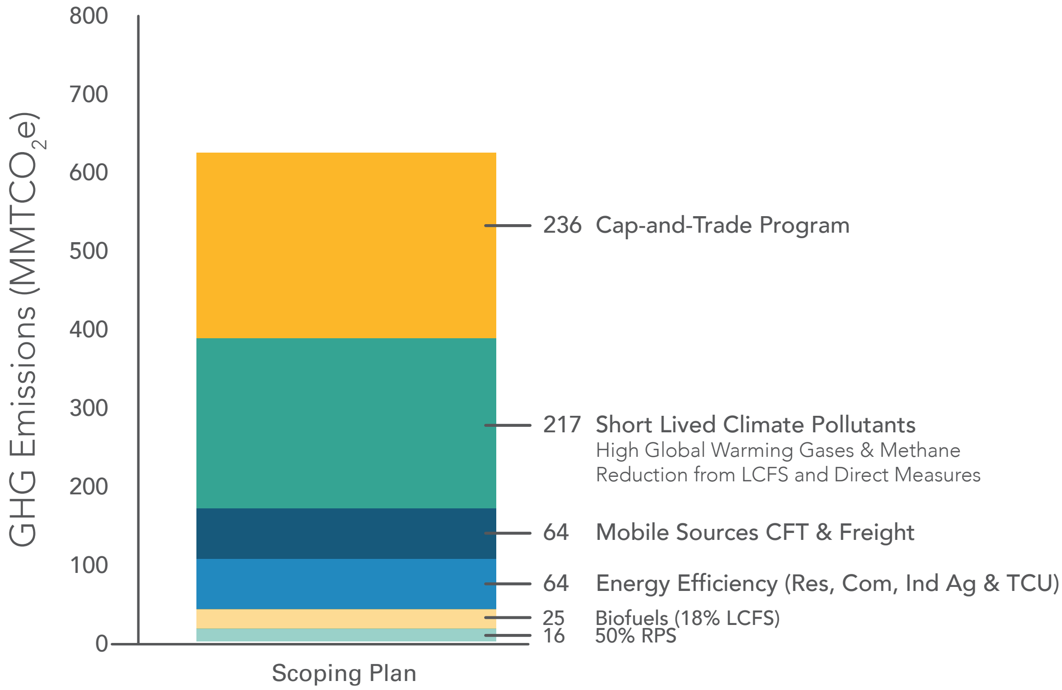
Further, the Cap-and-Trade Program is designed to protect electricity and natural gas residential ratepayers from higher energy prices. The program includes a mechanism for electricity and natural gas utilities to auction their freely allocated allowances, with the auction proceeds benefiting ratepayers. The Climate Credit is a twice-annual bill credit given to investor-owned utility electricity residential customers. The total value of the Climate Credit for vintage 2013 auction allowances alone was over $400 million. The first of these credits appeared on customer bills in April 2014.[62] Currently, natural gas utilities are permitted to use a portion of their freely allocated allowances to meet their own compliance obligations; however, over time, they must consign a larger percentage of allowances and continue to provide the value back to customers.

Additionally, under this measure, the State would preserve its current linkages with its Canadian partners and support future linkages with other jurisdictions, thus facilitating international action to address climate change. The high compliance rates with the Cap-and-Trade Program also demonstrate that the infrastructure and implementation features of the program are effective and understood by the regulated community. This measure also lends itself to integration with the Clean Power Plan requirements and is flexible to allow expansion to other sectors or regions.

In late 2017, CARB began evaluating changes to program design features for post-2020 in accordance with AB 398.[63] This includes changes to the offset usage limit, direction on allocation, two price containment points, and a price ceiling – which, if in the unlikely event were to be accessed, must result in GHG reductions by compensating for any GHG emissions above the cap, ensuring the environmental integrity of the program. Changes to conform to the requirements of AB 398 will be subject to a public process, coordinated with linked partners, and be part of a future rulemaking that would take effect by January 1, 2021.

62 *www.arb.ca.gov/cc/capandtrade/allowanceallocation/edu-v2013-allowance-value-report.pdf*
63 *www.arb.ca.gov/cc/capandtrade/meetings/20171012/ct_presentation_11oct2017.pdf*

Figure 7: Scoping Plan Scenario – Estimated Cumulative GHG Reductions by Measure (2021–2030)[64]



The Scoping Plan Scenario in Figure 7 represents an expected case where current and proposed GHG reduction policies and measures begin as expected and perform as expected, and technology is readily available and deployed on schedule. An Uncertainty Analysis was performed to examine the range of outcomes that could occur under the Scoping Plan policies and measures. The uncertainty in the following factors was characterized and evaluated:

- Economic growth through 2030;
- Emission intensity of the California economy;
- Cumulative emissions reductions (2021 to 2030) achieved by the prescriptive measures, including the known commitments; and
- Cumulative emissions reductions (2021 to 2030) that can be motivated by emission prices under the Cap-and-Trade Program.

The combined effects of these uncertainties are summarized in Figure 8. As shown in Figure 7, the Scoping Plan analysis estimates that the prescriptive measures will achieve cumulative emissions reductions of 385 $MMTCO_2e$, the Cap-and-Trade Program will achieve 236 $MMTCO_2e$, resulting in total cumulative emissions reductions of 621 $MMTCO_2e$. These values are again reflected in the bar on the left of Figure 8. The results of the Uncertainty Analysis are summarized in the three bars on the right of the figure as follows:

- The cumulative emissions reductions required to achieve the 2030 emission limit has the potential to be higher or lower than the Scoping Plan estimate. The uncertainty analysis simulates an average required emissions reductions of about 660 $MMTCO_2e$ with a range of +130 $MMTCO_2e$.[65] This estimate and the range are shown in Figure 8 as the bar on the right. Notably, the estimate of the average required emissions reductions is 40 $MMTCO_2e$ greater than the estimate in the Scoping Plan analysis.
- The prescriptive measures have the potential to underperform relative to expectations. Based on CARB staff assessments of the potential risk of underperformance of each measure, the average emissions reductions simulated to be achieved was 335 $MMTCO_2e$, or about 13 percent below the Scoping Plan estimate. The range for the performance of the measures was about +50 $MMTCO_2e$.

64 The whole number values displayed in Figure 7 do not mathematically sum to 621 $MMTCO_2e$, consistent with the modeling results summary in Table 2. This is a result of embedded significant figures and rounding for graphic display purposes. Please refer to the corresponding PATHWAYS modeling data spreadsheets for details.

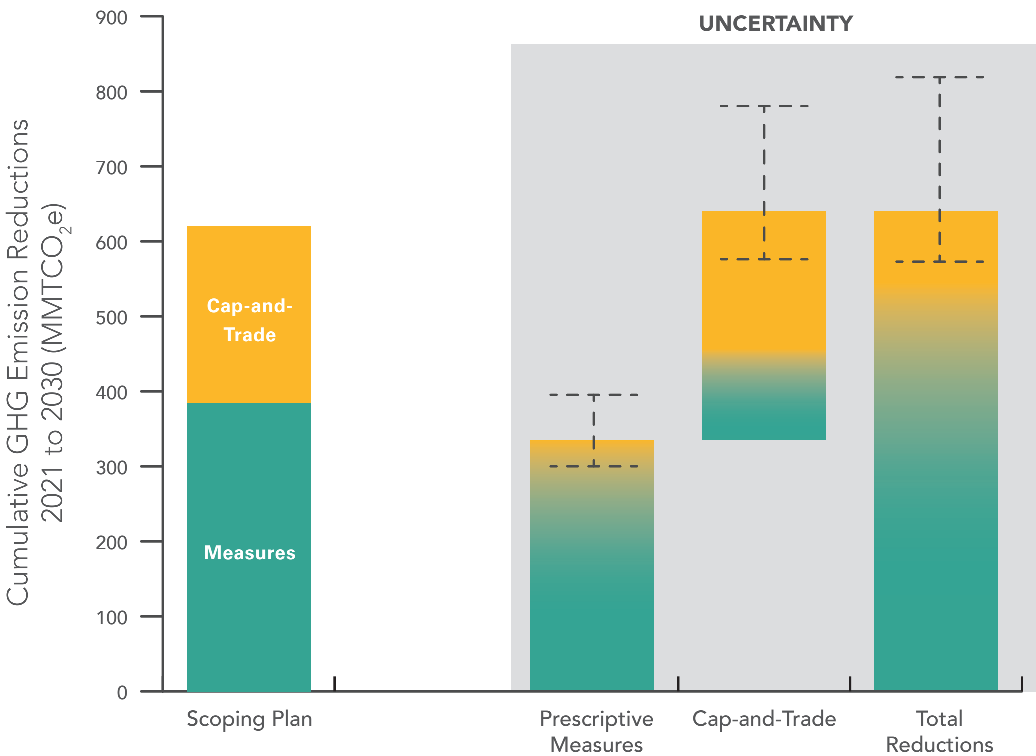
65 The ranges presented are the 5th and 95th percentile observations in the Uncertainty Analysis. See Appendix E for details.

These values for the potential reductions achieved by the measures are shown in the figure.

- The Cap-and-Trade program is designed to fill the gap in the required emissions reductions over and above what is achieved by the prescriptive measures. Because the total required emissions reductions are uncertain, and the emissions reductions achieved by the prescriptive measures are uncertain, the required emissions reductions from the Cap-and-Trade Program are also uncertain. The Uncertainty Analysis simulated the average emissions reductions achieved by the Cap-and-Trade Program at about 305 $MMTCO_2e$, or about 30 percent higher than the Scoping Plan estimate. The range was simulated to be about +120 $MMTCO_2e$. These values for the potential reductions achieved by the Cap-and-Trade Program are shown in the figure.

The Uncertainty Analysis provides insight into the range of potential emissions outcomes that may occur, and demonstrates that the Scoping Plan, with the Cap-and-Trade Program, is extremely effective in the face of uncertainty, assuring that the required emissions reductions are achieved (see Appendix E for more detail). The Uncertainty Analysis also indicates that the Cap-and-Trade Program could contribute a larger or smaller share of the total required cumulative emissions reductions than expected in the Scoping Plan analysis.

Figure 8: Uncertainty Analysis



While the modeling results provide estimates of the GHG reductions that could be achieved by the measures, the results also provide other insights and highlight the need to ensure successful implementation of each measure. The SLCP Strategy will provide significant reductions with a focus on methane and hydrofluorocarbon gases. To ensure the SLCP Strategy implementation is successful, it will be critical to ensure programs such as LCFS maintain incentives to finance the capture and use of methane as a transportation fuel–further reducing the State's dependence on fossil fuels. The modeling also shows that actions on energy efficiency could provide the same magnitude of GHG emissions reductions as the mobile source measures, but each effort will provide different magnitudes of air quality improvements and cost-effectiveness as discussed in Chapter 3.

Another way to look at this scenario is to understand the trajectory of GHG reductions over time, relative to the 2030 target. Figure 9 provides the trajectory of GHG emissions modeled for the Scoping Plan Scenario. Again, this depicts a straight-line path to the 2030 target for discussion purposes, but in reality GHG emissions may be above or below the line in any given year(s).

FIGURE 9: SCOPING PLAN SCENARIO GHG REDUCTIONS

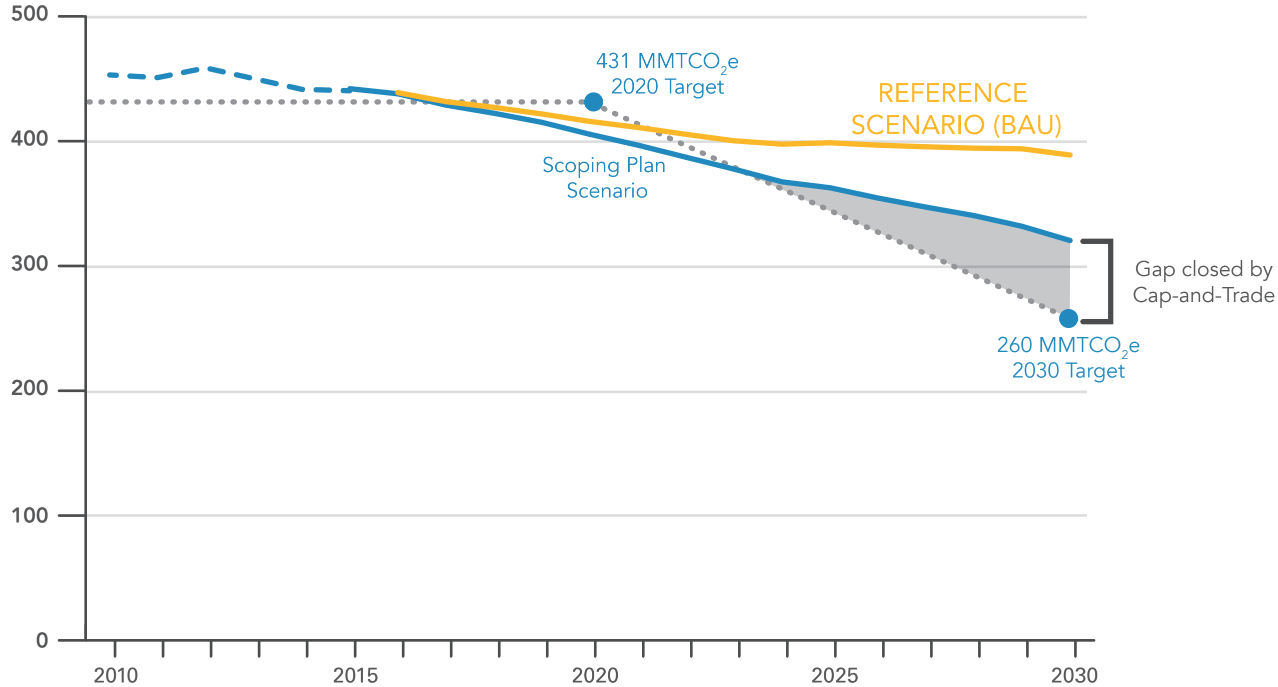


Figure 9 shows the Reference Scenario (yellow) and the version of the Scoping Plan Scenario that excludes the Cap-and-Trade Program (blue). Until 2023, the measures in the Scoping Plan Scenario constrain GHG emissions below the dotted straight line. After 2023, GHG emissions continue to fall, but at a slower rate than needed to meet the 2030 target. It is the Cap-and-Trade Program that will reduce emissions to the necessary levels to achieve the 2030 target. In this scenario, it is estimated that the known commitments will result in an emissions level of about 320 $MMTCO_2e$ in 2030. Thus, for the Scoping Plan Scenario, the Cap-and-Trade Program would deliver about 60 $MMTCO_2e$ in 2030 and ensure the 2030 target is achieved.

To understand how the Scoping Plan affects the main economic sectors, Table 3 provides estimated GHG emissions by sector, compared to 1990 levels, and the range of GHG emissions for each sector estimated for 2030. This comparison helps to illustrate which sectors are reducing emissions more than others and where to focus additional actions to reduce GHGs across the entire economy.

Table 3: Estimated Change in GHG Emissions by Sector ($MMTCO_2E$)

	1990	2030 Scoping Plan Ranges[66]	% change from 1990
Agriculture	26	24–25	-8 to -4
Residential and Commercial	44	38–40	-14 to -9
Electric Power	108	30–53[67]	-72 to -51
High GWP	3	8–11[68]	267 to 367
Industrial	98	83–90[69]	-15 to -8
Recycling and Waste	7	8–9[70]	14 to 29**
Transportation (Including TCU)	152	103–111	-32 to -27
Natural Working Lands Net Sink*	-7***	TBD	TBD
Sub Total	431	294–339	-32 to -21
Cap-and-Trade Program	n/a	34–79	n/a
Total	**431**	**260**	**-40**

* Work is underway through 2017 to estimate the range of potential sequestration benefits from the natural and working lands sector.

** The SLCP will reduce emissions in this sector by 40 percent from 2013 levels. However, the 2030 levels are still higher than the 1990 levels as emissions in this sector have grown between 1990 and 2013.

*** This number reflects net results and is different than the intervention targets discussed in Chapter 4.

The sector ranges may change in response to how the sectors respond to the Cap-and-Trade Program. While the known commitments will deliver some reductions in each sector, the Cap-and-Trade Program will deliver additional reductions in the sectors it covers. Annual GHG reporting and the GHG inventory will track annual changes in emissions, and those will provide ongoing assessments of how each sector is reducing emissions due to the full complement of known commitments and the Cap-and-Trade Program, as applicable.

Scenario Modeling

There are a variety of models that can be used to model GHG emissions. For this Plan, the State is using the PATHWAYS model.[70] PATHWAYS is structured to model GHG emissions while recognizing the integrated nature of the industrial economic and energy sectors. For example, if the transportation sector adds more electric vehicles, PATHWAYS responds to reflect an energy demand increase in the electricity sector. However, PATHWAYS does not reflect any change in transportation infrastructure and land use demand associated with additional ZEVs on the road. The ability to capture a subset of interactive effects of policies and measures helps to provide a representation of the interconnected nature of the system and impacts to GHGs.

66 Unless otherwise noted, the low end of the sector range is the estimated emissions from the Scoping Plan Scenario and the high end adjusts the expected emissions by a risk factor that represents sector underperformance.

67 The high end of the electric power sector range is represented by the Scoping Plan Scenario, and the low end by enhancements and additional electricity sector measures such as deployment of additional renewable power, greater behind-the-meter solar PV, and additional energy efficiency. The electric power sector range provided in Table 3 will be used to help inform CARB's setting of the SB 350 Integrated Resource Plan greenhouse gas emissions reduction planning targets for the sector. CARB, CPUC, and CEC will continue to coordinate on this effort before final IRP targets are established for the sector, load-serving entities, and publicly-owned utilities. State agencies will investigate the potential for and appropriateness of deeper electric sector reductions in light of the overall needs of the Scoping Plan to cost-effectively achieve the statewide GHG goals. Concurrently, CEC and CPUC are proceeding with their respective IRP processes using this range.

68 The sector emissions are anticipated to increase by 2030. As such, the high end of the sector range is the estimated emissions from the Scoping Plan Scenario and the low end adjusts the expected emissions by a risk factor that represents sector over performance.

69 This estimate does not account for the reductions expected in this sector from the Cap-and-Trade Program. The Cap-and-Trade line item includes reductions that will occur in the industrial sector.

70 CARB. 2016. AB 32 Scoping Plan Public Workshops. *www.arb.ca.gov/cc/scopingplan/meetings/meetings.htm*

At this time, PATHWAYS does not include a module for natural and working lands. As such, PATHWAYS cannot be used to model the natural and working lands sector, the interactive effects of polices aimed at the economic and energy sectors and their effect on land use or conditions, or the interactive effects of polices aimed at the natural environment and their impact on the economic and energy sectors. For this Plan, external inputs had to be developed for PATHWAYS to supply biofuel volumes. The natural and working lands sector is also being modeled separately as described in Chapter 4. Moving forward, CARB and other State agencies will work to integrate all the sectors into one model to fully capture interactive effects across both the natural and built environments.

Lastly, the PATHWAYS assumptions and results in this Plan show the significant action that the State must take to reach its GHG reduction goals. It is important to note that the modeling assumptions may differ from other models used by other State agencies. Modeling exercises undertaken in future regulatory proceedings may result in different measures, programs, and program results than those used in the modeling for this Scoping Plan. State agencies will engage on their specific policies and measure development processes separately from CARB Scoping Plan activities, in public forums to engage all stakeholders.

Uncertainty

Several types of uncertainty are important to understand in both forecasting future emissions and estimating the benefits of emissions reductions scenarios. In developing the Scoping Plan, we have forecast a Reference Scenario and estimated the GHG emissions outcome of the Scoping Plan using PATHWAYS. Inherent in the Reference Scenario modeling is the expectation that many of the existing programs will continue in their current form, and the expected drivers for GHG emissions such as energy demand, population growth, and economic growth will match our current projections. However, it is unlikely that the future will precisely match our projections, leading to uncertainty in the forecast. Thus, the single "reference" line should be understood to represent one possible future in a range of possible predictions. For the Scoping Plan Scenario, PATHWAYS utilized inputs that are assumptions external to the model. PATHWAYS was provided plausible inputs such as energy demand over time, the start years for specific policies, and the penetration rates of associated technologies. Each of the assumptions provided to PATHWAYS has some uncertainty, which is also reflected in the results. Thus, while the results presented in the Scoping Plan may seem precise due to the need for precision in model inputs, these results are estimates, and the use of ranges in some of the results is meant to capture that uncertainty.

Further, as noted in the November 7, 2016, 2030 Target Scoping Plan Workshop, "All policies have a degree of uncertainty associated with them."[71] As this Scoping Plan is meant to chart a path to achieving the 2030 target, additional work will be required to fully design and implement any policies identified in this Scoping Plan. During the subsequent development of policies, CARB and other State agencies will learn more about technologies, cost, and how each industry works as a more comprehensive evaluation is conducted in coordination with stakeholders. Given the uncertainty around assumptions used in modeling, and in performance once specific policies are fully designed and implemented, estimates associated with the Scoping Plan Scenario are likely to differ from what actually occurs when the Scoping Plan is implemented. One way to mitigate for this risk is to develop policies that can adapt and increase certainty in GHG emissions reductions. Periodic reviews of progress toward achieving the 2030 target and the performance of specific policies will also provide opportunities for the State to consider any changes to ensure we remain on course to achieve the 2030 target. The need for this periodic review process was anticipated in AB 32, as it calls for updates to the Scoping Plan at least once every five years. Additional information on the uncertainty analyses conducted in the development of this Scoping Plan is located in Appendix E.

71 Bushnell, James. Economic Modeling and Environmental Policy Choice. PowerPoint. Department of Economics, University of California, Davis. *www.arb.ca.gov/cc/scopingplan/meetings/110716/bushnellpresentation.pdf*

Policy Analysis of Scoping Plan Scenario

The following key criteria were considered while evaluating potential policies beyond the known commitments. The results of the economic analysis (presented in Chapter 3) were also important in the design of this Scoping Plan.

- **Ensure the State achieves the 2030 target.** The strategy must ensure that GHG emissions reductions occur and are sufficient to achieve the 2030 target.
- **Provide air quality co-benefits.** An important concern for environmental justice communities is for any Scoping Plan to provide air quality co-benefits.
- **Prioritize rules and regulations for direct GHG reductions.** AB 197 requires CARB in developing this Scoping Plan to prioritize emissions reductions rules and regulations that result in direct emissions reductions at large stationary sources of GHG emissions sources and direct emissions reductions from mobile sources.
- **Provide protection against emissions leakage.** Require any policies to achieve the statewide limits to minimize emissions leakage to the extent possible. Emissions leakage can occur when production moves out-of-state, so there appears to be a reduction in California's emissions, but the production and emissions have just moved elsewhere. This loss in production may be associated with loss in jobs and decreases in the State's gross domestic product (GDP) and could potentially increase global GHG emissions if the production moves to a less efficient facility outside of California.
- **Develop greenhouse gas reduction programs that can be readily exported to other jurisdictions.** Currently, California's Cap-and-Trade Program is linked with Québec's program and is scheduled to link with Ontario's cap-and-trade program beginning in 2018. At the same time, California's ambitious policies such as the RPS, LCFS, and Advanced Clean Cars have resulted in other regions adopting similar programs.
- **Minimize costs and increase investment in disadvantaged and low-income communities, and low-income households.** Currently, Cap-and-Trade auction proceeds from the sale of State-owned allowances are appropriated for a variety of programs to reduce GHGs, and provide other environmental, health and economic benefits including job creation and economic development. Under AB 1550, a minimum of 25 percent of the proceeds are to be invested in projects located in and benefiting disadvantaged communities, with an additional minimum 10 percent to projects in low-income communities, and low-income households. It is important to understand if the strategy will require or result in funding to support these GHG reductions and associated benefits.
- **Avoid or minimize the impacts of climate change on public health by continuing reductions in GHGs.** Climate change has the potential to significantly impact public health, including increases in heat illness and death, air pollution-related exacerbation of cardiovascular and respiratory diseases, injury and loss of life due to severe storms and flooding, increased vector-borne and water-borne diseases, and stress and mental trauma due to extreme weather-related catastrophes.
- **Provide compliance flexibility.** Flexibility is important as it allows each regulated entity the ability to pursue its own path toward compliance in a way that works best for its business model. Flexibility also acknowledges that regulatory agencies may not have a complete picture of all available low-cost compliance mechanisms or opportunities even across the same sector. In addition, under AB 32 and AB 197, the strategy to reduce GHGs requires consideration of cost-effectiveness, which compliance flexibility provides.
- **Support the Clean Power Plan and other federal climate programs.** California will continue to support aggressive federal action, as well as to defend existing programs like the Clean Power Plan, which is the most prominent federal climate regulation applicable to stationary sources. The U.S. Supreme Court has repeatedly confirmed that federal greenhouse gas regulation must move forward under the federal Clean Air Act, so it is important to ensure that California's programs can support federal compliance as well. Although continuing litigation has stayed certain Clean Power Plan deadlines in the near term, and U.S. EPA has proposed to reconsider aspects of the rule as issued, the Clean Power Plan remains the law of the land. California is vigorously defending this important program, and is continuing to support federal climate regulation as is required by law. U.S EPA also has a legal obligation to implement GHG controls for power plants, even if it proposes to alter the form of those controls in the future. Therefore, the Clean Power Plan and other federal efforts are important considerations for this Scoping Plan. With regard to the

Clean Power Plan, California power plants are expected to be within their limits as set forth by the State's compliance plan, which was approved by CARB on July 27, 2017. However, the State still needs a mechanism to ensure the emissions for the covered electricity generating plants do not exceed the federal limits. This mechanism must be federally enforceable with regard to the affected power plants, and limit their emissions in accordance with the federal limit.

Table 4 uses the criteria listed above to assess the Scoping Plan Scenario. This assessment is based on CARB staff evaluation as well as the analyses described in Chapter 3.

Table 4: Policy Assessment of the Scoping Plan

Criteria	Details
Ensure the State Achieves the 2030 Target	• Incorporates existing and new commitments to reduce emissions from all sectors • The Cap-and-Trade Program scales to ensure reductions are achieved, even if other policies do not achieve them. This is particularly critical given the uncertainty inherent in both CARB's emission forecast and its estimate of future regulations.
Provide Air Quality Co-Benefits	• Reduced fossil fuel use and increased electrification (including plug-in hybrid electric, battery-electric, and hydrogen fuel cell vehicles) from policies such as the Mobile Source Strategy, enhanced LCFS and RPS, energy efficiency, and land conservation will likely reduce criteria pollutants and toxic air contaminants. • The Cap-and-Trade Program will ensure GHG emissions reductions within California that may reduce criteria pollutants and toxic air contaminants.
Prioritize Rules and Regulations for Direct GHG Reductions	• Advanced Clean Cars regulations require reduction in the light-duty vehicle sector. • Enhanced LCFS requires reductions in light-duty and heavy-duty transportation. • SB 350, RPS, and energy efficiency will reduce the need for fossil power generation. • The Cap-and-Trade Program constrains and reduces emissions across approximately 80 percent of California GHG emissions. • SB 1383 and the Short-lived Climate Pollutant Reduction Strategy require reductions in the agricultural, commercial, residential, industrial, and energy sectors.
Protect Against Emissions Leakage	• Free allowance allocation to minimize leakage, where supported by research.
Develop GHG Reduction Programs that can be Readily Exported to Other Jurisdictions	• Supports existing and future linkages, allows for larger GHG emissions reductions worldwide through collaborative regional efforts. • Provides leadership on how to integrate short-lived climate pollutants into the broader climate mitigation program.
Minimize Costs and Invest in Disadvantaged and Low-Income Communities, and Low-Income Households	• Continue to fund programs and projects that reduce GHGs and meaningfully benefit disadvantaged and low-income communities and low-income households through the Greenhouse Gas Reduction Fund.
Avoid or Minimize the Impacts of Climate Change on Public Health	• Reduces GHGs and provides leadership nationally and internationally for climate action. • Provides funding for programs such as home weatherization focused on disadvantaged communities, to mitigate potential cost impacts.
Compliance Flexibility	• Regulated sources self-identify and implement some GHG emissions reductions actions, beyond those already required to comply with additional prescriptive measures.
Support the Clean Power Plan and other Federal Climate Programs	• Post-2020 Cap-and-Trade Program can be used to comply with the Clean Power Plan.

Chapter 3

Evaluations

Programs for Air Quality Improvement in California

For half a century, CARB has been a leader in measuring, evaluating, and reducing sources of air pollution that impact public health. Its air pollution programs have been adapted for national programs and emulated in other countries. Significant progress has been made in reducing diesel particulate matter (PM), which is a designated toxic air contaminant, and many other hazardous air pollutants. CARB partners with local air districts to address stationary source emissions and adopts and implements State-level regulations to address sources of criteria and toxic air pollution, including mobile sources. The key air quality strategies being implemented by CARB include the following:

- **State Implementation Plans (SIPs).**[72] These comprehensive plans describe how an area will attain national ambient air quality standards by deadlines established by the federal Clean Air Act. SIPs are a compilation of new and previously submitted plans, programs, air district rules, State regulations, and federal controls designed to achieve the emissions reductions needed from mobile sources, fuels, stationary sources, and consumer products. On March 23, 2017, CARB adopted the Revised Proposed 2016 State Strategy for the SIP, describing the commitments necessary to meet federal ozone and $PM_{2.5}$ standards over the next 15 years.
- **Diesel Risk Reduction Plan.**[73] The plan, adopted by CARB in September 2000, outlined 14 recommended control measures to reduce the risks associated with diesel PM and achieve a goal of 75 percent PM reduction by 2010 and 85 percent by 2020. Since 2000, CARB has adopted regulations to reduce smog-forming pollutants and diesel PM from mobile vehicles and equipment (e.g., trucks, buses, locomotives, tractors, cargo handling equipment, construction equipment, marine vessels, transport refrigeration units); stationary engines and portable equipment (e.g., emergency standby generators, prime generators, agricultural irrigation pumps, portable generators); and diesel fuels. Diesel PM accounts for approximately 60 percent of the current estimated inhalation cancer risk for background ambient air.[74] CARB staff continues to work to improve implementation and enforcement efforts and examine needed amendments to increase the community health benefits of these control measures.
- **Sustainable Freight Action Plan.**[75] This joint agency strategy was developed in response to Governor's Executive Order B-32-15 to improve freight efficiency, transition to zero emission technologies, and increase the competitiveness of California's freight system. The transition of the freight transport system is essential to support the State's economic development in the coming decades and reduce air pollution affecting many California communities.
- **AB 32 Scoping Plan.**[76] This comprehensive strategy is updated at least every five years and is designed to achieve the State's climate goals, which includes measures that achieve air pollutant reduction co-benefits.
- **AB 1807.**[77] AB 1807 (Tanner, 1983) created California's program to reduce exposure to air toxics. CARB uses a comprehensive process to prioritize the identification of substances that pose the greatest health threat and to develop airborne toxic control measures to reduce those exposures. CARB has reduced public exposure to toxic air contaminants (TACs) through control of motor vehicles, fuels, consumer products, and stationary sources, including adopting control measures for

72 CARB. 2016. California State Implementation Plans. *www.arb.ca.gov/planning/sip/sip.htm*
73 CARB. 2000. Final Diesel Risk Reduction Plan with Appendices. *www.arb.ca.gov/diesel/documents/rrpapp.htm*
74 CARB and California Air Pollution Control Officers Association. 2015. Risk Management Guidance for Stationary Sources of Air Toxics. July 23. *www.arb.ca.gov/toxics/rma/rmgssat.pdf*
75 CARB. 2016. Sustainable Freight Transport. *www.arb.ca.gov/gmp/sfti/sfti.htm*
76 CARB. 2016. AB 32 Scoping Plan. *www.arb.ca.gov/cc/scopingplan/scopingplan.htm*
77 CARB. 2014. California Air Toxics Program – Background. *www.arb.ca.gov/toxics/background.htm*

industrial sources (e.g., perchloroethylene in automotive products; hexavalent chromium from cooling towers, automotive coatings and plating; ethylene oxide from sterilizers and aerators; dioxins from medical waste incinerators; perchloroethylene from dry cleaners; cadmium from metal melting).

- **AB 2588 Air Toxics "Hot Spots" Program.**[78] The Hot Spots Program supplements the AB 1807 program by requiring a statewide air toxics inventory, identification of facilities having localized impacts, notification of nearby residents exposed to a significant health risk, and facility risk management plans to reduce those significant risks to acceptable levels.
- **AB 617 Community Air Protection Program.** Together with the extension of the Cap-and-Trade Program and in recognition of ongoing air quality challenges, California has committed to expand its criteria and toxic emissions reductions efforts through the pursuit of a multipronged approach to reduce localized air pollution and address community exposure, framed by recently-signed new legislation, AB 617 (C. Garcia, 2017). AB 617 outlines actions in five core areas, to be completed in the 2018 to 2020 timeframe, to reduce criteria and toxic emissions in the most heavily impacted areas of the State:
  - **Community-scale air monitoring.** Ambient air monitoring is needed to evaluate the status of the atmosphere compared to clean air standards and historical data. Monitoring helps identify and profile air pollution sources, assess emerging measurement methods, characterize the degree and extent of air pollution, and track progress of emissions reductions activities. AB 617 requires a statewide assessment of the current air monitoring network and identification of priority locations where community-level air monitoring will be deployed.
  - **Statewide Strategy to reduce air pollutants impacting communities.** CARB will identify locations with high cumulative exposure to criteria and toxic pollutants, the sources contributing to those exposures, and select locations that will be required to develop a community action plan to reduce pollutants to acceptable levels.
  - **Community Action Plans to reduce emissions in identified communities.** High priority locations identified in the Statewide Strategy will need to prepare a community action plan that includes emissions reductions targets, measures, and an implementation timeline. The plan will be submitted to CARB for review and approval.
  - **Accelerated retrofits and technology clearinghouse.** This effort will focus on stationary source equipment at Cap-and-Trade facilities that, as of 2007, have not been retrofitted with BARCT-level emission controls for nonattainment pollutants. In addition, creation of a statewide clearinghouse that identifies BACT and BARCT technologies and emission levels for criteria pollutants and TACs will be developed to assist the air districts with the BARCT evaluation and identify available emission controls for the Statewide Strategy.
  - **Direct reporting of facility emissions data to CARB.** An improved, standardized emission inventory promotes a better understanding of actual emissions and helps identify major emission sources, priorities for emissions reduction, and data gaps requiring further work. AB 617 requires CARB to establish a uniform emission inventory system for stationary sources of criteria pollutants and TACs. Data integration and transparency-related efforts are already required by AB 197 (E. Garcia, 2016) and underway at CARB, so this new task will build on these efforts. Moreover, it is clear that better data reporting is necessary to identify localized exposure risk to harmful criteria and toxic pollutants and actions to address any localized impacts must be taken as quickly as possible.

To support efforts to advance the State's toxics program, the Office of Environmental Health Hazard Assessment (OEHHA) finalized a new health risk assessment methodology, *Air Toxics Hot Spots Program Risk Assessment Guidelines: Guidance Manual for Preparation of Health Risk Assessments*, on March 6, 2015, which updates the previous version of the guidance manual and reflects advances in the field of risk assessment along with explicit consideration of infants and children.[79] Subsequently, CARB, in collaboration with the California Air Pollution Control Officers Association (CAPCOA), finalized a *Risk Management Guidance for Stationary Sources of Air Toxics* for the air districts to use to incorporate OEHHA's new health risk assessment methodology into their stationary source permitting and AB 2588 Air Toxics Hot Spots programs.[80]

Together, all of these efforts will reduce criteria and toxics emissions in the State, with a focus on the most burdened communities. In particular, AB 617 responds to environmental justice concerns that the Cap-and-

78 CARB. 2016. AB 2588 Air Toxics "Hot Spots" Program. *www.arb.ca.gov/ab2588/ab2588.htm*

79 OEHHA. 2015. Notice of Adoption of Air Toxics Hot Spots Program Guidance Manual for the Preparation of Health Risk Assessments 2015. *http://oehha.ca.gov/air/crnr/notice-adoption-air-toxics-hot-spots-program-guidance-manual-preparation-health-risk-0*

80 *www.arb.ca.gov/toxics/rma/rmgssat.pdf*

Trade Program does not force large GHG emitters to reduce air pollution which results in localized health impacts. Prior to the passage of AB 617, in February 2017, OEHHA published the first in a series of reports tasked with evaluating the impacts of California's climate change programs on disadvantaged communities. The initial report focused on the Cap-and-Trade Program.[81] Future reports will focus on the impacts of other climate programs on disadvantaged communities. The report confirms disadvantaged communities are frequently located close to large stationary and mobile sources of emissions. It also notes there are complexities in trying to correlate GHGs with criteria and toxics emissions across industry and within sectors, although preliminary data review shows there may be some poor to moderate correlations in specific instances. Lastly, the report noted, "…the emissions data available at this time do not allow for a conclusive analysis."

Two additional reports were released during this same period of time: a California Environmental Justice Alliance (CEJA) report focused on identifying equity issues for disadvantaged communities resulting from the implementation of the Cap-and-Trade Program[82] and a research paper examining the question of whether the Cap-and-Trade Program is causing more GHG emissions in disadvantaged communities when compared to other regions.[83] Both of these reports also confirmed that disadvantaged communities are disproportionately located close to large stationary and mobile sources of emissions. While the CEJA report noted, "Further research is needed before firm policy conclusions can be drawn from this preliminary analysis," the research paper, in reference to GHGs, states, "By and large, the annual change in emissions across disadvantaged and non-disadvantaged communities look similar."

While the reports do not provide evidence that implementation of the Cap-and-Trade Program is contributing to increased local air pollution, they do underscore the need to use all of the tools (e.g., enhanced enforcement, new regulations, tighter permit limits) available to the State and local agencies to achieve further emissions reductions of toxic and criteria pollutants that are impacting community health. Importantly, AB 617 provides a new framework and tools for CARB, in collaboration with local air districts, to deploy focused monitoring and ensure criteria and toxics emissions reductions at the State's largest GHG emitters.

AB 197 Measure Analyses

This section provides the required AB 197 estimates for the measures evaluated in this Scoping Plan. These estimates provide information on the relative impacts of the evaluated measures when compared to each other. To support the design of a suite of policies that result in GHG reductions, air quality co-benefits, and cost-effective measures, it is important to understand if a measure will increase or reduce criteria pollutants or toxic air contaminant emissions, or if increasing stringency at additional costs yields few additional GHG reductions. To this end, AB 197 (E. Garcia, Chapter 250, Statutes of 2016) requires the following for each potential reduction measure evaluated in any Scoping Plan update:

- The range of projected GHG emissions reductions that result from the measure.
- The range of projected air pollution reductions that result from the measure.
- The cost-effectiveness, including avoided social costs, of the measure.

As the Scoping Plan was developed, it was important to understand if any of the proposed policies or measures would increase criteria pollutant or toxic air contaminant emissions. Note the important caveats around some of the estimates; they must be considered when using the information in the tables below for purposes other than as intended.

Estimated Emissions Reductions for Evaluated Measures

For many of the existing programs with known commitments, such as the Mobile Source Strategy, previous analyses provide emission factors or other methods for estimating the impacts required by AB 197. Where available, these values were used. In some cases, estimates are based on data from other sources, such as the California Public Utilities Commission (CPUC) Renewables Portfolio Standard Calculator. For newly proposed measures, assumptions were required to estimate the values. Consequently, the estimates for the newly proposed measures have substantial uncertainty. The uncertainty in the impacts of these measures would be reduced as the measures are defined in greater detail during the regulatory processes that are undertaken to

81 *https://oehha.ca.gov/media/downloads/environmental-justice/report/oehhaab32report020217.pdf*
82 *http://dornsife.usc.edu/PERE/enviro-equity-CA-cap-trade*
83 *https://www.dropbox.com/s/se3ibxkv8t4at8g/Meng_CA_EJ.pdf?dl=1*

define and adopt the programs. For example, as a measure is developed in detail, ways to obtain additional co-pollutant reductions or avoid co-pollutant increases may be identified and evaluated.

Table 5 provides the estimates for the measures evaluated during the development of the Scoping Plan. Based on the estimates below, these measures are expected to provide air quality benefits. The table also provides important context, limitations, and caveats about the values. As shown, the table includes criteria pollutant and diesel PM estimates. As mentioned in the Diesel Risk Reduction Plan, diesel PM accounts for 60 percent of the current estimated inhalation cancer risk for background ambient air. As we do not have direct modeling results for criteria and toxic pollutant estimates from PATHWAYS, we are estimating air quality benefits by using reductions in GHGs to assign similar reductions for criteria and toxic pollutants. By assigning an arbitrary 1:1 relationship in changes between GHGs and criteria and toxic pollutants, the air quality reductions likely overestimate the actual reductions from implementation of the measures. As noted in the OEHHA report, the exact relationship between GHGs and air pollutants is not clearly understood at this time. Moving forward, CARB will continue to assess the nature of the exact relationship between GHGs and criteria and toxics emissions. All estimates in Table 5 have some inherent uncertainty. The table allows for assessing measures against each other and should not be used for other purposes without understanding the limitations on the how the air quality values are derived.

Table 6 provides a summary of the total estimated emissions reductions for the Scoping Plan Scenario as outlined in Table 1. Table 6 was developed by adding the estimated emissions reductions for all of the measures included within the Scoping Plan Scenario in Table 1. More detail on the estimates for the Scoping Plan Scenario, as well as the specific measures included in each of the other four alternative scenarios can be found in Appendix G. In 2030, the Scoping Plan scenario and alternatives will provide comparable GHG and air quality reductions. When there is a range, the measure or policy should be designed to maximize the benefit to the extent possible.

Table 5: Ranges of Estimated Air Pollution Reductions by Policy or Measure in 2030

Measure	Range of NO_x Reductions (Tons/Day)	Range of VOC Reductions (Tons/Day)	Range of $PM_{2.5}$ Reductions (Tons/Day)	Range of Diesel PM Reductions (Tons/Day)
50 percent RPS	~0.5	<0.1	~0.4	< 0.01
Mobile Sources CTF and Freight	51–60	4.6–5.5	~1.1	~0.2
18 percent Carbon Intensity Reduction Target for LCFS - Liquid Biofuels*	3.5–4.4	0.5–0.6	0.4–0.6	~0.5
Short-Lived Climate Pollutant Strategy	–	–	–	–
2x additional achievable energy efficiency in the 2015 Integrated Energy Policy Report (IEPR)	0.4–0.5	0.5–0.7	< 0.1	< 0.01
Cap-and-Trade Program	A	A	A	4–9

* LCFS estimates include estimates of the NO_x and $PM_{2.5}$ tailpipe benefits limited to renewable diesel consumed in the off-road sector.

– CARB is evaluating how to best estimate these values. Criteria and toxic values are shown in tons per day, as they are episodic emissions events with residence times of a few hours to days, unlike GHGs, which have atmospheric residence times of decades.

A Due to the inherent flexibility of the Cap-and-Trade Program, as well as the overlay of other complementary GHG reduction measures, the mix of compliance strategies that individual facilities may use is not known. However, based on current law and policies that control industrial and electricity generating sources of air pollution, and expected compliance responses, CARB believes that emissions increases at the statewide, regional, or local level due to the regulation are not likely. A more stringent post-2020 Cap-and-Trade Program will provide an incentive for covered facilities to decrease GHG emissions and any related emissions of criteria and toxic pollutants. Please see CARB's Co-Pollutant Emissions Assessment for a more detailed evaluation of a cap-and-trade program and associated air emissions impacts: *www.arb.ca.gov/regact/2010/capandtrade10/capv6appp.pdf*

NO_x = nitrogen oxides; VOC = volatile organic compound

Important: These estimates assume a 1:1 relationship between changes in GHGs, criteria pollutants, and toxic air contaminant emissions, and it is unclear whether that is ever the case. The values should not be considered estimates of absolute changes for other analytical purposes and only allow for comparison across measures in the table. The values are estimates that represent current assumptions of how programs may be implemented; actual impacts may vary depending on the design, implementation, and performance of the policies and measures. The table does not show interactions between measures, such as the relationship with increased transportation electrification and associated increase in energy demand for the electricity sector. The measures in the Scoping Plan Scenario are shown in bold font in the table below. Additional details, including GHG reductions, are available in Appendix G.

Table 6: Summary of Ranges of Estimated Air Pollution Reductions for the Scoping Plan Scenario in 2030

Scenario	Range of NO_x Reductions (Tons/Day)	Range of VOC Reductions (Tons/Day)	Range of $PM_{2.5}$ Reductions (Tons/Day)	Range of Diesel PM Reductions (Tons/Day)
Scoping Plan Scenario	48–73	5.1–7.3	1.4–2.4	5–10
The total estimates for air pollution reductions provided in this table for the Scoping Plan Scenario are estimated by adding the air pollution benefits for the subset of individual measures examined in Table 5 and included in the Scoping Plan Scenario described in Table 1, and scaled by a risk adjustment factor to capture interactive effects and risks of under/over achieving on air pollution reductions. Appendix G includes details of the specific measures in the Scoping Plan Scenario and Alternatives. **All caveats in Table 5 apply to air quality estimates in this table.**				

Estimated Social Costs of Evaluated Measures

Consideration of the social costs of GHG emissions is a requirement in AB 197, including evaluation of the avoided social costs for measures within this Scoping Plan.[84] Social costs are generally defined as the cost of an action on people, the environment, or society and are widely used to evaluate the impact of regulatory actions. Social costs do not represent the cost of abatement or the cost of GHG reductions, rather social costs estimate the harm that is avoided by reducing GHGs.

Since 2008, federal agencies have been incorporating the social costs of GHGs, including carbon dioxide, methane, and nitrous oxide into the analysis of their regulatory actions. Agencies including the U.S. Environmental Protection Agency (U.S. EPA), Department of Transportation (DOT), and Department of Energy (DOE) are subject to Executive Order 12866, which directs agencies "to assess both the costs and benefits of the intended regulation…".[85] In 2007, the National Highway Transportation Safety Administration (NHTSA) was directed by the U.S. 9th Circuit Court of Appeals to include the social cost of carbon in a regulatory impact analysis for a vehicle fuel economy rule. The Court stated that "[w]hile the record shows that there is a range of values, the value of carbon emissions reduction is certainly not zero."[86]

In 2009, the Council of Economic Advisors and the Office of Management and Budget convened the Interagency Working Group on the Social Cost of Greenhouse Gases[87] (IWG) to develop a methodology for estimating the social cost of carbon (SC-CO_2). This methodology relied on a standardized range of assumptions and could be used consistently when estimating the benefits of regulations across agencies and around the world. The IWG, comprised of scientific and economic experts, recommended the use of SC-CO_2 values based on three integrated assessment models (IAMs) developed over decades of global peer-reviewed research.[88]

In this Scoping Plan, CARB utilizes the current IWG supported SC-CO_2 values to consider the social costs of actions to reduce GHG emissions. This approach is in line with Executive Orders including 12866 and the OMB Circular A-4 of September 17, 2003, and reflects the best available science in the estimation of the socio-economic impacts of carbon.[89] CARB is aware that the current federal administration has recently withdrawn certain social cost of carbon reports as no longer representative of federal governmental policy.[90] However, this determination does not call into question the validity and scientific integrity of federal social

84 AB 197 text available at: *https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB197*.
85 *https://www.reginfo.gov/public/jsp/Utilities/EO_12866.pdf*
86 Center for Biological Diversity v National Highway Traffic Safety Administration 06-71891 (9th Cir, November 15 2007)
87 Originally titled the Interagency Working Group on the Social Cost of Carbon, the IWG was renamed in 2016.
88 Additional technical detail on the IWG process is available in the Technical Updates of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866. Iterations of the Updates are available at: *https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf*, *https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf*, and *https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf*.
89 OMB circular A-4 is available at: *https://www.transportation.gov/sites/dot.gov/files/docs/OMB%20Circular%20No.%20A-4.pdf*.
90 See Presidential Executive Order, March 28, 2017, sec. 5(b).

cost of carbon work, or the merit of independent scientific work. Indeed, the IWG's work remains relevant, reliable, and appropriate for use for these purposes.

The IWG describes the social costs of carbon as follows:

> *The social cost of carbon (SC-CO_2) for a given year is an estimate, in dollars, of the present discounted value of the future damage caused by a 1-metric ton increase in carbon dioxide (CO_2) emissions into the atmosphere in that year, or equivalently, the benefits of reducing CO_2 emissions by the same amount in that year. The SC-CO_2 is intended to provide a comprehensive measure of the net damages – that is, the monetized value of the net impacts – from global climate change that result from an additional ton of CO_2.*
>
> *These damages include, but are not limited to, changes in net agricultural productivity, energy use, human health, property damage from increased flood risk, as well as nonmarket damages, such as the services that natural ecosystems provide to society. Many of these damages from CO_2 emissions today will affect economic outcomes throughout the next several centuries.*[91]

Table 7. presents the range of IWG SC-CO_2 values used in regulatory assessments including this Scoping Plan.[92]

Table 7: SC-CO_2, 2015-2030 (in 2007 $ per Metric Ton)

Year	5 Percent Discount Rate	3 Percent Discount Rate	2.5 Percent Discount Rate
2015	$11	$36	$56
2020	$12	$42	$62
2025	$14	$46	$68
2030	$16	$50	$73

The SC-CO_2 is year specific, that is, the IAMs estimate the environmental damages from a given year in the future and discount the value of the damages back to the present. For example, the SC-CO_2 for the year 2030 represents the value of climate change damages from a release of CO_2 in 2030 discounted back to today. The SC-CO_2 increases over time as systems become stressed from the aggregate impacts of climate change and future emissions cause incrementally larger damages. Table 7 presents the SC-CO_2 across a range of discount rates – or the value today of preventing environmental damages in the future. A higher discount rate decreases the value placed on future environmental damages. This Scoping Plan utilizes the IWG standardized range of discount rates, from 2.5 to 5 percent to represent varying valuation of future damages.

The SC-CO_2 is highly sensitive to the discount rate. Higher discount rates decrease the value today of future environmental damages. This Scoping Plan utilizes the IWG standardized range of discount rates, from 2.5 to 5 percent to represent varying valuation of future damages. The value today of environmental damages in 2030 is higher under the 2.5 percent discount rate compared to the 3 or 5 percent discount rate, reflecting the trade-off of consumption today and future damages. The IWG estimates the SC-CO_2 across a range of discount rates that encompass a variety of assumptions regarding the correlation between climate damages and consumption of goods and is consistent with OMB's Circular A-4 guidance.[93]

There is an active discussion within government and academia about the role of SC-CO_2 in assessing regulations, quantifying avoided climate damages, and the values themselves. In January 2017, the National Academies of Sciences, Engineering, and Medicine (NAS) released a report examining potential approaches for a comprehensive update to the SC-CO_2 methodology to ensure resulting cost estimates reflect the best available science. The NAS review did not modify the estimated values of the SC-CO_2, but evaluated the models, assumptions, handling of uncertainty, and discounting used in the estimating of the SC-CO_2. The report titled, "Valuating Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide," recommends near-term improvements to the existing IWG SC-CO_2 as well as a long-term strategy to more comprehensive updates.[94] The State will continue to follow updates to the IWG SC-CO_2, including changes

91 From The National Academies, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, 2017, available at: *http://www.nap.edu/24651*

92 The SC-CO_2 values as of July 2015 are available at: *https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf*

93 The National Academies, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, 2017, available at: *http://www.nap.edu/24651.*

94 The National Academies, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, 2017, available at:

outlined in the NAS report, and incorporate appropriate peer-reviewed modifications to estimates based on the latest available data and science.

It is important to note that the SC-CO_2, while intended to be a comprehensive estimate of the damages caused by carbon globally, does not represent the cumulative cost of climate change and air pollution to society. There are additional costs to society outside of the SC-CO_2, including costs associated with changes in co-pollutants, the social cost of other GHGs including methane and nitrous oxide, and costs that cannot be included due to modeling and data limitations. The IPCC has stated that the IWG SC-CO_2 estimates are likely underestimated due to the omission of significant impacts that cannot be accurately monetized, including important physical, ecological, and economic impacts.[95] CARB will continue engaging with experts to evaluate the comprehensive California-specific impacts of climate change and air pollution.

The Social Cost of GHG Emissions

Social costs for methane (SC-CH_4) and nitrous oxide (SC-N_2O) have also been developed using methodology consistent with that used in estimating the IWG SC-CO_2. These social costs have also been endorsed by the IWG and have been used in federal regulatory analyses.[96] Along with the SC-CO_2, the State also supports the use of the SC-CH_4 and SC-N_2O in monetizing the impacts of GHG emissions.

While the SC-CO_2, SC-CH_4, and SC-N_2O provide metrics to account for the social costs of climate change, California will continue to analyze ways to more comprehensively identify the costs of climate change and air pollution to all Californians. This will include following updates to the IWG methodology and social costs of GHGs and incorporating the SC-CO_2, SC-CH_4, and SC-N_2O into regulatory analyses.

Table 9 presents the estimated social cost for each policy or measure considered in the development of the Scoping Plan in 2030. For each measure or policy, Table 9 includes the range of the IWG SC-CO_2 values that result from the anticipated range of GHG reductions in 2030 presented in Appendix G. The SC-CO_2 range is obtained using the IWG SC-CO_2 values in 2030 at the 2.5, 3, and 5 percent discount rates. These values (of $16 using the 5 percent discount rate, $50 using the 3 percent discount rate, and $73 using the 2.5 percent discount rate) are translated into 2015 dollars and multiplied across the range of estimated reductions by measure in 2030 to estimate the value of avoided social costs from each measure in that year.[97]

Implementation of the SLCP Strategy will result in reduction of a variety of GHGs, including methane and HFCs, which reported in carbon dioxide equivalent (CO_2e). While there is no social cost of CO_2e, the avoided damages associated with the methane reductions outlined in the SLCP Strategy are estimated in Table 9 using the IWG SC-CH_4 as presented in Table 8.[98]

Table 8: SC-CH_4, 2015-2030 (in 2007$ per Metric Ton)

Year	5 Percent Discount Rate	3 Percent Discount Rate	2.5 Percent Discount Rate
2015	$450	$1000	$1400
2020	$540	$1200	$1600
2025	$650	$1400	$1800
2030	$760	$1600	$2000

The range of SC-CH_4 is obtained using the IWG SC-CH_4 values in 2030 at the 2.5, 3, and 5 percent discount rates. The SC-CH_4 values (e.g., $760 using the 5 percent discount rate, $1,600 using the 3 percent discount rate, and $2,000 using the 2.5 percent discount rate) are translated into 2015 dollars and multiplied across the range of estimated methane reductions in 2030 to estimate the value of climate benefits from the SLCP

http://www.nap.edu/24651

95 https://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch3s3-5-3-3.html

96 More information is available at: https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/august_2016_sc_ch4_sc_n2o_addendum_final_8_26_16.pdf

97 The IWG.SC-CO_2 values are in 2007 dollars. In 2015 dollars, $16, $50, and $73 in 2007 translates to about $18, $57, and $83, respectively, based on the Bureau of Labor Statistics GDP Series Table 1.1.4.

98 https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/august_2016_sc_ch4_sc_n2o_addendum_final_8_26_16.pdf

Strategy.[99] As the social cost associated with the SLCP Strategy does not include the impact associated with non-methane reductions, Table 9 underestimates the avoided social costs of this Scoping Plan as calculated using the IWG valuations.

As this Scoping Plan is a suite of policies developed to reduce GHGs to a specific level in 2030, any alternative scenario that also achieves the 2030 target (with the same proportion of carbon dioxide and methane reductions) will have the same avoided social cost, as estimated using the IWG social cost of GHGs, for the single year 2030. The social costs of alternatives could vary if the 2030 target is achieved with vastly different ratios of carbon dioxide to methane reductions. However, all alternatives in this Scoping Plan are anticipated to achieve the same proportion of carbon dioxide and methane reductions and will therefore all have the same estimated avoided social damage or social cost. This social cost, as estimated in 2030 using the IWG SC-CO_2 and SC-CH_4, ranges from $1.9 to $11.2 billion using the 2.5 to 5 percent discount rates, and is estimated at $5.0 to $7.8 billion using the 3 percent discount rate. For example, in Table 9 the CH_4 reductions for the SCLP strategy are about 1 MMTCH_4. That value is multiplied by the 2030 SC-CH_4 values in Table 8 for the 2030 values at the 2.5 and 5 percent discount rates to get a range of $860 to $2,260 in 2015 dollars.

99 The IWG.SC-CH_4 values are in 2007 dollars. In 2015 dollars, the range of SC-CH_4 translates to about $858, $1,807, and $2,259, for the 5 percent, 3 percent, and 2.5 percent discount rates, respectively. These values are based on the Bureau of Labor Statistics GDP Series Table 1.1.4.

Table 9: Estimated Social Cost (Avoided Economic Damages) of Policies or Measures Considered in the 2017 Scoping Plan Development#

Measure (Measures in bold are included in the Scoping Plan)	Range of Social Cost of Carbon $ million USD (2015 dollars)**
50 percent Renewables Portfolio Standard (RPS)	$55–$250
Mobile Sources CTF and Freight	$200–$1,080
18 percent Carbon Intensity Reduction Target for LCFS -Liquid Biofuels	$70–$330
Short-Lived Climate Pollutant Strategy	$860-$2,260 ($SC-CH_4$)
2x additional achievable energy efficiency in the 2015 IEPR	$125–$750
Cap-and-Trade Program	$610–$6,560
10 percent incremental RPS and additional 10 GW behind-the-meter solar PV*	$250–$1,160
25 percent Carbon Intensity Reduction Target for LCFS and a Low-Emission Diesel Standard - Liquid Biofuels*	$90–$415
20 percent Refinery	$55–$500
30 percent Refinery	$20–$250
25 percent Industry	$20–$415
25 percent Oil and Gas	$35–$330
5 percent Increased Utilization of RNG (core and non-core)	$35–$165
Mobile Source Strategy (CTF) with Increased ZEVs in South Coast and early retirement of LDVs with more efficient LDVs*	$55–$500
2.5x additional achievable energy efficiency in the 2015 IEPR, electrification of buildings (heat pumps and res. electric stoves) and early retirement of HVAC*	$70–$580
Carbon Tax	$775–$8,300
All Cap-and-Trade	$700–$6,890
Cap-and-Tax	$775–$8,300
Scoping Plan Scenario $SC-CO_2$ Scoping Plan Scenario $SC-CH_4$ **Scoping Plan Scenario (Total)**	$1,060–$8,970 $860–$2,260 **$1,920–$11,230**

Note: All values are rounded. The values for $SC-CO_2$ and $SC-CH_4$ in 2030 are presented in Tables 7 and 8.

* Where enhancements have been made to a measure or policy, the ranges in emissions reductions are incremental to the original measure. For example, the ranges for the 25 percent LCFS are incremental to the emissions ranges for the 18 percent LCFS.

\# Measures included in the Scoping Plan and the All Cap-and-Trade measure reflect emissions reductions from modeling changes after passage of AB 398. Emissions reductions from all other measures reflect modeling completed prior to passage of AB 398. See Appendix G for additional details.

** All values have been rounded to the nearest 0 or 5.

~ Some measures do not show a significant change in 2030 when there is an incremental increase in measure stringency or when modeling uncertainty was factored.

Social Costs of GHGs in Relation to Cost-Effectiveness

AB 32 includes a requirement that "rules and regulations achieve the maximum technologically feasible and cost-effective greenhouse gas emissions reductions."[100] Under AB 32, cost-effectiveness means the relative cost per metric ton of various GHG reduction strategies, which is the traditional cost metric associated with emission control. In contrast, the SC-CO_2, SC-CH_4, and SC-N_2O are estimates of the economic benefits, and not the cost of reducing GHG emissions.

There may be technologies or policies that do not appear to be cost-effective when compared to the SC-CO_2, SC-CH_4, and SC-N_2O associated with GHG reductions. However, these technologies or policies may result in other benefits that are not reflected in the IWG social costs. For instance, the evaluation of social costs might include health impacts due to changes in local air pollution that result from reductions in GHGs, diversification of the portfolio of transportation fuels (a goal outlined in the LCFS) and reductions in criteria pollutant emissions from power plants (as in the RPS).

Estimated Cost Per Metric Ton by Measure

AB 197 also requires an estimation of the cost-effectiveness of the potential measures evaluated for the Scoping Plan. The values provided in Table 10 are estimates of the cost per metric ton of estimated reductions for each measure in 2030. To capture the fuel and GHG impacts of investments made from 2021 through 2030 to meet the 2030 GHG goal, the table also includes an evaluation of the cost per metric ton based on the cumulative GHG emissions reductions and cumulative costs or savings for each potential measure from 2021 through 2030. While it is important to understand the relative cost effectiveness of measures, the economic analysis presented in Appendix E provides a more comprehensive analysis of how the Scoping Plan and alternative scenarios affect the State's economy and jobs.

The cost (or savings) per metric ton of CO_2e reduced for each of the measures is one metric for comparing the performance of the measures. Additional factors beyond the cost per metric ton that could be considered include continuity with existing laws and policies, implementation feasibility, contribution to fuel diversity and technology transformation goals, as well as health and other benefits to California. These considerations are not reflected in the cost per ton metric below.

Because many of the measures interact with each other, isolating the cost and GHG savings of an individual measures is analytically challenging. For example, the performance of the renewable electricity measure impacts the GHG savings and cost per ton associated with increasing the use of electric vehicles. Likewise, the increased use of electric vehicles may increase flexible loads on the electric system, enabling increased levels of renewable electricity to be achieved more cost effectively. Both the renewable electricity measure and the increased use of electric vehicles affect the cost of meeting the Low-Carbon Fuel Standard.

For most of the measures shown in Table 10, the 2030 cost per metric ton is isolated from the other measures by performing a series of sensitivity model runs in the California PATHWAYS model. This cost per metric ton is calculated as the difference in the 2030 annualized cost (or savings) with and without the measure. For the measures in the Scoping Plan Scenario, the analysis starts with the Scoping Plan Scenario PATHWAYS estimates, and then costs and emissions are recalculated with each measure removed individually. For measures included in the No Cap-and-Trade Scenario, the approach starts with the No Cap-and-Trade Scenario PATHWAYS estimates and then each measure is removed. Using this approach, the incremental impact on GHG emissions and costs for each measure is calculated. The incremental cost in 2030 is divided by the incremental GHG emission impact to calculate the cost per ton in 2030.

The same approach of removing each measure individually is used to estimate the incremental cost and emission impacts of each measure for the period 2021 to 2030. For each measure, its annual incremental costs from 2021 to 2030 are calculated and then discounted to 2021 using the discount rate used in PATHWAYS to levelize capital costs over the life of equipment. As a result, the discounted incremental cost of each measure is the total investment required from 2021 to 2030 to achieve each measure's emissions reductions from 2021 to 2030 (including both incremental capital costs and incremental fuel savings/expenditures). This discounted cost for each measure was divided by its cumulative emissions reductions from 2021 to 2030 to calculate a cost per ton for the measure for the period. A second calculation was also made that divides each measure's discounted cost by its discounted emissions reductions from 2021 to 2030. The

100 *www.arb.ca.gov/cc/docs/ab32text.pdf*

same discount rate is used to discount both incremental costs and emissions in this approach. The estimates are presented in the table below.

Costs that represent transfers within the state, such as incentive payments for early retirement of equipment, are not included in this California total cost metric. The cost ranges shown below represent some of the uncertainty inherent in estimating this metric. The details of how the ranges for each measure were estimated are described in the footnotes below. All cost estimates have been rounded representing further uncertainty in individual values.

It is important to note that this cost per metric ton does not represent an expected market price value for carbon mitigation associated with these measures. In addition, the single year (2030) values and the estimates that encompass 2021 to 2030 do not capture the fuel savings or GHG reductions associated with the full economic lifetime of measures that have been implemented by 2030, but whose impacts extend beyond 2030. The estimates also do not capture the climate or health benefits of the GHG mitigation measures. Table 10 also notes the measures for which sources other than the PATHWAYS model were used to develop estimates of the cost per metric ton. The estimates in the table indicate that the relative cost of the measures is reasonably consistent across the different measures of cost per metric ton. Measures that are relatively less costly using the 2030 cost per metric ton are also less costly using the cost per metric ton based on the period 2021 to 2030. However, for several measures the sign of the estimate differs, such that in 2030 the measure has a positive cost while there is a negative cost for the period 2021 to 2030. This difference in sign occurs because the measure includes increasingly costly investments toward the end of the period examined. By examining only 2030, the lower cost components of the measure that occur in earlier years are omitted, resulting in a higher cost estimate for 2030 alone.

Table 10: Estimated Cost Per Metric Ton of Measures Considered in the 2017 Scoping Plan Development and Averaged from 2021 through 2030

Important: As individual measures are designed and implemented they will be subject to further evaluation and refinement and public review, which may result in different findings than presented below. The ranges are estimates that represent current assumptions of how programs may be implemented and may vary greatly depending on the design, implementation, and performance of the policies and measures. Measures in bold text are included in the Scoping Plan.

Measure	Cost/metric ton in 2030*	Cost/metric ton 2021-2030**
50 percent Renewables Portfolio Standard (RPS) [a]	**$175**	**$100 to $200**
Mobile Sources CFT and Freight [b]	**<$50**	**<$50**
Liquid Biofuels (18 percent Carbon Intensity Reduction Target for LCFS) [c]	**$150**	**$100 to $200**
Short-Lived Climate Pollutant Strategy [d]	**$25**	**$25**
2x additional achievable energy efficiency in the 2015 IEPR [f]	**-$350**	**-$300 to -$200**
10 percent incremental RPS and additional 10 GW behind-the-meter solar PV [a]	$350	$250 to $450
Liquid Biofuels (25 percent Carbon Intensity Reduction Target for LCFS and a Low-Emission Diesel Standard) [b]	$900	$550 to $975
20 percent Refinery [d]	$100	$50 to $100
30 percent Refinery [d]	$300	$175 to $325
25 percent Industry [d]	$200	$150 to $275
25 percent Oil and Gas [d]	$125	$100 to $175
5 percent Increased Utilization of renewable natural gas - core and non-core [e]	$1500	$1350 to $3000
Mobile Source Strategy (CFT) with Increased ZEVs in South Coast & additional reductions in VMT and energy demand & early retirement of LDVs with more efficient LDVs [b]	$100	<$50
2.5x additional achievable energy efficiency in the 2015 IEPR, electrification of buildings (heat pumps & res. electric stoves) and early retirement of HVAC [f]	$75	-$120 to -$70

* Where enhancements have been made to a measure or policy, the cost per metric ton are incremental to the original measure. For example, the cost per metric ton for the 25 percent LCFS are incremental to the cost per metric ton for the 18 percent LCFS.

** The lower values use a cost discount rate of 10 percent and cumulative emissions for the period 2021 to 2030. The higher values discount both costs and emissions using a discount rate of 10 percent.

a Cost estimate is based on PATHWAYS sensitivity analysis as described in the main text.

b Cost estimate is based on PATHWAYS sensitivity analysis as described in the main text.

c Liquid biofuel values are calculated as the average unsubsidized cost of biofuels supplied above that of an equivalent volume of fossil fuels. These values do not reflect impacts from other biofuel policies, such as the Renewable Fuel Standard or production tax credits, that are partially supported by fuel purchasers/taxpayers outside of California. Therefore, these values do not represent LCFS program costs or potential LCFS credit prices.

d See Appendix D

e Cost estimate is based on PATHWAYS sensitivity analysis as described in the main text.

f Cost estimate is based on PATHWAYS sensitivity analysis as described in the main text. The cost per metric ton does not represent the results of the CPUC's or CEC's standard cost-effectiveness evaluation tests

Health Analyses

Climate mitigation will result in both environmental and health benefits. This section presents information about the potential health benefits of the Scoping Plan. The impacts are primarily from reduced particulate matter pollution, reduced toxics pollution (both diesel combustion particles and other toxic pollutants), and the health benefits of increased physical activity that will result from more active modes of transportation such as walking and biking in lieu of driving. CARB is using the AB 197 air quality estimates in Table 5 as a proxy to understand the potential health impacts from the Scoping Plan. There is uncertainty in the air quality estimates and that is carried through to the health impacts evaluation presented here. In the future, CARB will be working to explore how to better integrate health analysis and health considerations in the design and implementation of climate programs.

Because the health endpoints of each of these benefits is different (e.g., fewer incidences of premature mortality, lower cancer risk, and fewer incidences of heart disease), the methodologies for estimating the benefits differ. Further, the methodologies are statistical estimates of adverse health outcomes aggregated to the statewide level. Therefore, this information should only be used to understand the relative health benefits of the various strategies and should not be taken as an absolute estimate of the health outcomes of the Scoping Plan statewide, or within a specific community. The latter is a function of the unique exposure to air pollutants within each community and each individual's choice of more active transport modes that increase physical activity.

The estimates of health benefits in this section do not include any potential avoided adverse health impacts associated with a reduction in global climate change. While we recognize that mitigating climate change will, for example, prevent atmospheric temperature rise, thereby preventing increases in ozone in California, which will result in fewer breathing problems, the connection is difficult to estimate or model. Since it takes collective global action to mitigate climate change, the following analyses do not attempt to quantify the improved health outcomes from reducing or stopping the rise in global temperatures.

The estimated statewide health benefits of the Scoping Plan are dominated by reductions in particulate matter from mobile sources and wood burning and a switch to more active transport modes. In particular, the focus on the impacts of exposure to particulate matter from mobile sources is expected because this is a major cause of air pollution statewide. For this reason, the actions concerning mobile sources in the Scoping Plan were specifically developed with the goal of achieving health-based air quality standards by reducing criteria and toxics emissions as well as GHG emissions simultaneously. In addition, actions that support walkable communities not only result in reduced VMT and related GHG emissions, but promote active transport and increased physical activity that is strongly related to improved health.

Table 11 provides a summary of the total estimated health benefits from the relevant metrics for the Scoping Plan. The sections below summarize the methodologies used to estimate these benefits. More detail on how these estimates were calculated can be found in Appendix G. The air pollutant values used in estimating the health impacts are from Table 5 and all caveats in the estimation of the air quality impacts must be considered when reviewing the health impacts discussed below as the air pollutant values are likely overestimates based on assigned relationships to GHGs that may not be real.

Potential Health Impacts of Reductions in Particulate Matter Air Pollution

CARB relied on an U.S. EPA-approved methodology to estimate the health impacts of reducing air pollution by actions in the Scoping Plan. This methodology relies on an incidents-per-ton factor to quantify the health benefits of directly emitted (diesel particles and wood smoke) and secondary $PM_{2.5}$ formed from oxides of nitrogen from reductions due to regulatory controls. It is similar in concept to the methodology developed by the U.S. EPA for comparable estimations[101], but uses California air basin specific relationships between emissions and air quality. The basis of the methodology is an approximately linear relationship between changes in $PM_{2.5}$ emissions and estimated changes in health outcomes. In this methodology, the number of premature deaths is estimated by multiplying emissions by the incidents-per-ton scaling factor. The factors are derived from studies that correlate the number of incidents (premature deaths, hospitalizations, emergency room visits) associated with exposure to $PM_{2.5}$.

101 Fann, N., Fulcher, C.M, & Hubbell, B.J. (2009) The influence of location, source, and emission type in estimates of the human health benefits of reducing a ton of air pollution. (2009)Air Quality, Atmosphere & Health 2(3), 169–176

Potential Health Impacts of Reductions in Toxic Air Pollution

A number of factors complicate any attempt to evaluate the health benefits of reducing exposure to toxic air pollution. First, there are hundreds of individual chemicals of concern with widely varying health effects and potencies. Therefore, a single metric is of limited value in capturing the range of potential toxics benefits. Furthermore, unlike the criteria pollutants whose impacts are generally measured on regional scales, toxics pose concern for both near-source impacts and larger-scale photochemical transformations and transport. Finally, the accepted scientific understanding for cancer risk is that there is usually no safe threshold for exposures to carcinogens. Therefore, cancer risks are usually expressed as "chances per million" of contracting cancer over a (70-year) lifetime exposure (in Table 11 lifetime exposure is provided in the far right column).

In light of these complexities, CARB relied on the most recent National Air Toxics Assessment (NATA) conducted by the U.S. EPA.[102] The NATA 2011 models the potential risks from breathing emissions of approximately 180 toxic air pollutants across the country. Modeled cancer risk results are available by census tract. The NATA data cover industrial facilities, mobile sources (on-road and off-road), small area-wide sources, and more. CARB multiplied the NATA "cancer risk-per-million" values by census tract by the census tract's population, in order to estimate a population-weighted metric that could be aggregated to the statewide level. This statistic should not be construed as actual real-world cancers (due to the many uncertainties in estimating the real-world levels of risk). Next, CARB applied the percent reductions in emissions due to Scoping Plan actions, in order to obtain an estimate of the "avoided incidence" of statistical lifetime cancers attributable to implementation of the Scoping Plan. Again, the "avoided incidence" is a construct designed to provide a useful statistical metric for comparative purposes among scenarios. It should not be construed to be a real-world parameter.

Potential Health Impacts of Active Transportation

High levels of active transportation have been linked to improved health and reduced premature mortality by increasing daily physical activity, representing a major direct co-benefit of using active transportation as a strategy to reduce GHG emissions. The benefits of physical activity can be very large. Individuals who are active for approximately 12 minutes a day have a 20 percent lower risk of dying early than those who are active for just 5 minutes a day and those who are active an hour a day, have close to a 40 percent lower risk of premature death.[103]

The Scoping Plan includes reductions in VMT, which can be achieved in a number of ways, including increased active transportation. To estimate the potential health benefits of active transport, CARB staff reviewed work done by the California Department of Public Health (CDPH) concerning the potential health benefits associated with the Caltrans Strategic Management Plan. In this Management Plan, Caltrans set a target for increasing the adoption of active transportation, aiming for a doubling of walking and a tripling of bicycle trips by 2020 compared to 2010. While this plan itself is not part of the Scoping Plan, it helps provide a sense of the magnitude of health benefits associated with increased active transportation.

CDPH performed a risk assessment to compare the number of premature deaths due to physical inactivity and traffic injuries in the baseline year of 2010 to the year 2020, assuming that Caltrans' walking and bicycling mode share targets were met.[104] CPDH's methodology has been documented in a publicly available technical manual[105] and the model has appeared in many peer-reviewed research articles.[106] It has been in development

102 U.S. Environmental Protection Agency (2011), National Air Toxics Assessment (NATA) 2011, *https://www.epa.gov/national-air-toxics-assessment/2011-nata-assessment-results*

103 U.S. Department of Health and Human Services (2008) Physical Activity Guidelines Advisory Committee. Physical Activity Guidelines Advisory Committee Report, Washington, DC

104 Maizlish, N. (2016a) Increasing Walking, Cycling, and Transit: Improving Californians' Health, Saving costs, and Reducing Greenhouse Gases. Office of Health Equity, California Department of Public Health. *https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/Maizlish-2016-Increasing-Walking-Cycling-Transit-Technical-Report-rev8-17-ADA.pdf*

105 Maizlish, N. (2016b) Integrated Transport and Health Impact Model (ITHIM): A Guide to Operation, Calibration and Integration with Travel Demand Models. California Spreadsheet Version December 12, 2016.

106 Gotschi, T., Tainio, M., Maizlish, N., Schwanen, T., Goodman, A., & Woodcock, J. (2015). Contrasts in active transport behaviour across four countries: how do they translate into public health benefits? Preventative Medicine, 74, 42-48. doi:10.1016/j.ypmed.2015.02.009

Maizlish, N., Woodcock, J., Co, S., Ostro, B., Fanai, A., & Fairley, D. (2013). Health cobenefits and transportation-related reductions in greenhouse gas emissions in the San Francisco Bay area. American journal of public health, 103(4), 703-709. doi:10.2105/ajph.2012.300939

Whitfield, G. P., Meehan, L. A., Maizlish, N., & Wendel, A. M. (2016). The Integrated Transport and Health Impact Modeling since 2009, and a California-specific version was released with a recent update in November 2016.[107]

CDPH estimated that 2,100 premature deaths annually would be avoided if Californians met the Management Plan's 2020 targets were met by Californians compared to 2010 travel patterns. A recent paper by Dr. Maizlish et al[108] quantified the health co-benefits of the preferred Sustainable Communities Strategies scenarios (compared to the 2010 baseline travel pattern) for the major Metropolitan Planning Organizations using the same methodology and found that 940 deaths annually would be avoided. For both analyses, there were significant reductions in cause-specific premature mortality due to increased physical activity, which was slightly counteracted by a much smaller increase in fatal traffic injuries due to the increased walking and bicycling. When taken together, the health benefit of increasing active transportation greatly outweighed the increased mortality from road traffic collisions. The Scoping Plan goals related to active transportation are more aggressive than those in both the Maizlish et al. 2017 publication and the analysis by CDPH for the Management Plan. Therefore, CARB staff used the CDPH estimate of approximately 2,100 fewer premature deaths from the Management Plan as a lower bound of what could be realized through implementation of the VMT reductions and active transport goals called for in the Scoping Plan Scenario.

Table 11: Summary of Ranges of Estimated Health Impacts for the Scoping Plan Scenario in 2030

	Fewer Premature Deaths	Fewer Hospitalizations (all)	Fewer ER visits	Fewer cancers *
Diesel PM	~60-91	~9-14	~25-38	
Secondary PM	~76-120	~11-17	~33-50	
Toxics				~21-61
Wood smoke	~1000	~ 148	~ 418	
Active Transport**	>2100			
Total	~3300	~180	~500	~21-61

* This metric should not be construed as actual real-world cancer cases. It is intended to be a comparative metric, based on the NATA estimates of lifetime cancer risk (chances-per-million over a 70 year life-time exposure) by census tract multiplied by the tract population.

** Reduction in premature death assumes meeting the CSMP 2020 mode shift target.

Note: The numbers in the table represent individual avoided incidences.

Tool in Nashville, Tennessee, USA: Implementation Steps and Lessons Learned. Journal of transport & health, 3. doi:10.1016/j.jth.2016.06.009

Woodcock, J. (2015). Integrated Transport and Health Impact Modelling Tool (ITHIM). Retrieved from *http://www.cedar.iph.cam.ac.uk/research/modelling/ithim/*

Woodcock, J., Edwards, P., Tonne, C., Armstrong, B. G., Ashiru, O., Banister, D., & Roberts, I. (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport. Lancet, 374(9705), 1930-1943. doi:10.1016/s0140-6736(09)61714-1

Woodcock, J., Givoni, M., & Morgan, A. S. (2013). Health impact modelling of active travel visions for England and Wales using an Integrated Transport and Health Impact Modelling Tool (ITHIM). PLoS One, 8(1), e51462. doi:10.1371/journal.pone.0051462

Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O., & Goodman, A. (2014). Health effects of the London bicycle sharing system: health impact modelling study. BMJ (Clinical research ed.), 348, g425. doi:10.1136/bmj.g425

107 Woodcock, J. Maizlish, N. (2016). ITHIM: Integrated Transport & Health Impact Modelling, California Version, November 11, 2016. Original citation: Woodcock J, Givoni M, Morgan AS. Health Impact Modelling of Active Travel Visions for England and Wales Using an Integrated Transport and Health Impact Modelling Tool (ITHIM). PLoS One. 2013;8(1):e51462.

108 Maizlish N, Linesch N,& Woodcock J.(2017) Health and greenhouse gas mitigation benefits of ambitious expansion of cycling, walking, and transit in California. Journal of Transport and Health. ; doi: 10.1016/j.jth.2017.04.011

Future Health Activities

As Table 11 shows, the Scoping Plan measures would have significant potential positive health outcomes. The integrated nature of the strategies to reduce emissions of GHGs and criteria and toxics emissions could provide multiple benefits. Actions to reduce black carbon from wood smoke are reducing the same particles that lead to premature mortality. Reductions in fossil combustion will not only reduce GHG emissions, but also toxics emissions. Finally, reducing VMT with strategies that provide opportunities for people to switch to active transport modes can have very large health benefits resulting from increased physical activity.

In recognition of the potential for significant positive health benefits of the Scoping Plan, CARB is initiating a process to better understand how to integrate health analysis broadly into the design and implementation of our climate change programs with the goal of maximizing the health benefits. Although health impact assessments have been used to inform CARB's policymaking, these analyses have not been consistently integrated into the general up-front design of CARB programs. To begin the effort to increase health benefits from climate change mitigation policies, CARB will convene a public meeting in Spring 2018 to solicit input on how best to incorporate health analyses into our policy development. CARB staff will seek appropriate tools for these analyses and will assemble a team of academic advisors to provide input on the latest developments in methods and data sources.

Economic Analyses

The following section outlines the economic impact of the Scoping Plan relative to the business-as-usual Reference Scenario. Additional detail on the economic analysis, including modeling details and the estimated economic impact of alternative scenarios is presented in Appendix E.

The Scoping Plan outlines a path to achieve the SB 32 target that requires less reliance on fossil fuels and increased investment in low carbon fuels and clean energy technologies. Through this shift, California can lead the world in developing the technologies needed to reduce the global risks of climate change. This builds on California's current successes of reducing GHG emissions while also developing a cleaner, resilient economy that uses less energy and generates less pollution. Innovation in low-carbon technologies will continue to open growth opportunities for investors and businesses in California. As modeled, the analysis in this Scoping Plan suggests that the costs of transitioning to this lower carbon economy are small, even without counting the potential opportunities for new industries and innovation in California. Under the Scoping Plan, the California economy, employment, and personal income will continue to grow as California businesses and consumers make clean energy investments and improve efficiency and productivity to reduce energy costs.

In 2030, the California economy is projected to grow to $3.4 trillion, an average growth rate of 2.2 percent per year from 2021 to 2030. It is not anticipated that implementation of the Scoping Plan will change the growth of annual State Gross Domestic Product (GDP). Further, this growth in GDP will occur under the entire projected range of Cap-and-Trade Program allowance prices. Based on this analysis, in 2030 the California economy will take only three months longer to grow to the GDP estimated in the absence of the Scoping Plan–referred to as the Reference Scenario. The impact of the Scoping Plan on job growth is also negligible, with employment less than one half of one percent smaller in 2030 compared to the Reference Scenario.

Additionally, reducing GHG emissions 40 percent below 1990 levels under the Scoping Plan will lead to avoided social damages from climate change on the order of $1.9 to $11.2 billion, as estimated using the SC-CO_2 and SC-CH_4, as well as additional potential savings from reductions in air pollution and petroleum dependence. These impacts are not accounted for in this economic analysis. The estimated impact to California households is also modest in 2030. In 2030, the average annual household impact of the Scoping Plan ranges from $115 to $280, depending on the price of reductions under the Cap-and-Trade Program.[109] Estimated personal income in California is also relatively unchanged by the implementation of the Scoping Plan.

109 Household projections are obtained from the California Department of Finance and were access on March 16, 2017 at: *http://www.dof.ca.gov/Forecasting/Demographics/projections/*.

Overview of Economic Modeling

Two models are used to estimate the economic impact of the Scoping Plan and California's continued clean energy transition: (1) the California PATHWAYS model, and (2) the Regional Economic Models, Inc. (REMI) Policy Insight Plus model. The California PATHWAYS model estimates the direct costs and GHG emissions reductions of implementing the prescriptive (or non-Cap-and-Trade) measures in the Scoping Plan relative to the BAU scenario.[110] Direct costs are the sum of the incremental changes in capital expenditures and fuel expenditures, including fuel savings for reduced energy use from efficiency measures. In most cases, reducing GHG emissions requires the use of more expensive equipment that can be operated using less fuel. In the Scoping Plan, the prescriptive measures modeled in PATHWAYS account for a portion of the GHG reductions required to meet the 2030 target. The remaining reductions are delivered through the Cap-and-Trade Program. The direct costs associated with the Cap-and-Trade Program are calculated outside of PATHWAYS based on an assumed range of Cap-and-Trade allowance prices from 2021 through 2030.

To estimate the future costs of the Scoping Plan, this economic analysis necessarily creates a hypothetical future California that is essentially identical to today, adjusted for currently existing climate policy as well as projected economic and population growth through 2030. The analysis cannot predict the types of innovation that will create efficiencies nor can it fully account for the significant economic benefits associated with reducing emissions. Rather, the economic modeling is conducted by estimating incremental capital and clean fuel costs of measures and assigning those costs to certain sectors within this hypothetical future.

The macroeconomic impacts of the Scoping Plan on the California economy are modeled using the REMI model with output from California PATHWAYS and estimated Cap-and-Trade Program costs as inputs. Additional methodological detail is presented in Appendix E.[111]

Estimated Cost of Prescriptive Measures

As described above, the Scoping Plan combines new measures addressing legislative mandates and the extension of existing measures, including a comprehensive cap on overall GHG emissions from the State's largest sources of pollution. The PATHWAYS model calculates costs and GHG emissions reductions associated with the prescriptive measures in the Scoping Plan. Changes in energy use and capital investment are calculated in PATHWAYS and represent the estimated cost of achieving an estimated 50 to 70 percent of the cumulative GHG reductions required to reach the SB 32 target between 2021 and 2030. The Cap-and-Trade Program delivers any remaining reductions, as shown in Figure 8.

Table 12 outlines the cost of prescriptive measures by sector in 2030, compared to the Reference Scenario, as calculated in PATHWAYS. Estimated capital costs of equipment are levelized over the life of the equipment using a 10 percent discount rate and fuel costs are calculated on an annual basis.[112] The costs in Table 12 are disaggregated into capital costs and fuel costs, which includes the varying costs of gasoline, diesel, biofuels, natural gas, electricity and other fuels.[113] Table 12 assumes that all prescriptive measures deliver anticipated GHG reductions, and does not include any uncertainty in GHG reductions or cost.[114] The impact of uncertainty in GHG reductions is explored in more detail in Appendices E, which include additional detail on measure, cost, and Reference Scenario uncertainty.

The prescriptive measures result in incremental capital investments of $6.7 billion per year in 2030, but these annual capital costs are nearly offset by annual fuel savings of $6.6 billion in 2030. The incremental net cost of prescriptive measures in the Scoping Plan is estimated at $100 million in 2030, which represents 0.03 percent of the projected California economy in 2030. The residential and transportation sectors are anticipated to see net savings in 2030 as fuel savings for these areas vastly outweigh annual capital investment. Several sectors will see a net cost increase from implementation of the prescriptive measures. The industrial sector sees higher fuel costs relative to the Reference Scenario. In the agriculture sector, capital expenditures are due to investments in more efficient lighting and the mitigation of agricultural methane and nitrogen oxides. Agricultural fuel costs increase due to higher electricity and liquid biofuel costs.

110 The PATHWAYS modeling is described in Chapter 2, and additional detail is presented in Appendix D.

111 Additional modeling details are available at the REMI PI+ webpage: *http://www.remi.com/products/pi*.

112 PATHWAYS costs are calculated in real $2012. For this analysis, all costs are reported in $2015. The PATHWAYS costs are inflated using Bureau of Economic Analysis (BEA) data available at: *https://www.bea.gov/iTable/iTable.cfm?ReqID=9#reqid=9&step=1&isuri=1&903=4*.

113 Additional information on the fuels included in PATHWAYS is available at: *www.arb.ca.gov/cc/scopingplan/meetings/1142016/e3pathways.pdf*.

114 More information on the inputs to the California PATHWAYS model is available at: *www.arb.ca.gov/cc/scopingplan/scoping_plan_scenario_description2016-12-01.pdf*.

Table 12: Change in PATHWAYS Sector Costs in 2030 Relative to the Reference Scenario (Billion $2015)[115]

End Use Sector[116]	Levelized Capital Cost	Fuel Cost	Total Annual Cost
Residential	$0.1	-$1.2	-$1.1
Commercial	$1.8	-$1.8	$0.1
Transportation	$3.5	-$3.8	-$0.3
Industrial	$0.8	$0.3	$0.5
Oil and Gas Extraction	$0.0	$0.0	$0.1
Petroleum Refining	$0.0	$0.0	$0.0
Agriculture	$0.3	$0.2	$0.5
TCU (Transportation Communications and Utilities)	$0.1	$0.1	$0.2
Total	$6.7	-$6.6	$0.1

Note: Table values may not add due to rounding.

Estimated Cost of the Cap-and-Trade Program

The direct cost of achieving GHG reductions through the Cap-and-Trade Program is estimated outside of PATHWAYS. The Cap-and-Trade Program sets an economy-wide GHG emissions cap and gives firms the flexibility to choose the lowest-cost approach to reduce emissions. As with the prescriptive measures, the direct costs of any single specific GHG reduction activity under the Cap-and-Trade Program is subject to a large degree of uncertainty. However, as Cap-and-Trade allows covered entities to pursue the reduction options that emerge as the most efficient, overall abatement costs can be bounded by the allowance price. Covered entities should pursue reduction actions with costs less than or equal to the allowance price. An upper bound on the compliance costs under the Cap-and-Trade Program can therefore be estimated by multiplying the range of anticipated allowance prices by the anticipated GHG reductions needed (in conjunction with the reductions achieved through the prescriptive measures) to achieve the SB 32 target.

A large number of factors influence the allowance price, including the ease of substituting lower carbon production methods, consumer price response, the pace of technological progress, and impacts to the price of fuel. Other policy factors that also affect the allowance price include the use of auction proceeds from the sale of State-owned allowances and linkage with other jurisdictions.

Flexibility allows the Cap-and-Trade allowance price to adjust to changes in supply and demand while a firm cap ensures GHG reductions are achieved. This analysis includes a range of allowance prices bounded at the low end by the Cap-and-Trade auction floor price (C+T Floor Price) which represents the minimum sales price for allowances sold at auction and the Allowance Price Containment Reserve Price (C+T Reserve Price), which represents the price at which an additional pool of allowances will be made available to ensure entities can comply with the Cap-and-Trade Program and is the highest anticipated price under the Program. Table 13 outlines the projected allowance prices used in this analysis.[117]

115 PATHWAYS costs reported in $2012 are inflated to $2015 using the Bureau of Economic Analysis (BEA) data available at: *https://www.bea.gov/iTable/iTable.cfm?ReqID=9#reqid=9&step=1&isuri=1&903=4*.

116 Information on the end use sectors are available in the California PATHWAYS documentation available at: *www.arb.ca.gov/cc/scopingplan/scopingplan.htm*.

117 The Cap-and-Trade allowance price range is based on the Cap-and-Trade Regulation approved by the Office of Administrative

Table 13: Estimated Range of Cap-and-Trade Allowance Price 2021–2030*

($2015)	2021	2025	2030
C+T Floor Price	$16.2	$19.7	$25.2
C+T Reserve Price	$72.9	$76.4	$81.9

* Based on current regulation in effect October 1, 2017

Uncertainty in the GHG reduction potential of prescriptive measures in the Scoping Plan can affect the cost of achieving the 2030 target. The aggregate emissions cap of the Cap-and-Trade Program ensures that the 2030 target will be met–irrespective of the GHG emissions realized through prescriptive measures. If GHG reductions anticipated under prescriptive measures do not materialize, the Cap-and-Trade Program will be responsible for a larger share of emissions reductions. Under that scenario, the demand for Cap-and-Trade allowances may rise, resulting in an increase in allowance price. While the Cap-and-Trade allowance price may rise, it is highly unlikely that it will rise above the C+T Reserve price, given the program design. If prescriptive measures deliver anticipated GHG reductions, demand for allowances will be low, depressing the price of allowances. However, the C+T Floor Price represents the lowest price at which allowances can be sold at auction.

Table 14 presents the estimated direct cost estimates for GHG reductions achieved through the Cap-and-Trade Program in 2030. These costs represent the lower and upper bounds of the cost of reducing GHG emissions to achieve the SB 32 target under the Scoping Plan. The estimated direct costs range from $1.6 to $5.1 billion dollars (in $2015), depending on the allowance price in 2030. This range highlights the allowance price uncertainty that is a trade-off to the GHG reduction certainty provided by the Cap-and-Trade Program. The estimated cost of GHG reductions is calculated by multiplying the allowance price by the GHG emissions reductions required to achieve the SB 32 target.

Sensitivity Analysis

In addition to uncertainty in the Cap-and-Trade allowance price and uncertainty in the GHG reductions achieved through the prescriptive measures, there is uncertainty in the GHG emissions that will occur under the Reference Scenario, as presented in Figure 6. There is also uncertainty in costs embedded within the Reference Scenario including the price of oil, other energy costs, and technology costs.

The PATHWAYS incremental cost results are also sensitive to the fossil fuel price assumptions. Altering the fuel price trajectory in the Reference Scenario directly impacts the incremental cost of achieving GHG reductions in the Scoping Plan, as the costs of the Scoping Plan are relative to the Reference Scenario.[118]

The PATHWAYS scenarios use fossil fuel price projections from the Annual Energy Outlook (AEO) 2015 reference case.[119] To estimate the impact of changes in future fuel prices on the estimated incremental cost of the Scoping Plan two sensitivities were conducted. In the low fuel price sensitivity, the AEO low oil and natural gas price case is used to project the future cost of fuels in the Reference Scenario. The cost of the Scoping Plan, relative to the Reference Scenario, increases under these conditions, since fuel savings are less valuable when fuel prices are low. A second sensitivity shows that high future oil and natural gas prices (as projected in the AEO high oil price case) reduce the net cost of the Scoping Plan, relative to the Reference Scenario. This is because avoided fuel savings are more valuable when fuel prices are high. Table 14 outlines the costs and savings from the Scoping Plan (both prescriptive measures and cap-and-trade) under the high and low fuel price sensitivities.

The price of oil and natural gas affects the value of fuel savings (as presented in Table 12), which are estimated to be significant using AEO reference oil and natural gas prices. Under the low fuel price sensitivity,

Law on September 18, 2017. Documentation is available at: *www.arb.ca.gov/regact/2016/capandtrade16/capandtrade16.htm*

118 In addition to the fuel cost sensitivities presented in this section, Appendix E includes an uncertainty analysis of the Scoping Plan Scenario and alternatives. This analysis addresses uncertainty in the Reference Scenario emissions, GHG reductions from each measure, as well as capital and fuel costs.

119 The high and low fuel price sensitivity ranges are derived from differences between the AEO 2016 High Oil Price or Low Oil Price forecast and the AEO 2016 reference case, and are applied as ratios to the base case fuel price assumptions (which are based on the AEO 2015 report). The AEO 2015 report is available at: *http://www.eia.gov/outlooks/aeo/pdf/0383(2015).pdf* and the AEO 2016 report is available for download at: *http://www.eia.gov/outlooks/aeo/pdf/0383(2016).pdf*.

the net incremental cost of prescriptive measures is $2.9 billion in 2030. Under the high fuel price sensitivity, the prescriptive measures result in net *savings of* $4.9 billion in 2030. Table 14 also shows that these price uncertainties are captured within the analyzed range of allowance prices. As described above, changes in fuel prices may affect the price of Cap-and-Trade allowances, but the price is highly unlikely to go outside the range of prices bounded by the C+T Floor Price and C+T Reserve Price. The final column in Table 14 presents the estimated direct cost of the Scoping Plan, including both the prescriptive measures and a range of estimated costs to achieve GHG reductions under the Cap-and-Trade Program for varying projections of future fuel prices. The total cost, reflecting fuel and allowance price uncertainty, ranges from an annual savings to California of $3.3 billion to an annual cost of $8.0 billion in 2030. The net climate benefits, as estimated by the SC-CO_2 and SC-CH_4, outweigh these direct costs.[120]

Table 14: Estimates of Direct Cost and Climate Benefits in 2030 Relative to the Reference Scenario and Including Fuel Price Sensitivity (Billion $2015)

Scenario	Prescriptive Measures	C+T Floor Price	C+T Reserve Price	2030 Total Cost
Scoping Plan	$0.1	$1.6	$5.1	$1.7 to $5.2
Low Fuel Price Sensitivity	$2.9	$1.6	$5.1	$4.5 to $8.0
High Fuel Price Sensitivity	-$4.9	$1.6	$5.1	-$3.3 to -$0.2

Fuel price sensitivity is directly modeled in PATHWAYS, resulting in a range of impacts from prescriptive measures. The range of costs labeled "2030 Total Cost" includes the cost of prescriptive measures estimated in PATHWAYS and the impact of the Cap and-Trade Program calculated at the C+T Floor Price (the lower bounds) and the C+T Reserve Price (the upper bounds).
The social cost of GHGs estimated range in 2030 is $1.9 to $11.2 billion.

Macroeconomic Impacts

The macroeconomic impacts of the Scoping Plan are estimated using the REMI model. Annual capital and fuel costs (for example, the costs in Table 12) are estimated using PATHWAYS and input into the REMI model to estimate the impact of the Scoping Plan on the California economy each year relative to GDP, which is often used as a proxy for economic growth, as well as employment, personal income, and changes in output by sector and consumer spending. Table 15 presents key macroeconomic impacts of implementing the Scoping Plan, based on the range of anticipated allowance prices. In 2030, under the Scoping Plan, growth across the indicators is about one-half of one percent less than the Reference Scenario. The results in Table 15 include not only the estimated direct cost of the Cap-and-Trade Program, but also distribution of allowance value from the auction of Cap-and-Trade allowances to California and consumers. See Appendix E for more detail on the modeling of the return of allowance value under the Cap-and-Trade Program in REMI.

The Cap-and-Trade Program is modeled in REMI as an increase in production cost to sectors based on estimated future GHG emissions and anticipated free allowance allocation. If a sector is expected to receive free allocation of allowances, the value of those free allowances is not modeled as a cost in REMI. The analysis does include the estimated benefit to sectors due to the proceeds from the auction of cap-and-trade allowances and assumes that each year $2 billion of proceeds from the auction of State-owned cap-and-trade allowances are distributed to the economic sectors currently receiving GGRF appropriations. These funds work to achieve further GHG reductions in California, lower the cost to businesses of reducing GHG emissions and protect disadvantaged communities. Any auction proceeds remaining after the distribution of $2 billion through GGRF sectors are distributed evenly to consumers in California as a dividend. The estimated costs in Table 15 include the cost of the GHG reductions to sectors, as well as the benefit to those sectors when allowance proceeds are returned through the GGRF and as a dividend to consumers, as detailed in Appendix E.

120 Climate benefits are estimated using the Social Cost of Carbon in 2030 across the range of discount rates from 2.5 to 5 percent. All values are reported in $2015. Additional information on the Social Cost of Carbon is available from the National Academies of Sciences, Engineering, and Medicine at: *https://www.nap.edu/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of*.

Table 15: Macroeconomic Indicators in 2030 Under Base Fuel Price Assumptions

	Reference Scenario (2030)	Scoping Plan (2030)	Percentage Change Relative to Reference Scenario
California GDP (Billion $2015)	$3,439	$3,430 to $3,420	-0.3 percent to -0.6 percent
Employment (Thousand Jobs)	23,522	23,478 to 23,441	-0.2 percent to -0.3 percent
Personal Income (Billion $2015)	$3,010	$3,006 to $3,008	-0.1 percent to -0.1 percent

Table 15 was estimated using the REMI model. The range of costs for the Scoping Plan represents the impact of achieving the SB 32 target through prescriptive measures and the Cap-and-Trade Program at the C+T Floor Price (the lower bounds) and the C+T Reserve Price (the upper bounds).

It is important to put the results of Table 15 into context of the growing $3.4 trillion California economy in 2030. As noted earlier, the economic analysis does not include avoided social damages and other potential savings from reductions in air pollution and petroleum dependency.

Determining employment changes as a result of policies is challenging to model, due to a range of uncertainties and global trends that will influence the California economy, regardless of implementation of the Scoping Plan. The global economy is seeing a shift toward automation and mechanization, which may lead to slowing of employment across some industries globally, irrespective of California's energy and low carbon investments. In California, employment is projected to reach 23.5 million jobs in 2030. In this analysis, implementing the Scoping Plan would slow the growth of employment by less than one-half of one percent in 2030.

Estimated personal income in California is relatively unchanged under the Scoping Plan relative to the Reference Scenario. Considering the uncertainty in the modeling, modest changes in the growth of personal income are not different from zero, which suggests that meeting the SB 32 target will not change the growth of personal income relative to the Reference Scenario.

When analyzing the estimated macroeconomic impacts, it is important to remember that a major substitution of electricity and capital away from fossil fuels is anticipated to have a very small effect on California GDP, employment, and personal income–less than one percent relative to the Reference Scenario in 2030. The economic impacts indicate that shifting money and investment away from fossil fuels and to clean energy is likely to have a negligible effect on the California economy. Additionally, it is certain that innovation will continue as new technologies are developed and implemented. While this analysis projects the costs and GHG reductions of current technologies over time, it does not capture the impact of new technologies that may shift the economy and California in unanticipated ways or benefits related to changes in air pollution and improvements to human health, avoided environmental damages, and positive impacts to natural and working lands. Thus, the results of this analysis very likely underestimate the benefits of shifting to a clean energy economy.

Consumer spending also shifts in response to implementation of the Scoping Plan relative to the Reference Scenario. As presented in Table 15, there is a negligible impact to consumer income, but small changes in income can alter the distribution of consumer spending among categories. In 2030, consumer spending is lower under the Scoping Plan than in the Reference Scenario across all analyzed allowance prices. Consumers spend less on fuels, electricity, natural gas, and capital as a result of measures in the Scoping Plan that reduce demand, increase efficiency, and drive technological innovations. The estimated impact to California households is also modest in 2030. The estimated cost to California households in 2030 ranges from $115 to $280, depending on the price of reductions under the Cap-and-Trade Program.[121]

The household impact is estimated using the per-household change in personal income as modeled in REMI and utilizing household estimates from the California Department of Finance. The household impact does not account for benefits from reduced climate impacts, health savings from reduced air pollution impacts, or lower petroleum dependence costs that might impact households. Additional details are presented in Appendix E.

As modeled, the household impact of the Scoping Plan comprises approximately one percent of average household expenditures in 2030. To ensure that vulnerable populations and low-income households are not

121 Household projections are obtained from the California Department of Finance and are available at: *http://www.dof.ca.gov/Forecasting/Demographics/projections/*.

disproportionately affected by California's climate policy, CARB is taking steps to better quantify localized economic impacts and ensure that low-income households see tangible benefits from the Scoping Plan. Researchers at the University of California, Los Angeles (UCLA) are currently working on a retrospective analysis that will estimate the impacts across California communities of the implementation of AB 32, which will help identify areas of focus as 2030 measures are developed. The Cap-and-Trade Program will also continue to provide benefit to disadvantaged communities through the disbursement of GGRF funds.

The investments made in implementing the Scoping Plan will have long-term benefits and present significant opportunities for California investors and businesses, as upfront capital investments will result in long-term fuel and energy efficiency savings, the benefits of which will continue into the future. The California economy will continue to grow under the Scoping Plan, but it will grow more resilient, more sustainable, and will be well positioned to reap the long-term benefits of lower carbon investments.

Economic Modeling of Health Impacts

Health benefits associated with reductions in diesel particulate matter (DPM) and nitrogen oxides (NO_X) are monetized for inclusion in the macroeconomic modeling. The health benefits are estimated by quantifying the harmful future health effects that will be avoided by reducing human exposure to DPM and NO_X, as detailed in Appendix G, and monetized by estimating a health effect's economic value to society. As previously noted the health impacts are based on air quality benefits estimated in Table 6, which have important limitations and likely overestimate the impacts of the Scoping Plan. Additional detail on the economic modeling of health impacts, including the monetization methodology and modeling results for all Scoping Plan scenarios, is presented in Appendix E. Including the monetized health impacts in the REMI modeling has no discernible impact on the overall results. The impact of including the monetized health impacts is indiscernible relative to the impact of the Scoping Plan.

Estimating the Economic Impact on Disadvantaged Communities (DACs)

Implementing the Scoping Plan is estimated to have a small impact on the Statewide California economy through 2030. However, shifting from fossil fuels can disproportionately affect specific geographic regions whose local economies rely on fossil fuel intensive industries. These regions can also include vulnerable populations and disadvantaged communities who may be disproportionately impacted by poor air quality and climate.

The regional impacts of the Scoping Plan, including the impact to disadvantaged communities, are estimated using the REMI California County model, which represents the 58 counties and 160 sectors of the California economy. Utilizing the same inputs used for modeling the statewide impact of the Scoping Plan relative to the Reference Scenario, the California County model estimates how measures will affect employment, value added, and other economic indicators at the county level across the state.

The county-level REMI output is also used to estimate impacts on disadvantaged communities affected by the Scoping Plan by allocating county impacts proportional to their share of economic indicators unique to each census tract.[122] These indicators include industry output, industry consumption by fuel category, personal consumption, and population. The overall impact on employment across regions is not significant and there is no discernible difference in the impact to employment in disadvantaged communities. There is also no discernible impact to wages in disadvantaged communities across regions in California. Additional details on the regional modeling, including the results for the Scoping Plan and alternatives, is presented in Appendix E.

In addition to the regional modeling conducted in this analysis, there are currently three research contracts underway at CARB to quantify the impact of California's climate policy on regions and disadvantaged communities throughout California. As mentioned above, researchers from UCLA are estimating the improvements in health outcomes associated with AB 32, with a focus on disadvantaged communities. This research will be informed by input from technical advisory committees including a group focused on environmental justice.

122 Census tracts are small geographic areas within greater metropolitan areas that usually have a population between 2,500 and 8,000 persons. More information on the composition of census tracts available here: *https://www.census.gov/geo/reference/gtc/gtc_ct.html*. Disadvantaged census tracts are identified using CalEnviroScreen 2.0. Additional information is available at: *https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-version-20*.

There are also two studies currently underway to quantify the impact of GGRF funds. A UCLA contract focuses on quantifying jobs supported by GGRF funds in California, while a University of California, Berkeley contract is constructing methodologies to assess the co-benefits of GGRF projects across California. These research efforts will provide a regional analysis of the impact of and benefits to specific communities and sectors to ensure that all Californians see economic benefits, in addition to clean air benefits, from the implementing the Scoping Plan.

Public Health

Many measures to reduce GHG emissions also have significant health co-benefits that can address climate change *and* improve the health and well-being of all populations across the State. Climate change is already affecting the health of communities.[123] Climate-related health impacts can include increased heat illness and death, increases in air pollution-related exacerbation of cardiovascular and respiratory diseases, injury and loss of life due to severe storms and flooding, increased vector-borne and water-borne diseases, and stress and mental trauma due to extreme weather-related catastrophes.[124] The urgency of action to address the impacts already being felt from a changing climate and the threats in coming decades provides a unique opportunity for California's leadership in climate action to reduce GHG emissions and create healthy, equitable, and resilient communities where all people thrive. This section discusses the link between climate change and public health. It does not analyze the specific measures included in the strategy but provides context for assessing the potential measures and scenarios.

Achieving Health Equity through Climate Action

Many populations in California face *health inequities,* or unfair and unjust health differences between population groups that are systemic and avoidable.[125] Differences in environmental and socioeconomic determinants of health result in these health inequities. Those facing the greatest health inequities include low-income individuals and households, the very young and the very old, communities of color, and those who have been marginalized or discriminated against based on gender or race/ethnicity.[126] It is these very same populations, along with those suffering existing health conditions and certain populations of workers (e.g., outdoor workers), that climate change will most disproportionately impact.[127] The inequitable distribution of social, political, and economic power results in health inequities, while perpetuating systems (e.g., economic, transportation, land use, etc.) that drive GHG emissions. As a result, communities face inequitable living conditions. For example, low-income communities of color tend to live in more polluted areas and face climate change impacts that can compound and exacerbate existing sensitivities and vulnerabilities.[128,129] Fair and healthy climate action requires that the inequities creating and intensifying community vulnerabilities be addressed. Living conditions and the forces that shape them, such as income, education, housing, transportation, environmental quality, and access to services, significantly drive the capacity for climate resilience. Thus, strategies such as alleviating poverty, increasing access to opportunity, improving living conditions, and reducing health and social inequities will result in more climate-resilient communities. In fact, there are already many "no-regret" climate mitigation and adaptation measures available (discussed below) that can reduce health burdens, increase community resilience, and address social inequities.[130] Focusing efforts to achieve health equity can thus lead to significant progress in addressing human-caused climate change.

123 USGCRP. 2016. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Crimmins, A., J. Balbus, J. L. Gamble, C. B. Beard, J. E. Bell, D. Dodgen, R. J. Eisen, N. Fann, M. D. Hawkins, S. C. Herring, L. Jantarasami, D. M. Mills, S. Saha, M. C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, Washington, D.C., 312 pp.

124 Ibid.

125 Whitehead, M. 1992. "The concepts and principles of equity and health." International Journal of Health Services 22(3), 429–445.

126 California Department of Public Health (CDPH). 2015. The Portrait of Promise: The California Statewide Plan to Promote Health and Mental Health Equity. A Report to the Legislature and the People of California by the Office of Health Equity. Sacramento, CA: California Department of Public Health, Office of Health Equity.

127 Shonkoff, S., R. Morello-Frosch, M. Pastor, and J. Sadd. 2011. "The climate gap: Environmental health and equity implications of climate change and mitigation policies in California–a review of the literature." Climatic Change 109 (Suppl 1):S485–S503.

128 Ibid.

129 Rudolph, L. and S. Gould. 2015. "Climate change and health inequities: A framework for action." Annals of Global Health 81:3, 432–444.

130 Watts N, Adger WN, Agnolucci P, et al. 2015. Health and climate change: policy responses to protect public health. Lancet: 386, 1861-1914

Potential Health Impacts of Climate Change Mitigation Measures

Socioeconomic Factors: Income, Poverty, and Wealth

Economic factors, such as income, poverty, and wealth, are collectively one of the largest determinants of health. As such, climate mitigation measures that yield economic benefits can improve population health significantly, especially if the economic benefits are directed to those most vulnerable and disadvantaged (including those living in poverty) who often face the most health challenges. From the poorest to richest ends of the income spectrum, higher income is associated with greater longevity in the United States.[131,132,133] The gap in life expectancy between the richest 1 percent and poorest 1 percent of Americans was almost 15 years for men in 2014, and about 10 years for women.[134] Early death among those living in poverty is not a result of those with higher incomes having better access to quality health care.[135] Only about 10-20 percent of a person's health status is accounted for by health care (and 20-30 percent attributed to genetics), while the remainder is attributed to the social determinants of health. These include environmental quality, social and economic circumstances, and the social, media, policy, economic, retail, and built environments– all of which in turn shape stress levels and behaviors, including smoking, diet, and exercise.[136,137,138,139,140,141,142,143,144,145,146] In fact, where people live, work, learn, and play is often a stronger predictor of life expectancy than their genetic and biological makeup.[147] The World Health Organization's Commission on the Social Determinants of Health concluded that the poor health of poor people, and the social gradient in health, are caused by the unequal distribution of power, income, goods, and services resulting from poor social policies and programs, unfair economic arrangements, and bad politics.[148] Thus, improving the conditions of daily life and tackling the inequitable distribution of power, money, and resources can remedy inequitable health outcomes.[149] Simply put, the more evenly distributed the wealth, the healthier a society is.[150]

The wealth-health gradient has significant implications for this Scoping Plan. State climate legislation and policies require prioritizing GHG reduction strategies that serve vulnerable populations and improve well-being for disadvantaged communities. As such, strategies that improve the financial security of communities facing disadvantages while reducing GHG emissions are win-win strategies. These include providing funds or services for GHG reduction programs (e.g., weatherization, energy efficiency, renewable energy, ZEVs, transit, housing, and others) to low-income individuals and households to help them reduce costs. Among the poorest 25 percent of people, per capita government expenditures are strongly associated with longer

131 Chetty, R., M. Stepner, S. Abraham, et al. 2016. "The Association Between Income and Life Expectancy in the United States, 2001–2014." JAMA Published online April 10, 2016. doi:10.1001/jama.2016.4226.

132 Marmot, M., S. Friel, R. Bell, et al. 2008. "Closing the gap in a generation: Health equity through action on the social determinants of health." The Lancet 372, 9650: 1661–1669.

133 Woolf, S. H., and P. Braveman. 2011. "Where health disparities begin: The role of social and economic determinants–and why current policies may make matters worse." Health Affairs (Millwood) 30(10), 1852–1859.

134 Chetty R, Stepner M, Abraham S, et al. 2016. The Association between Income and Life Expectancy in the United States, 2001-2014. JAMA. Published online April 10, 2016. doi:10.1001/jama.2016.4226

135 Ibid.

136 DHHS, Public Health Service. 1980. Ten leading causes of death in the United States. Atlanta, GA: Bureau of State Services.

137 McGinnis, J., and W. Foege. 1993. "Actual causes of death in the United States." JAMA 270(18), 2207–2212.

138 Lantz, P. et al. 1998. "Socioeconomic factors, health behaviors, and mortality: Results from a nationally representative prospective study of US adults." JAMA 279(21), 1703–1708.

139 McGinnis, J. et al. 2002. "The case for more active policy attention to health promotion." Health Affairs 21(2), 78–93.

140 Mokdad, A. et al. 2004. "Actual causes of death in the United States, 2000." JAMA 291(10), 1238–1245.

141 Danaei, G. et al. 2009. "The preventable causes of death in the United States: Comparative risk assessment of dietary, lifestyle, and metabolic risk factors." PLoS Medicine 6(4), e1000058.

142 World Health Organization (WHO). 2009. Global health risks: Mortality and burden of disease attributable to selected major risks. Geneva: WHO.

143 Booske, B. et al. 2010. Different perspectives for assigning weights to determinants of health. County Health Rankings Working Paper. Madison, WI: University of Wisconsin Population Health Institute.

144 Stringhini, S. et al. 2010. "Association of socioeconomic position with health behaviors and mortality." JAMA 303(12), 1159–1166.

145 Thoits, P. 2010. "Stress and health: Major findings and policy implications." *Journal of Health and Social Behavior* 51 Suppl, S41–53.

146 McGovern, L., G. Miller and P. Highes-Cromwick. 2014. "Health policy brief: The relative contribution of multiple determinants to health outcomes." Health Affairs

147 Iton, A. 2006. Tackling the root causes of health disparities through community capacity building. In: Hofrichter R, ed. Tackling Health Inequities Through Public Health Practice: A Handbook for Action. Washington, D.C., and Lansing, MI: National Association of County and City Health Officials and Ingham County Health Department; 116–136.

148 Marmot M, Friel S, Bell R, et al. 2008. Closing the gap in a generation: health equity through action on the social determinants of health. The Lancet , Volume 372 , Issue 9650, 1661 – 1669

149 Ibid.

150 Smith, R. 1996. "The big idea." British Medical Journal 312:April 20th, Editor's choice.

life spans.[151] Successful strategies California has already implemented to assure the poor do not pay higher costs for societal GHG reductions include low-income energy discount programs, in combination with direct climate credits, and policies and programs that help Californians reduce electricity, natural gas, and gasoline consumption.[152] More such strategies could be pursued. To tackle the inequitable distribution of power that leads to disparate health outcomes, agencies can first assure their hearing and decision-making processes provide opportunities for civic engagement so people facing health inequities can themselves participate in decision-making about solutions. Whether it is absolute poverty or relative deprivation that leads to poor health, investments and policies that both lift up the poor and reduce wealth disparities will address the multiple problems of climate change mitigation, adaptation, and health inequities.

Employment

Employment status impacts human health in many ways. Poor health outcomes of unemployment include premature death, self-rated ill-health (a strong predictor of poor health outcomes), and mental illness.[153,154,155,156] Economic strain related to unemployment can impact mental health and trigger stress that is linked to other health conditions.[157,158] Populations of color are overrepresented in the unemployment and under-employment ranks, which likely contributes to racial health inequities. In 2014, 14.7 percent of African-Americans, 12.1 percent of American Indians and Alaska Natives, and 9.8 percent of Latinos were unemployed, compared to 7.9 percent of Whites.[159] In addition to providing income, the work experience has health consequences. There is a *work status–health gradient* similar to the wealth–health gradient. Workers with lower occupational status have a higher risk of death,[160] increased blood pressure,[161] and more heart attacks.[162,163] Higher status workers often have a greater sense of autonomy, control over their work, and predictability, compared to lower status workers, whose lack of control and predictability translates to stress that shortens their lives.[164] Nonstandard working arrangements such as part-time, seasonal, shift, contract, or informal sector work have been linked to greater psychological distress and poorer physical health.[165,166] Women are heavily overrepresented in nonstandard work, as are people of color and people with low levels of education.[167,168]

The implementation of California's climate change goals provides great opportunity to not only improve the habitability of the planet, but also to increase economic vitality, employ historically disadvantaged people

151 Chetty R, Stepner M, Abraham S, et al. 2016. The Association between Income and Life Expectancy in the United States, 2001-2014. JAMA. Published online April 10, 2016. doi:10.1001/jama.2016.4226

152 Gattaciecca, J., C. Callahan, and J. R. DeShazo. 2016. Protecting the most vulnerable: A financial analysis of Cap-and-Trade's impact on households in disadvantaged communities across California. UCLA Luskin School of Public Affairs: Los Angeles, CA. *http://innovation.luskin.ucla.edu/content/protecting-most-vulnerable*. Accessed April 22, 2016.

153 Krueger, P., and S. Burgard. 2011. Income, occupations and work. In: Rogers R, Crimmins E, eds. International Handbook of Adult Mortality. New York: Springer: 263–288.

154 Rogers, R., R. Hummer, and C. Nam. 2000. Living and Dying in the USA. Behavioral, health, and social differentials of adult mortality. New York, NY: Academic.

155 Ross, C. and J. Mirowsky. 1995. "Does employment affect health?" Journal of Health and Social Behavior 36(3):230–243.

156 Burgard, S., and K. Lin. 2013. "Bad jobs, bad health? How work and working conditions contribute to health disparities." Am Behav Sci 57(8).

157 Price, R., D. Friedland, J. Choi, and R. Caplan. 1998. Job-loss and work transitions in a time of global economic change.

158 Price, R., J. Choi, and A. Vinokur. 2002. "Links in the chain of adversity following job loss: How financial strain and loss of personal control lead to depression, impaired functioning, and poor health." Journal of Occupational Health Psychology 7(4), 302.

159 U.S. Census Bureau. 2014. American Community Survey 1-Year Estimates. *http://www2.census.gov/programs-surveys/acs/summary_file/2014/data/*. Last updated August 31, 2015. Accessed April 20, 2016.

160 Rogers R, Hummer R, and Nam C. 2000. Living and Dying in the USA. Behavioral, health, and social differentials of adult mortality. New York, NY: Academic

161 Colhoun, H., H. Hemingway, and N. Poulter. 1998. "Socio-economic status and blood pressure: An overview analysis." Journal of Human Hypertension 12(2).

162 Möller, J., T. Theorell, U. De Faire, A. Ahlbom, and J. Hallqvist. 2005. "Work related stressful life events and the risk of myocardial infarction. Case-control and case-crossover analyses within the Stockholm heart epidemiology programme (SHEEP)." Journal of Epidemiology and Community Health 59(1), 23–30.

163 Burgard S, Lin K. 2013. Bad jobs, bad health? How work and working conditions contribute to health disparities. Am Behav Sci: 57(8).

164 Marmot, M., G. Rose, M. Shipley, and P. Hamilton. 1978. "Employment grade and coronary heart disease in British civil servants." Journal of Epidemiology and Community Health 32(4), 244–249.

165 Dooley, D., and J. Prause. 2004. Settling down: Psychological depression and underemployment. The social costs of underemployment, 134-157. In: Dooley, D. and J. Prause. The Social Costs of Underemployment: Inadequate Employment as Disguised Unemployment.

166 Virtanen, M., M. Kivimäki, M. Joensuu, P. Virtanen, M. Elovainio, and J. Vahtera. 2005. "Temporary employment and health: A review." International Journal of Epidemiology 34(3): 610–622.

167 Nollen, S. 1996. "Negative aspects of temporary employment." Journal of Labor Research 17(4): 567–582.

168 Burgard S, Lin K. 2013. Bad jobs, bad health? How work and working conditions contribute to health disparities. Am Behav Sci: 57(8)

in secure jobs, and improve the health of the population. Measures in the Scoping Plan that aim to reduce GHGs can simultaneously improve health and social equity by prioritizing or requiring that: (1) infrastructure projects using public funds pay living wages, provide quality benefits to all employees, and minimize nonstandard work; (2) locals are hired as much as is feasible; (3) preference is given for women-owned and minority-owned businesses; (4) employers receiving public funds assess and reduce work stress and lack of workplace control; (5) projects benefiting from State climate investments prioritize hiring from historically hard-to-employ groups, such as youth (especially youth of color), formerly incarcerated people, and people with physical or mental illness; and (6) training is provided to these same groups to work in jobs in sectors that will support a sustainable economy.

Communications Supporting Climate Change Behaviors and Policies

California's leadership on GHG reductions is exceptional. However, climate mitigation goals are often treated independently by sector, and the public does not see a unified message that changes must take place on every level in every sector to preserve human health and well-being. Climate strategy could be supported by public communications campaigns that link sectors and present a message of the need for bold action, along with the benefits that action can yield. Mass media communications and social marketing campaigns can help shift social and cultural norms toward sustainable and healthy practices. Messaging about the co-benefits of climate change policies in improving health and well-being can lead to increased community and decision-maker support among vulnerable groups for policies and measures outlined in the Scoping Plan.

Community Engagement Leads to Robust, Lasting, and Effective Climate Policies

For California's climate change policies to be supported by the public and be implemented with enthusiasm, they must be developed through ample, genuine opportunities for community members to discuss and provide input. Californians' contributions to the policy arena strengthen the end products and assist in their implementation and enforcement.

Efforts to mitigate climate change through policy, environmental, and systems change present considerable opportunities to promote sustainable, healthy, resilient, and equitable communities. The measures in the Scoping Plan, and the way they are implemented, can help create living conditions that facilitate physical activity; encourage public transit use; provide access to affordable, fresh, and nutritious foods; protect the natural systems on which human health depends; spur economic development; provide safe, affordable, and energy-efficient housing; enable access to jobs; and increase social cohesion and civic engagement. These climate change mitigation measures can improve overall population health, as well as material conditions, access to opportunity, and health and well-being in communities facing health inequities. Approaching the policy solutions outlined in the Scoping Plan with a health and equity lens can ultimately help lead to a California in which all current and future generations of Californians can benefit and thrive.

Environmental Analysis

CARB, as the lead agency, prepared a Draft Environmental Analysis (Draft EA) in accordance with the requirements of the California Environmental Quality Act (CEQA) and CARB's regulatory program (CARB's program has been certified as complying with CEQA by the Secretary of Natural Resources; see California Code of Regulation, title 17, sections 60006-60008; California Code of Regulation, title 14, section 15251, subdivision (d)). The resource areas from the CEQA Guidelines Environmental Checklist were used as a framework for a programmatic environmental analysis of the reasonably foreseeable compliance responses resulting from implementation of the measures proposed in the Scoping Plan to achieve the 2030 target. Following circulation of the Draft EA for an 80-day public review and comment period (January 20, 2017 through April 10, 2017), CARB prepared the Final Environmental Analysis Prepared for the Proposed Strategy for Achieving California's 2030 Greenhouse Gas Target (Final EA), which includes minor revisions to the Draft EA, and the Response to Comments on the Draft Environmental Analysis prepared for the Proposed Strategy for Achieving California's 2030 Greenhouse Gas Target (RTC). The Final EA is included as Appendix F to the 2017 Scoping Plan. The Final EA and RTC were posted on CARB's Scoping Plan webpage before the Board hearing in December 2017.

The Final EA provides a programmatic level of analysis of the adverse environmental impacts that are reasonably foreseeable as resulting from implementation of the proposed Scoping Plan measures; feasible mitigation measures; a cumulative impacts analysis and an alternatives analysis.

Collectively, the Final EA concluded that implementation of these actions could result in the following short-term and long-term beneficial and adverse environmental impacts:

- Beneficial long-term impacts to air quality, energy demand and greenhouse gas emissions.
- Less than significant impacts to energy demand, resources related to land use planning, mineral resources, population and housing, public services, and recreational services.
- Potentially significant and unavoidable adverse impacts to aesthetics, agriculture and forest resources, air quality, biological resources, cultural resources, geology and soils, hazards and hazardous materials, hydrology and water quality, resources related to land use planning, noise, recreational services, transportation/traffic, and utilities and service systems.

The potentially significant and unavoidable adverse impacts are disclosed for both short-term construction-related activities and long-term operational activities, which explains why some resource areas are identified above as having both less-than-significant impacts and potentially significant impacts. For a summary of impacts, please refer to the table in Attachment B to the Final EA.

Key Sectors

Climate change mitigation policies must be considered in the context of the sector's contribution to the State's total GHGs, while also considering any co-benefits for criteria pollutant and toxic air contaminant reductions. The transportation, electricity (in-state and imported), and industrial sectors are the largest contributors to the GHG inventory and present the largest opportunities for GHG reductions. However, to ensure decarbonization across the entire economy and to meet our 2030 GHG target, policies must be considered for all sectors. Policies that support energy efficiency, alternative fuels, and renewable power also can provide co-benefits for both criteria and toxic air pollutants.

The specific policies identified in this Scoping Plan are subject to additional analytical and public processes to refine the requirements and methods of implementation. For example, a change in the LCFS Carbon Intensity (CI) target would only take effect after a subsequent rulemaking for that regulation, which would include its own public process and environmental, economic, and public health analyses. As described in Chapter 2, many policies for reducing emissions toward the 2030 target are already known. This Scoping Plan identifies these and additional policies or program enhancements needed to achieve the remaining GHG reductions in a complementary, flexible, and cost-effective manner to meet the 2030 target. These policies should continue to encourage reductions beyond 2030 to keep us on track to stabilize the climate. Policies that ensure economy-wide investment decisions that incorporate consideration of GHG emissions are particularly important.

As we pursue GHG reduction targets, we must acknowledge the integrated nature of our built and natural environments, and cross-sector impacts of policy choices. The State's Green Buildings Strategy is one such example of this type of integrated approach. Buildings have tremendous cross-sector interactions that influence our health and well-being and affect land use and transportation patterns, energy use, water use, communities, and the indoor and outdoor environment. Green building regulations and programs offer complementary opportunities to address the direct and indirect effects of buildings on the environment by incorporating strategies to minimize overall energy use, water use, waste generation, and transportation impacts. The Governor's Green Buildings Executive Order B-18-12 for State buildings and the California Green Building Standards (CALGreen) Code[169] are key state initiatives supporting emissions reductions associated with buildings. Local governments are taking action by adopting "beyond code" green building standards. Additional efforts to maintain and operate existing buildings as third-party certified green buildings provides a significant opportunity to reduce GHG emissions associated with buildings. These foundational regulations and programs for reducing building-related emissions are described in more detail in Appendix H. Looking forward, there is a need to establish a path toward transitioning to zero net carbon buildings[170], which will be the next generation of buildings that can contribute significantly to achieving long-term climate goals. A discussion of how the green buildings strategy can support GHG reductions to help meet the 2030 target is provided in Appendix I. Recent research activities have provided results to better quantify GHG emissions reductions of green buildings, and additional research activities need to continue to expand their focus to support technical feasibility evaluations and implementation. Research needs related to green buildings are included in Appendix I.

Further, each of the policies directed at the built environment must be considered in the broader context of the high-level goals for other sectors, including the natural and working lands sector. For example, policies that support natural and working lands can reduce emissions and sequester carbon, while also providing ecosystem benefits such as better water quality, increased water yield, soil health, reduced erosion, and

169 The authority to update and implement the CALGreen Code is the responsibility of several State agencies identified in California Building Standards Law.

170 A zero carbon building generates zero or near zero GHG emissions over the course of a year from all GHG emission sources associated, directly and indirectly, with the use and occupancy of the building (initial definition included in the May 2014 *First Update to the Climate Change Scoping Plan*).

habitat connectivity. These policies and co-benefits will be considered as part of the integrated strategy outlined above. Table 16 provides examples of the cross-sector interactions between and among the main sectors analyzed for the Scoping Plan that are discussed in this chapter (Energy, Transportation, Industry, Water, Waste Management, and Natural and Working Lands, including agricultural lands).

This chapter recognizes these interactions and relates these broad strategic options to the specific additional programs recommended in Chapter 2 of this document. Accordingly, Chapter 4 provides an overview of each sector's contributions to the State's GHG emissions, a description of both ongoing and proposed programs and policies to meet the 2030 target, and additional climate policy or actions that could be considered in the future. The wide array of complementary and supporting measures being contemplated or undertaken across State government are detailed here. The broad view of State action described in this chapter thus provides context for the narrower set of measures discussed in detail in Chapter 2 of this Scoping Plan. It is these measures in Chapter 2 that CARB staff has identified as specific actions to meet the 2030 target in SB 32.

The following phrases have specific meanings in this discussion of the policy landscape: "Ongoing and Proposed Measures" refers to programs and policies that are either ongoing existing efforts, or efforts required by statute, or which are otherwise underway or about to begin. These measures include, but are not limited to, those identified as necessary specific actions to meet the 2030 GHG target, and which are set apart and described in greater detail in Chapter 2. "Sector Measures" listed also include cross-cutting measures that affect many entities in the sector; some of these are also identified in Chapter 2. "Potential Additional Actions" are not being proposed as part of the specific strategy to achieve the 2030 target in this Scoping Plan. This Scoping Plan includes this broader, comprehensive, review of these measures because it aims to spur thinking and exploration of innovative new technologies and polices that may help the State achieve its long-term climate goals. Some of these items may not ever be formally proposed, but they are included here because CARB, other agencies, and stakeholders believe their potential should be explored with stakeholders in coming years.

Table 16: Cross-Sector Relationships

Sector	Example Interactions with Other Sectors
Energy	• Hydroelectric power, cooling, cleaning, waste water treatment plant (WWTP) bioenergy • Vehicle-to-grid power; electricity supply to vehicle charging infrastructure • Biomass feedstock for bioenergy, land for utility-scale renewable energy (solar, wind) • Agricultural waste and manure feedstocks for bioenergy/biofuels • Organic waste for bioenergy
Transportation	• Electric vehicles, natural gas vehicles, transit/rail; more compact development patterns that reduce vehicle miles traveled (VMT) also demand less energy per capita • More compact development patterns that reduce VMT also demand less water per capita and reduce conversion of natural and working lands • Reducing VMT also reduces energy demands necessary for producing and distributing fuels and vehicles and construction and maintenance of roads • Biomass feedstock for biofuels • Agricultural waste and manure feedstocks for biofuels • Organic waste for biofuels • Greenfield suburban development on natural and working lands leads to increased VMT
Industry	• Potential to electrify fossil natural gas equipment, substitution of fossil-based energy with renewable energy • Greenfield urban development impacts
Water	• Energy consumption for water pumping, treatment, heating; resource for cooling, cleaning; WWTP bioenergy • Use of compost to help with water retention / conservation / drought mitigation • Land conservation results in healthier watersheds by reducing polluted runoff, allowing groundwater recharge, and maintaining properly functioning ecosystems
Waste Management	• Composting, anaerobic digestion, and wastewater treatment plant capacity to help process organic waste diverted from landfills • Compost for carbon sequestration, erosion control in fire-ravaged lands, water conservation, and healthy soils • Replacing virgin materials with recycled materials associated with goods production; enhanced producer responsibility reduces energy impacts of consumption • Efficient packaging materials reduces energy consumption and transportation fuel use
Agriculture	• Crop production, manure management; WWTP biosolids for soil amendments • Agricultural waste and manure feedstocks for bioenergy • Compost production in support of Healthy Soils Initiative
Natural and Working Lands	• Healthy forestlands provide wood and other forest products • Restoring coastal and sub-tidal areas improves habitat for commercial and other fisheries • Sustainable management can provide biomass for electricity • Sustainable management can provide biomass for biofuels • Resilient natural and working lands provide habitat for species and functions to store water, recharge groundwater, naturally purify water, and moderate flooding. Forests are also a source of compost and other soil amendments. • Conservation and land protections help reduce VMT and increase stable carbon pools in soils and above-ground biomass

Low Carbon Energy

The energy sector in California is composed of electricity and natural gas infrastructure, which brings electricity and natural gas to homes, businesses, and industry. This vast system is critical to California's economy and public well-being, and pivotal to reducing its GHG emissions.

Historically, power plants generated electricity largely by combusting fossil fuels. In the 1970s and early 1980s, a significant portion of California's power supply came from coal and petroleum resources. To reduce air pollution and promote fuel diversity, the State has shifted away from these resources to natural gas, renewable energy, and energy efficiency programs, resulting in significant GHG emissions reductions. Emissions from the electricity sector are currently approximately 20 percent below 1990 levels and are well on their way to achieving deeper emissions cuts by 2030. Since 2008, renewable generation has almost doubled, coal generation has been reduced by more than half, and GHG emissions have been reduced by a quarter.

Carbon dioxide is the primary GHG associated with electricity and natural gas systems. The electricity sector, which is composed of in-State generation and imported power to serve California load, has made great strides to help California achieve its climate change objectives. Renewable energy has shown tremendous growth, with capacity from solar, wind, geothermal, small hydropower, and biomass power plants growing from 6,600 megawatts (MW) in 2010 to 27,500 MW as of June 2017.[171]

Renewable energy adoption in California has been promoted through the RPS and several funding mechanisms, such as the California Solar Initiative (CSI) programs, Self-Generation Incentive Program (SGIP), Net-Energy Metering (NEM), and federal tax credits. These mandates and incentives have spurred both utility-scale and small-scale customer-developed renewable energy projects. SB 350 increased the RPS requirement from 33 percent by 2020 to 50 percent by 2030.

SB 350 requires publicly-owned utilities under the jurisdiction of the California Energy Commission (CEC) and all load-serving entities under the jurisdiction of the California Public Utilities Commission (CPUC) to file integrated resource plans (IRPs) with the CEC and CPUC, respectively. Through their IRPs, filing entities will demonstrate how they will plan to meet the electricity sector's share of the State's 2030 GHG reduction target while ensuring reliability in a cost-effective manner. The CEC and CPUC have developed the guidelines that publicly-owned utilities and load-serving entities will follow to prepare and submit IRPs, and CARB is working collaboratively with CEC and CPUC to set the sector and utility and load-serving entity planning targets. The Scoping Plan provides information to help establish the range of GHG reductions required for the electricity sector, and those numbers will be translated into planning target ranges in the IRP process. The IRP processes as currently proposed by CEC and CPUC staff will grant publicly-owned utilities flexibility to determine the optimal way to reduce GHG emissions, and load serving entities some flexibility to achieve the electricity sector's share of the 2030 goal. The CPUC has developed a Reference System Plan to help guide investment, resource acquisition, and programmatic decisions to reach the State's policy goals, in addition to informing the development of individual load serving entities' IRPs.

Energy efficiency is another key component to reducing energy sector GHG emissions, and is another consideration in each agency's IRP process. Utilities have been offering energy efficiency programs, such as incentives, to California customers for decades, and CEC has continually updated building and appliance standards. In the context of IRPs, utility-ratepayer-funded energy efficiency programs will likely continue to play an important role in reducing GHG emissions in the electricity sector.

SB 350 requires CEC and CPUC to establish annual targets for statewide energy efficiency savings and demand reduction that will achieve a cumulative doubling of statewide energy efficiency savings in electricity and natural gas end uses by 2030. These targets can be achieved through appliance and building energy efficiency standards; utility incentive, rebate, and technical assistance programs; third-party delivered energy efficiency programs; and other programs. Achieving greater efficiency savings in existing buildings, as directed by Governor Brown in his 2015 inaugural speech, will be essential to meet the goal of doubling energy efficiency savings. In September 2015, CEC adopted the Existing Buildings Energy Efficiency Action Draft Plan, which is designed to provide foundational support and strategies to enable scaling of energy efficiency in the built environment. Pursuant to SB 350, CEC published an updated Existing Buildings Energy Efficiency Action Plan prior to January 2017. More than $10 billion in private capital investment will be needed

171 California Energy Commission. August, 2017. Tracking Progress. Renewable Energy – Overview. *http://www.energy.ca.gov/renewables/tracking_progress/documents/renewable.pdf*

to double statewide efficiency savings in California.[172] Energy efficiency programs are one part of the broader green buildings strategy, which incorporates additional measures to minimize water use, waste generation, and transportation impacts. The green buildings strategy is described in further detail in Appendix I.

Heating fuels used for activities such as space and water heating in the residential, commercial, and industrial sectors represent a significant source of GHG emissions. Transitioning to cleaner heating fuels is part of the solution of achieving greater efficiency savings in existing buildings and has significant GHG emissions reductions potential. Examples of this transition can include use of renewable gas and solar thermal, as well as electrification of end uses in residential, commercial, and industrial sectors. However, achieving significant GHG emissions reductions can only be achieved by decarbonizing the electricity sector – switching from natural gas end uses to electricity generated by burning natural gas would not be effective. Electrification can complement renewables and energy storage if implemented in an integrated, optimized manner. Other hurdles that will have to be overcome include electric equipment performance across all California climate regions, seasonal variations of renewable generation, cost-effectiveness, and consumer acceptance of different heating fuel options.

Fossil-fuel-based natural gas is a significant fuel source for both in-State electricity generation and electricity imported into California. It is also used in transportation applications and in residential, commercial, industrial, and agricultural sector end uses. Greenhouse gas emissions from combustion of fossil natural gas decreased from 134.71 $MMTCO_2e$ in 2000 to 126.98 $MMTCO_2e$ in 2015, while natural gas pipeline fugitive emissions were estimated to be 4.0 $MMTCO_2e$ in 2015 and have been nearly unchanged since 2000.[173] Greenhouse gas-reduction strategies should focus on efficiency, reducing leakage from wells and pipelines, implementing the SLCP strategy, and studying the potential for renewable gas fuel switching (e.g., renewable hydrogen blended with methane or biomethane).

Moving forward, reducing use of fossil natural gas wherever possible will be critical to achieving the State's long-term climate goals. For end uses that must continue to rely on natural gas, renewable natural gas could play an important role. Renewable natural gas volume has been increasing from approximately 1.5 million diesel gallon equivalent (dge) in 2011 to more than 68.5 million dge in 2015, and continued substitution of renewable gas for fossil natural gas would help California reduce its dependence on fossil fuels. In addition, renewable gas can be sourced by in-vessel waste digestion (e.g., anaerobic digestion of food and other organics) and recovering methane from landfills, livestock operations, and wastewater treatment facilities through the use of existing technologies, thereby also reducing methane emissions. The capture and productive use of renewable methane from these and other sources is consistent with requirements of SB 1383.

Collectively, renewable energy and energy efficiency measures can result in significant public health and climate benefits by displacing air pollution and GHG emissions from fossil-fuel based energy sources, as well as by reducing the health and environmental risks associated with the drilling, extraction, transportation, and storage of fossil fuels, especially for communities living near fossil-fuel based energy operations.

As the energy sector continues to evolve and decarbonize, both the behavior of individual facilities and the design of the grid itself will change, with important distributional effects. Some power plants may operate more flexibly to balance renewables, emerging technologies (examples include storage, smart inverters, renewably-fueled fuel cells, and others) will become more prevalent, and aging facilities may retire and be replaced. In turn, this may shift patterns of criteria pollutant emissions at these facilities. Because many existing power plants are in, or near, disadvantaged communities, it is of particular importance to ensure that this transition to a cleaner grid does not result in unintended negative impacts to these communities.

Appendix H highlights the more significant existing policies, programs, measures, regulations, and initiatives that provide a framework for helping achieve GHG emissions reductions in this sector.

172 California Energy Commission. 2016. Existing Building Energy Efficiency Action Plan. page 61. Available at: *http://docketpublic.energy.ca.gov/PublicDocuments/16-EBP-01/TN214801_20161214T155117_Existing_Building_Energy_Efficency_Plan_Update_Deceber_2016_Thi.pdf*

173 CARB. 2017. CARB's Emission Inventory Activities. *www.arb.ca.gov/ei/ei.htm*

Looking to the Future

This section outlines the high-level objectives and goals to reduce GHGs in this sector.

Electricity Goals

- Achieve sector-wide, publicly-owned utility, and load-serving entity specific GHG reduction planning targets set by the State through Integrated Resource Planning.
- Reduce fossil fuel use.
- Reduce energy demand.

Natural Gas Goals

- Ensure safety of the natural gas system.
- Decrease fugitive methane emissions.
- Reduce dependence on fossil natural gas.

Cross-Sector Interactions

The energy sector interacts with nearly all sectors of the economy. Siting of power plants (including solar and wind facilities) and transmission and distribution lines have impacts on land use in California–be it conversion of agricultural or natural and working lands, impacts to sensitive species and habitats, or implications to disadvantaged, vulnerable, and environmental justice communities. Additionally, more compact development patterns reduce per capita energy demands, while less-compact sprawl increases them. Further, efforts to reduce GHG emissions in the transportation sector include electrification, such as PHEVs, BEVs, and FCEVs. Some industrial sources also use electricity as a primary or auxiliary source of power for manufacturing. In the future, industrial facilities may electrify their systems instead of relying on natural gas. These activities will increase demand in this sector. In addition, water is used in various applications in the energy sector, ranging in intensity from cooling of turbines and other equipment at power plants to cleaning solar photovoltaic panels. Given California's recent historic drought, water use for the electricity sector is an important consideration for operation, maintenance, and construction activities.

Continued planning and coordination with federal, State, and local agencies, governments, Tribes, and stakeholders will be crucial to minimizing environmental and health impacts from the energy sector, deploying new technologies, and identifying feedstocks.

Efforts to Reduce Greenhouse Gases

The measures below include some required and new potential measures to help achieve the State's 2030 target and to support the high-level objectives for this sector. Some measures may be designed to directly address GHG reductions, while others may result in GHG reductions as a co-benefit.

Ongoing and Proposed Measures – Electricity

- Per SB 350, with respect to Integrated Resource Plans, establish GHG planning targets for the electricity sector, publicly-owned utilities, and load-serving entities.
- Per SB 350, ensure meaningful GHG emissions reductions by publicly-owned utilities and load-serving entities through Integrated Resource Planning.
- Per AB 197, prioritize direct reductions at large stationary sources, including power-generating facilities.
- Per SB 350, increase the RPS to 50 percent of retail sales by 2030 and ensure grid reliability.
- Per Governor Brown's Clean Energy Jobs Plan, AB 327 (Perea, Chapter 611, Statutes of 2013), and AB 693 (Eggman, Chapter 582, Statutes of 2015), increase development of distributed renewable generation, including for low income households.
- Continue to increase use of distributed renewable generation at State facilities where space allows.
- Increase retail customers' use of renewable energy through optional utility 100 percent renewable energy tariffs.
- Continue GHG reductions through participation in the California Independent System Operator (CAISO) Energy Imbalance Market.

- Per SB 350, efforts to evaluate, develop, and deploy regionalization of the grid and integration of renewables via regionalization of the CAISO should continue while maintaining the accounting accuracy and rigor of California's GHG policies.
- Per SB 350, establish annual targets for statewide energy efficiency savings and demand reduction that will achieve a cumulative doubling of statewide energy efficiency savings in electricity and natural gas end uses by 2030.
- Per SB 350, implement the recommendations of the Barriers Study for increasing access to renewable energy generation for low-income customers, energy efficiency and weatherization investments for low-income customers, and contracting opportunities for local small business in disadvantaged communities.[174] And, track progress towards these actions over time to ensure disadvantaged communities are getting equal access and benefits relative to other parts of the State.
- Continue implementation of the Regulations Establishing and Implementing a Greenhouse Gases Emission Performance Standard for Local Publicly Owned Electric Utilities as required by SB 1368 (Perata, Chapter 598, Statutes of 2006), which effectively prohibits electric utilities from making new long-term investments in high-GHG emitting resources such as coal power.
- Per AB 802 (Williams, Chapter 590, Statutes of 2015), adopt the forthcoming CEC regulations governing building energy use data access, benchmarking, and public disclosure.
- Per AB 2868 (Gatto, Chapter 681, Statutes of 2016), encourage development of additional energy storage capacity on the transmission and distribution system.
- Per AB 758 (Skinner, Chapter 470, Statutes of 2009),[175] implement recommendations under State jurisdiction included in the AB 758 Action Plan developed by CEC.

Ongoing and Proposed Measures – Natural Gas

- Implement the CARB Regulation for Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities to reduce fugitive methane emissions from storage and distribution infrastructure.
- Per SB 1371 (Leno, Chapter 525, Statutes of 2014), adopt improvements in investor-owned utility (IOU) natural gas systems to address methane leaks.
- Implement the SLCP Strategy to reduce natural gas leaks from oil and gas wells, pipelines, valves, and pumps to improve safety, avoid energy losses, and reduce methane emissions associated with natural gas use.
- Per SB 1383, CEC will develop recommendations for the development and use of renewable gas as part of its 2017 Integrated Energy Policy Report (IEPR).
- Per SB 1383, adopt regulations to reduce methane emissions from livestock manure and dairy manure management operations by up to 40 percent below the dairy sector's and livestock sector's 2013 levels by 2030, including establishing energy infrastructure development and procurement policies needed to encourage dairy biomethane projects. The regulations will take effect on or after January 1, 2024.
- Per SB 1383, reduce methane emissions at landfills by reducing landfill disposal of organic waste 75 percent below 2014 levels by 2025, including establishing energy infrastructure development and procurement policies needed to encourage in-vessel digestion projects and increase the production and use of renewable gas.
- Per SB 887 (Pavley, Chapter 673, Statutes of 2016), initiate continuous monitoring at natural gas storage facilities and (by January 1, 2018) mechanical integrity testing regimes at gas storage wells, develop regulations for leak reporting, and require risk assessments of potential leaks for proposed new underground gas storage facilities.
- Per Public Utilities (PU) Code 454.56, CPUC, in consultation with CEC, (1) identifies all potentially achievable cost-effective natural gas efficiency savings and establishes gas efficiency targets for the gas corporation to achieve, and (2) requires gas corporations to first meet unmet resource needs through available natural gas efficiency and demand reduction resources that are cost-effective, reliable, and feasible (PU Codes 890–

174 CEC. 2016. Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities. *http://docketpublic.energy.ca.gov/PublicDocuments/16-OIR-02/TN214830_20161215T184655_SB_350_LowIncome_Barriers_Study_Part_A__Commission_Final_Report.pdf*

175 AB 758 requires CEC, in collaboration with CPUC, to develop a comprehensive program to achieve greater energy efficiency in the State's existing buildings.

900 provide public goods charge funding authorization for these programs).

- Per SB 185 (De Leon, Chapter 605, Statutes of 2015), implement the requirement for the California Public Employees' Retirement System (CalPERS) and the California State Teachers' Retirement System (CalSTRS) to sell their holdings in coal-producing companies by June 1, 2017, and explore extending divestiture requirements for additional fossil-fuel assets.

Sector Measures

- Implement the post-2020 Cap-and-Trade Program.

Potential Additional Actions

The actions below have the potential to reduce GHGs and complement the measures and policies identified in Chapter 2. These are included to spur thinking and exploration of innovation that may help the State achieve its long-term climate goals. It is anticipated that there will be workshops and other stakeholder forums in the years following finalization of the Scoping Plan to explore these potential actions.

- Further deploy fuel cells that use renewable fuels or those that generate electricity that is less carbon intensive than the grid.
- Increase use of renewable energy through long-term agreements between customers and utilities (such as Sacramento Municipal Utility District Solar Shares).
- Develop rules needed for the development of electricity storage technologies.
- Adopt a zero net energy (ZNE) standard for residential buildings by 2018/2019, and for commercial buildings by 2030.
- Through a public process, evaluate and set targets for the electrification of space and water heating in residential and commercial buildings and cleaner heating fuels that will result in GHG reductions, and identify actions that can be taken to spur market transformation in the 2021-2030 period.
- Expand the State Low-Income Weatherization Program (LIWP) to continue to improve energy efficiency and weatherize existing residential buildings, particularly for low-income individuals and households.
- Decrease usage of fossil natural gas through a combination of energy efficiency programs, fuel switching, and the development and use of renewable gas in the residential, commercial, and industrial sectors.
- Accelerate the deployment of heat pumps and the replacement of diesel generators.
- Consider enhanced energy efficiency (high efficiency air conditioners, light-emitting diode (LED) lamps, efficiency improvements in industrial process cooling and refrigeration, efficient street lighting).
- Promote programs to support third-party delivered energy efficiency projects.
- Per AB 33 (Quirk, Chapter 680, Statutes of 2016), consider large-scale electricity storage.
- Support more compact development patterns to promote reduced per capita energy demand (see the Transportation sector for specific policy recommendations).

Industry

California's robust economy, with the largest manufacturing sector in the United States, is supported by a variety of sub-industrial sectors, some of which include cement plants, refineries, food processors, paper products, wineries, steel plants, and industrial gas, entertainment, technology and software, aerospace, and defense companies. Together, industrial sources account for approximately 21 percent of the State's GHG emissions–almost equal to the amount of GHG emissions from the energy sector. Emissions in this sector are mainly due to fuel combustion and, in some industries, process-related emissions. Changes in this sector strongly correlate with changes in the overall economy. For example, housing and construction growth usually increases demand for cement. Moving toward a cleaner economy and ensuring we meet the statewide targets requires us to address GHG emissions in this sector, which has the potential to provide local co-benefits in criteria pollutant and toxic air contaminant reductions in immediate surrounding locations, especially in vulnerable communities. At the same time, we must ensure there is a smooth path to a cleaner future to support a resilient and robust economy with a strong job force, including training opportunities for workers in disadvantaged communities, while continuing to support economic growth in existing and new industries.

Greenhouse gas emissions in the Industrial sector have remained relatively flat for the last few years while the State's economy has continued to grow, meaning the GHG emissions to produce each dollar of gross standard product is decreasing. Manufacturing accounts for approximately 10 percent of the gross state product.[176] In 2016, California industry exported $163.6 billion in merchandise.[177]
Policies to address GHG emissions reductions must continue to balance the State's economic well-being with making progress toward achievement of the statewide limits.

As this sector is dominated by combustion-related emissions, policies and measures to supply cleaner fuels and more efficient technology are the key to reducing GHG emissions. Some sectors, such as cement and glass, also have significant process emissions, and it may be more challenging to address those process emissions, as they are related to chemical reactions and processes to meet safety, product-specific, or regulatory standards for the final products. Another important aspect for this sector is its role as the State transitions to a cleaner future. Infrastructure, including existing facilities and new facilities, can support the production of new technology to bolster the State's efforts to address GHGs. For example, existing refineries have an opportunity to move away from fossil fuel production and switch to the production of biofuels and clean technology. As the State works to double energy efficiency in existing buildings, there will be an increased demand for efficient lighting fixtures, building insulation, low-e[178] coatings for existing windows, or new windows–goods which could be produced in California. The predominant paths to reducing GHG emissions for the Industrial sector are: fuel switching, energy efficiency improvements, and process modifications. Carbon capture and sequestration also offers a potential new, long-term path for reducing GHGs for large stationary sources.

Relocation of production to outside the State would also reduce emissions, but this is disadvantageous for a couple of reasons and efforts are needed to avoid this outcome. First, AB 32 requires the State's climate policies to minimize emissions leakage, and relocation would shift GHG emissions outside of the State without the benefit of reducing pollutants that contribute to overall global warming impacts. Second, it could also reduce the availability of associated jobs and could impact a local tax base that supports local services such as public transportation, emergency response, and social services, as well as funding sources critical to protecting the natural environment and keeping it available for current and future generations.

Even while we continue to seek further GHG reductions in the sector, it is important to recognize the State has a long history of addressing health-based air pollutants in this sector. Many of the actions for addressing criteria pollutants and toxic air contaminants in the industrial sector are driven by California's local air district stationary source requirements to ensure progress toward achieving State and national ambient air quality standards. Some of those actions, such as use of Best Available Control Technology, have resulted in co-benefits in the form of GHG reductions. The State must continue to strengthen its existing criteria and toxic air pollutant programs and relationships with local air districts to ensure all Californians have healthy, clean air. This is especially true in disadvantaged communities.

AB 32 directed CARB to take several actions to address GHG emissions, such as early action measures, GHG reporting requirements for the largest GHG sources, and other measures. In response, the State adopted multiple measures and regulations, including regulations for high global warming potential (high-GWP) gases used in refrigeration systems and the semiconductor industry.[179] These regulations apply to specific GHGs and types of equipment that can be found across the economy. For example, high-GWP gases are found in refrigeration systems in large food processing plants and chemical and petrochemical facilities, among others.[180]

The State has also adopted the first in the world economy-wide cap-and-trade program that applies to all large industrial GHG emitters, imported electricity, and fuel and natural gas suppliers. As discussed in Chapters 2 and 3, the Cap-and-Trade Program is a key element of California's GHG reduction strategy. The

176 *http://www.investopedia.com/articles/investing/011416/californias-economy-9-industries-driving-gdp-growth.asp*

177 U.S. Department of Commerce. International Trade Administration. 2017. California Exports, Jobs, & Foreign Investment. *www.trade.gov/mas/ian/statereports/states/ca.pdf*

178 Low-e coatings reduce the emissivity, or heat transfer, from a window to improve its insulating properties.

179 CARB. Refrigerant Management Program. *www.arb.ca.gov/cc/rmp/rmp.htm*

180 The U.S. Environmental Protection Agency (U.S. EPA) has also enacted regulations to reduce hydrofluorocarbon (HFC) emissions by prohibiting high-GWP refrigerants in new retail food refrigeration equipment and in chillers used for large air-conditioning applications. On the international level, the European Union F-gas regulations went into effect January 1, 2015. Those regulations prohibit high-GWP HFCs in new equipment and require a gradual phasedown in the production and import of HFCs. A similar HFC phasedown that would take place globally was the subject of international negotiations during the Montreal Protocol meeting in Rwanda in October, 2016. Those negotiations resulted in an agreement that will phase down the use of HFCs and put the world on track to avoid nearly 0.5°C of warming by 2100.

Cap-and-Trade Program establishes a declining limit on major sources of GHG emissions, and it creates a powerful economic incentive for major investment in cleaner, more efficient technologies. The Cap-and-Trade Program applies to emissions that cover about 85 percent of the State's GHG emissions. CARB creates allowances equal to the total amount of permissible emissions (i.e., the "cap") over a given compliance period. One allowance equals one metric ton of GHG emissions. Fewer allowances are created each year, thus the annual cap declines and statewide emissions are reduced over time. An increasing annual auction reserve (or floor) price for allowances and the reduction in annual allowance budgets creates a steady and sustained pressure for covered entities to reduce their GHGs. All covered entities in the Cap-and-Trade Program are still subject to the air quality permit limits for criteria and toxic air pollutants.

The Cap-and-Trade Program is designed to achieve the most cost-effective statewide GHG emissions reductions; there are no individual or facility-specific GHG emissions reductions requirements. Each entity covered by the Cap-and-Trade Program has a compliance obligation that is set by its GHG emissions over a compliance period, and entities are required to meet that compliance obligation by acquiring and surrendering allowances in an amount equal to their compliance obligation. Companies can also meet a limited portion of their compliance obligation by acquiring and surrendering offset credits, which are compliance instruments that are based on rigorously verified emissions reductions that occur from projects outside the scope of the Cap-and-Trade Program. Like allowances, each offset credit is equal to one metric ton of GHG emissions. The program began in January 2013 and achieved a near 100 percent compliance rate for the first compliance period (2013–2014). Reported and verified emissions covered by the Cap-and-Trade Program have been below the cap throughout the first years of the Program.[181]

Allowances are issued by CARB and distributed by free allocation and by sale at auctions. CARB also provides for free allocation to some entities covered by the Program to address potential trade exposure due to the cost of compliance with the Program and address concerns of relocation of production out-of-state and resulting emissions leakage. Offset credits are issued by CARB to qualifying offset projects. Secondary markets exist where allowances and offset credits may be sold and traded among Cap-and-Trade Program participants. Facilities must submit allowances and offsets to match their annual GHG emissions. Facilities that emit more GHG emissions must surrender more allowances or offset credits, and facilities that can cut their emissions need to surrender fewer compliance instruments. Entities have flexibility to choose the lowest-cost approach to achieving program compliance; they may purchase allowances at auction, trade allowances and offset credits with others, take steps to reduce emissions at their own facilities, or utilize a combination of these approaches. Proceeds from the sale of State-owned allowances at auction are placed into the Greenhouse Gas Reduction Fund.

It is important to note that while the Cap-and-Trade Program is designed to reduce GHGs for the industrial sector, there are recommendations from the EJAC (or Committee) for the State to pursue more facility-specific GHG reduction measures to achieve potential local air quality co-benefits, and AB 197 directs CARB to prioritize direct reductions at large stationary sources. The Committee has expressed a strong preference to forgo the existing Cap-and-Trade Program and rely on prescriptive facility level regulations.

We agree with the EJAC that more can and should be done to reduce emissions of criteria pollutants and toxic air contaminants. These pollutants pose air quality and related health issues to the communities adjacent to the sources of industrial emissions. Further, many of these communities are already disadvantaged and burdened by a variety of other environmental stresses. As described in Chapter 3, however, there is not always a direct correlation between emissions of GHGs, criteria pollutants, and toxic air contaminants. Also, relationships between these pollutants are complex within and across industrial sectors. The solution, therefore, is not to do away with or change the regulation of GHGs through the Cap-and-Trade Program to address these legitimate concerns; instead, consistent with the direction in AB 197 and AB 617, State and local agencies must evaluate and implement additional measures that directly regulate and reduce emissions of criteria and toxic air pollutants through other programs.

181 CARB. 2016. Mandatory Greenhouse Gas Emissions Reporting. *www.arb.ca.gov/cc/reporting/ghg-rep/ghg-rep.htm*

Looking to the Future

This section outlines the high-level objectives and goals to reduce GHGs in this sector.

Goals

- Increase energy efficiency.
- Reduce fossil fuel use.
- Promote and support industry that provides products and clean technology needed to achieve the State's climate goals.
- Create market signals for low carbon intensity products.
- Maximize air quality co-benefits.
- Support a resilient low carbon economy and strong job force.
- Make California the epicenter for research, development, and deployment of technology needed to achieve a near-zero carbon future.
- Increase in-State recycling manufacturing.

Cross-Sector Interactions

There are clear, direct relationships between the industrial sector and other sectors that go beyond the economic support that a strong economy provides. For instance, this sector could increase its use of renewable fuels such as biomethane, which would be sourced from landfills or dairies. Additionally, some industries could shift from raw materials to recycled materials to reduce waste and reduce GHG emissions associated with processing of raw materials. Further, addressing energy efficiency could reduce onsite heating, water, and fuel demand. Moreover, supporting mass-transit or ride share programs for employees would reduce VMT. Finally, upgrading existing facilities or repurposing existing infrastructure instead of constructing new facilities or infrastructure would support land conservation and smart growth goals.

Efforts to Reduce Greenhouse Gases

The measures below include some required and new potential measures to help achieve the State's 2030 target and to support the high-level objectives for this sector. Some measures may be designed to directly address GHG reductions, while others may result in GHG reductions as a co-benefit.

Ongoing and Proposed Measures

- At the October 2016 annual Montreal Protocol Meeting of Parties in Kigali, Rwanda, an international amendment to globally phase down HFC production was agreed upon by more than 150 countries. Depending on the level of future HFC emissions reductions expected for California from the Kigali Agreement, California may also: (1) consider placing restrictions on the sale or distribution of refrigerants with a GWP > 2,500, and (2) consider prohibiting refrigerants with a GWP >= 150 in new stationary refrigeration equipment and refrigerants with a GWP >= 750 for new stationary air-conditioning equipment. At the time the SLCP Strategy was finalized, U.S. EPA was expected to continue implementing certain HFC reductions under its Significant New Alternatives Policy (SNAP). Recent litigation may result in CARB implementing similar measures as state law instead.
- Develop a regulatory monitoring, reporting, verification, and implementation methodology for the implementation of carbon capture and sequestration projects.
- Implement the CARB Regulation for Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities to reduce fugitive methane emissions from storage and distribution infrastructure.

Sector Measures

- Implement the post-2020 Cap-and-Trade Program.
- Continue and strategically expand research and development efforts to identify, evaluate, and help deploy innovative strategies that reduce GHG emissions in the industrial sector.
- Promote procurement policies that prioritize low carbon production to delivery options, including at the State and local government levels.
- Identify and remove barriers to existing grant funding for onsite clean technology or efficiency upgrades.

Potential Additional Actions

The actions below have the potential to reduce GHGs and complement the measures and policies identified in Chapter 2. These are included to spur thinking and exploration of innovation that may help the State achieve its long-term climate goals. It is anticipated that there will be workshops and other stakeholder forums in the years following finalization of the Scoping Plan to explore these potential actions.

- Further deploy fuel cells that use renewable fuels or those that generate electricity that is less carbon intensive than the grid.
- Decrease usage of fossil natural gas through a combination of efficiency, fuel switching, and the development and use of renewable gas.
- Partner with California's local air districts to effectively use BARCT to achieve air quality and GHG reduction co-benefits at large industrial sources.
- Evaluate the potential for and promote electrification for industrial stationary sources whose main emissions are onsite natural gas combustion.
- Identify new funding for grants and tariff opportunities for onsite clean technology, efficiency upgrades, diesel generator replacement, or recycling manufacturing technology.
- Develop an incentive program to install low-GWP refrigeration systems in retail food stores.
- Evaluate and design additional mechanisms to further minimize emissions leakage in the Cap-and-Trade Program (e.g., border carbon adjustment).

Transportation Sustainability

California's population is projected to grow to 50 million people by 2050. How and where the State grows will have important implications for all sectors of the economy, especially the transportation sector. Supporting this growth while continuing to protect the environment, developing livable and vibrant communities, and growing the economy is dependent on transitioning the State's transportation system to one powered by ZEVs (including PHEVs, BEVs, and FCEVs) and low carbon fuels. It must also offer other attractive and convenient low carbon transportation choices, including safe walking and bicycling, as well as quality public transportation. Investments should consider California's diverse communities and provide accessible and clean travel options to all while drastically reducing reliance on light-duty combustion vehicles.

The transportation system in California moves people between home, work, school, shopping, recreation, and other destinations, and connects ports, industry, residential communities, commercial centers, educational facilities, and natural wonders.[182] California's vast transportation system includes roads and highways totaling more than 175,000 miles and valued at approximately $1.2 trillion, 500 transit agencies, 245 public-use airports, 12 major ports, and the nation's first high-speed rail system, now under construction.[183] Transportation infrastructure also includes sidewalks, bicycle paths, parking, transit stations and shelters, street trees and landscaping, signage, lighting, and other elements that affect the convenience, safety, and accessibility of transportation choices. Increasingly, technologies such as real-time, web- and mobile-enabled trip planning and ride-sourcing services are changing how people travel. In the near future, automated and connected vehicles, and unmanned aerial systems (e.g., drones) are expected to be part of our transportation landscape and to transform the way that people and freight are transported. Responsibility for the transportation system is spread across State, regional, and local levels.

Through effective policy design, the State has an opportunity to guide technology transformation and influence investment decisions with a view to mitigate climate and environmental impacts while promoting economic opportunities and community health and safety. The network of transportation technology and infrastructure, in turn, shapes and is shaped by development and land use patterns that can either support or detract from a more sustainable, low carbon, multi-modal transportation future. Strategies to reduce GHG emissions from the transportation sector, therefore, must actively address not only infrastructure and technology, but also coordinated strategies to achieve development, conservation, and land use patterns that align with the State's GHG and other policy goals.

Transportation also enables the movement of freight such as food, building materials, and other consumable products, as well as waste and recyclables. The California freight system includes myriad equipment and

182 Caltrans. California Transportation Plan 2040, February 2016.
183 Ibid.

facilities,[184] and is the most extensive, complex, and interconnected system in the country, with approximately 1.5 billion tons of freight valued at $2.8 trillion shipped in 2015 to, through, and within California.[185] Freight-dependent industries accounted for over $740 billion of California's GDP and over 5 million California jobs in 2014.[186, 187]

Transportation has a profound and varied impact on individuals and communities, including benefits such as economic growth, greater accessibility, and transport-related physical activity, and adverse consequences such as GHG emissions, smog-forming and toxic air pollutants, traffic congestion, and sedentary behaviors. The sector is the largest emitter of GHG emissions in California. Air pollution from tailpipe emissions contributes to respiratory ailments, cardiovascular disease, and early death, with disproportionate impacts on vulnerable populations such as children, the elderly, those with existing health conditions (e.g., chronic obstructive pulmonary disease, or COPD), low-income communities, and communities of color.[188, 189, 190, 191, 192] Importantly, transportation costs are also a major portion of most Californian's household budgets.[193] Additionally, dependence on cars has a direct impact on levels of physical activity, which is closely linked to multiple adverse health outcomes.

Fortunately, many measures that reduce transportation sector GHG emissions simultaneously present opportunities to bolster the economy, enhance public health, revitalize disadvantaged communities, strengthen resilience to disasters and changing climate, and improve Californians' ability to conveniently access daily destinations and nature. These opportunities are particularly important for those who are not able to, or cannot afford to, drive. In addition, a growing market demand for walkable, bikeable, and transit-accessible communities presents a significant opportunity to shift California's transportation systems toward a lower-carbon future while realizing significant public health benefits through increased levels of physical activity (e.g., walking and bicycling). In fact, transport-related physical activity could result in reducing risks from chronic diseases such as cardiovascular disease, diabetes, certain cancers, and more, to such an extent that it would rank among the top public health accomplishments in modern history, and help to reduce the billions of dollars California spends each year to treat chronic diseases. Just as California was the first to mitigate the contribution of cars and trucks to urban smog, it is leading the way toward a clean, low carbon, healthy, interconnected, and equitable transportation system.

Continuing to advance the significant progress already underway in the areas of vehicle and fuel technology is critical to the transportation sector strategy and to reducing GHG emissions in the transportation sector. The rapid technological and behavioral changes underway with automated and connected vehicles, unmanned aerial systems, and ride-sourcing services are redefining the transportation sector, and should be part of the solution for a lower carbon transportation sector. It is critical to support and accelerate progress on transitioning to a zero carbon transportation system, while ensuring VMT reductions are still achieved. The growing severity of climate impacts, persistent public health impacts and costs from air pollution,[194] and rapid technology progress that supports the expectation that cost parity between some ZEVs and comparable internal combustion vehicles will be attained in a few years, underscores the need for further

184 The freight system includes trucks, ocean-going vessels, locomotives, aircraft, transport refrigeration units, commercial harborcraft and cargo handling, industrial and ground service equipment used to move freight at seaports, airports, border crossings, railyards, warehouses, and distribution centers.

185 U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration. Freight Analysis Framework, V 4.1, 2016.

186 U.S. Department of Commerce, Bureau of Economic Analysis. Regional Economic Accounts. Available at: *www.bea.gov/regional/index.htm*, accessed March 11, 2016.

187 State of California Employment Development Department. Labor Market Information by California Geographic Areas. Available at: *www.labormarketinfo.edd.ca.gov/geography/lmi-by-geography.html*, accessed March 21, 2016.

188 CARB. May 2016. Mobile Source Strategy. Available at: *www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf*

189 Hoek, G., Krishnan, R. M., Beelen, R., Peters, A., Ostro, B., Brunekreef, B., and Kaufman, J. D. 2013. Long-term air pollution exposure and cardio-respiratory mortality: a review. Environmental Health, 12(1), 1.

190 Friedman, M. S., K. E. Powell, L. Hutwagner, L. M. Graham, and W. G. Teague. 2001. "Impact of changes in transportation and commuting behaviors during the 1996 Summer Olympic Games in Atlanta on air quality and childhood asthma." JAMA 285(7), 897–905.

191 Bell, M. L., and K. Ebisu. 2012. "Environmental inequality in exposures to airborne particulate matter components in the United States." Environmental Health Perspectives 120(12), 1699.

192 Morello-Frosch, R., M. Zuk, M. Jerrett, B. Shamasunder, and A. D. Kyle. 2011. "Understanding the cumulative impacts of inequalities in environmental health: implications for policy." Health Affairs 30(5), 879–887.

193 H + T® Index website. *htaindex.cnt.org/*

194 For example, a recent report by the American Lung Association estimates the costs of climate and air pollution from passenger vehicles in California to be $15 billion annually. Holmes-Gen, B. and W. Barrett. 2016. Clean Air Future – Health and Climate Benefits of Zero Emission Vehicles. American Lung Association in California, October.

action on ZEVs. Therefore, CARB is signaling the need for additional policy and technical support on strategies to move toward a goal of achieving 100 percent ZEV sales in the light-duty vehicle sector. Austria, Germany, India, Netherlands, and Norway are all taking steps to, or have indicated a desire to, move to 100 percent ZEV sales in the 2020–2030 time frame.

In addition, policies that maximize the integration of electrified rail and transit to improve reliability and travel times, increase active transportation such as walking and bicycling, encourage use of streets for multiple modes of transportation, improve freight efficiency and infrastructure development, and shift demand to low carbon modes will need to play a greater role as California strives to achieve its 2030 and 2050 climate targets.[195]

The State's rail modernization program has identified critical elements of the rail network where improvements, either in timing of service or infrastructure, provide benefits across the entire statewide network, furthering the attractiveness of rail for a range of trip distances.[196] The State also uses the Transit and Intercity Rail Capital Program (TIRCP) and Low Carbon Transit Operations Program (LCTOP) to provide grants from GGRF to fund transformative improvements modernizing California's intercity, commuter, and urban rail systems, as well as bus and ferry transit systems, to reduce emissions of GHGs by reducing congestion and VMT throughout California. As the backbone of an electrified mass-transportation network for the State, the high-speed rail system catalyzes and relies on focused, compact, and walkable development well-served by local transit to funnel riders onto the system and provide alternative options to airplanes and automobiles for interregional travel. Concentrated development, such as that incentivized by the Affordable Housing and Sustainable Communities (AHSC) grant program, can improve ridership and revenue for the system while providing vibrant communities for all.

At the same time, more needs to be done to fully exploit synergies with emerging mobility solutions like ride-sourcing and more effective infrastructure planning to anticipate and guide the necessary changes in travel behavior, especially among millennials. Uniquely, high-speed rail affects air-miles traveled, diverting, at minimum, 30 percent of the intrastate air travel market in 2040.[197]

While most of the GHG reductions from the transportation sector in this Scoping Plan will come from technologies and low carbon fuels, a reduction in the growth of VMT is also needed. VMT reductions are necessary to achieve the 2030 target and must be part of any strategy evaluated in this Plan. Stronger SB 375 GHG reduction targets will enable the State to make significant progress toward this goal, but alone will not provide all of the VMT growth reductions that will be needed. There is a gap between what SB 375 can provide and what is needed to meet the State's 2030 and 2050 goals.

At the time of this writing, adoption of the first round of SCSs by MPOs is complete, and the second round of SCS planning is underway. Three MPO regions are in the very early stages of developing their third SCSs. To date, CARB staff reviewed the final determinations of 16 MPOs, and concluded that all 16 of those SCSs would achieve their targets, if implemented, with many of the MPOs indicating that they expect to exceed their targets. CARB staff recognizes the very strong performance in this first round of SCSs as a major success. Currently adopted sustainable communities strategies achieve, in aggregate, a 17 percent reduction in statewide per capita GHG emissions relative to 2005 by 2035.

Since 2014, CARB has been working with MPOs and other stakeholders to update regional SB 375 targets. At the same time, CARB has also conducted analysis for development of the Mobile Source Strategy and Scoping Plan that identifies the need for statewide per capita greenhouse gas emissions reductions on the order of 25 percent by 2035, to meet our climate goals. Many MPOs have identified challenges to incorporating additional strategies and reducing emissions further in their plans, principally tied to the need for additional and more flexible revenue sources. MPOs have submitted target update recommendations to CARB that in aggregate maintains a 17 percent reduction statewide, which includes commitments of 18 percent reduction by 2035 from each of the four largest MPOs in the State.

CARB is currently reviewing each MPOs target update recommendations alongside new State policies. State agencies have been working on new State-level VMT-related Policies and Measures (see Table 17) as part of this Scoping Plan intended to provide the State, MPOs, and local agencies with additional funding resources and tools to successfully meet the State's climate goals. CARB's preliminary review indicates that new State-level policies and measures will help support updated SB 375 targets that achieve up to 20 percent of the

195 Morello-Frosch, R., M. Zuk, M. Jerrett, B. Shamasunder, and A. D. Kyle. 2011. "Understanding the cumulative impacts of inequalities in environmental health: Implications for policy." Health Affairs 30(5), 879–887.

196 California State Transportation Agency. 2016. 2018 California State Rail Plan factsheet and TIRCP fact sheet.

197 California High-Speed Rail Authority. 2016. 2016 Business Plan. Ridership and Revenue Forecast.

needed statewide reduction, as well as help bridge the remaining VMT growth reduction gap.

Discussions among a broad suite of stakeholders from transportation, the building community, financial institutions, housing advocates, environmental organizations, and community groups are needed to begin the process to pursue and develop the needed set of strategies to ensure that we can achieve necessary VMT reductions, and that the associated benefits are shared by all Californians. Appendix C further details potential actions for discussion that can be taken by State government, regional planning agencies, and local governments, to achieve a broad, statewide vision for more sustainable land use and close the VMT gap.[198]

At the State level, a number of important policies are being developed. Governor Brown signed Senate Bill 743 (Steinberg, Chapter 386, Statutes of 2013), which called for an update to the metric of transportation impact in CEQA. That update to the CEQA Guidelines is currently underway. Employing VMT as the metric of transportation impact statewide will help to ensure GHG reductions planned under SB 375 will be achieved through on-the-ground development, and will also play an important role in creating the additional GHG reductions needed beyond SB 375 across the State. Implementation of this change will rely, in part, on local land use decisions to reduce GHG emissions associated with the transportation sector, both at the project level, and in long-term plans (including general plans, climate action plans, specific plans, and transportation plans) and supporting sustainable community strategies developed under SB 375. The State can provide guidance and tools to assist local governments in achieving those objectives.

Appendix H highlights the more significant existing policies, programs, measures, regulations, and initiatives that provide a framework for helping achieve GHG emissions reductions in this sector.

Looking to the Future

This section outlines the high-level objectives and goals to reduce GHGs in this sector.

Vibrant Communities and Landscapes / VMT Reduction Goals

- Implement and support the use of VMT as the metric for determining transportation impacts under CEQA, in place of level of service (LOS).
- Promote all feasible policies to reduce VMT, including:
  - Land use and community design that reduce VMT,
  - Transit oriented development,
  - Complete street design policies that prioritize transit, biking, and walking, and
  - Increasing low carbon mobility choices, including improved access to viable and affordable public transportation and active transportation opportunities.
- Complete the construction of high-speed rail integrated with enhanced rail and transit systems throughout the State.
- Promote transportation fuel system infrastructure for electric, fuel-cell, and other emerging clean technologies that is accessible to the public where possible, and especially in underserved communities, including environmental justice communities.
- Increase the number, safety, connectivity, and attractiveness of biking and walking facilities to increase use.
- Promote potential efficiency gains from automated transportation systems and identify policy priorities to maximize sustainable outcomes from automated and connected vehicles (preferably ZEVs), including VMT reduction, coordination with transit, and shared mobility, and minimize any increase in VMT, fossil fuel use, and emissions from using automated transportation systems.
- Promote shared-use mobility, such as bike sharing, car sharing and ride-sourcing services to bridge the "first mile, last mile" gap between commuters' transit stops and their destinations.
- Continue research and development on transportation system infrastructure, including:
  - Integrate frameworks for lifecycle analysis of GHG emissions with life-cycle costs for pavement and large infrastructure projects, and
  - Health benefits and costs savings from shifting from driving to walking, bicycling, and transit use.
- Quadruple the proportion of trips taken by foot by 2030 (from a baseline

198 CARB. Potential State - Level Strategies to Advance Sustainable, Equitable Communities and Reduce Vehicle Miles of Travel (VMT) -- for Discussion. *www.arb.ca.gov/cc/scopingplan/meetings/091316/Potential%20VMT%20Measures%20For%20Discussion_9.13.16.pdf*

- of the 2010–2012 California Household Travel Survey).
- Strive for a nine-fold increase in the proportion of trips taken by bicycle by 2030 (from a baseline of the 2010–2012 California Household Travel Survey).
- Strive, in passenger rail hubs, for a transit mode share of between 10 percent and 50 percent, and for a walk and bike mode share of between 10 percent and 15 percent.

Vehicle Technology Goals

- Through a strong set of complementary policies–including reliable incentives, significant infrastructure investment, broad education and outreach, and potential regulation–aim to reach 100 percent ZEV sales in the light-duty sector (PHEVs, BEVs, and FCEVs) by 2050.
- Make significant progress in ZEV penetrations in non-light-duty sectors.
- Deploy low-emission and electrified rail vehicles.

Clean Fuels Goals

- Electrify the transportation sector using both electricity and hydrogen.
- Promote research development and deployment of low carbon fuels such as renewable gas, including renewable hydrogen.
- Rapidly reduce carbon intensity of existing liquid and gaseous transportation fuels.

Sustainable Freight Goals

- Increase freight system efficiency of freight operations at specific facilities and along freight corridors such that more cargo can be moved with fewer emissions.
- Accelerate use of clean vehicle and equipment technologies and fuels of freight through targeted introduction of zero emission or near-zero emission (ZE/NZE) technologies, and continued development of renewable fuels.
- Encourage State and federal incentive programs to continue supporting zero and near-zero pilot and demonstration projects in the freight sector.
- Accelerate use of clean vehicle, equipment, and fuels in freight sector through targeted introduction of ZE/NZE technologies, and continued development of renewable fuels. This includes developing policy options that encourage ZE/NZE vehicles on primary freight corridors (e.g., Interstate-710); examples of such policy options include a separated ZE/NZE freight lane, employing market mechanisms such as favorable road pricing for ZE/NZE vehicles, and developing fuel storage and distribution infrastructure along those corridors.

Cross-Sector Interactions

The transportation sector has considerable influence on other sectors and industries in the State. California's transportation sector is still primarily powered by petroleum, and to reduce statewide emissions, California must reduce demand for driving; continue to reduce its gasoline and diesel fuel consumption; diversify its transportation fuel sources by increasing the adoption of low- and zero-carbon fuels; increase the ease and integration of the rail and transit networks to shift travel mode; and deploy ZE/NZE vehicles.

As California's population continues to increase, land use patterns will directly impact GHG emissions from the transportation sector, as well as those associated with the conversion and development of previously undeveloped land. Specifically, where and how the State population grows will have implications on distances traveled and tailpipe emissions; as well as on secondary emissions from the transportation sector, including emissions from vehicle manufacturing and distribution, fuel refining and distribution, demand for new infrastructure (including roads, transit, and active transportation infrastructure), demand for maintenance and upkeep of existing infrastructure. Conversion of natural and working lands further affects emissions, with the attendant impacts to food security, watershed health, and ecosystems. Less dense development also demands higher energy and water use. With the exception of VMT reductions, none of these secondary emissions are currently accounted for in the GHG models used in this Scoping Plan, but are nonetheless important considerations. Additionally, compact, lower-VMT future development patterns are essential to achieving public health, equity, economic, and conservation goals, which are also not modeled but are important co-benefits of the overall transportation sector strategy. For example, high-speed rail station locations were identified in downtown areas to reinforce existing city centers.

Achieving LCFS targets and shifting from petroleum dependence toward greater reliance on low carbon fuels also has the potential to affect land use in multiple ways. For example, increased demand for conventional biofuels could require greater use of land and water for purpose-grown crops, which includes interactions with the agricultural and natural and working lands sectors. On the other hand, continuing growth in fuels from urban organic waste, as well as waste biomass such as composting residues, by-processing residues and agricultural waste and excess forest biomass acts to alleviate the pressure on croplands to meet the need for food, feed, and fuel. Likewise, captured methane from in-vessel digestion, landfills or dairy farms for use in vehicles requires close interaction with the waste and farming sectors.

Also, as more electric vehicles and charging stations are deployed, drivers' charging behavior will affect the extent to which additional electric generation capacity and ancillary services are needed to maintain a reliable grid and accommodate a portfolio of 50 percent renewable electricity by 2030. Charging control and optimization technologies will determine how well integrated the electric and transportation sectors can become, including, for instance, the widespread use of electric vehicles as storage for excess renewable generation, vehicle to grid, smart charging, and/or smart grid. The GHG emissions intensity of electricity affects the GHG savings of fuel switching from petroleum-based fuels to electricity; the cleaner the electric grid, the greater the benefits of switching to electricity as a fuel. Similar to electric vehicles, hydrogen fuel cell electric vehicles have zero-tailpipe emissions and can mitigate GHGs and criteria pollutants. Greenhouse gas emissions could be further reduced with the use of renewable hydrogen, which can be produced using renewable electricity or renewable natural gas.

Efforts to Reduce Greenhouse Gases

The measures below include some required and new potential measures to help achieve the State's 2030 target and to support the high-level objectives for the transportation sector. Some measures may be designed to directly address GHG reductions, while others may result in GHG reductions as a co-benefit.

Ongoing and Proposed Measures – Vibrant Communities and Landscapes / VMT Reduction Goals

- Mobile Source Strategy – 15 percent reduction in total light-duty VMT from the BAU in 2050 (with measures to achieve this goal not specified; potential measures identified in Appendix C).
- Work with regions to update SB 375 Sustainable Communities Strategies targets for 2035 to better align with the 2030 GHG target and take advantage of State rail investments.
- Stronger SB 375 GHG reduction targets will enable the State to make significant progress toward the goal of reducing total light-duty VMT by 15 percent from expected levels in 2050, but alone will not provide all of the VMT reductions that will be needed. The gap between what SB 375 can provide and what is needed to meet the State's 2030 and 2050 goals needs to be addressed through additional VMT reduction measures such as those mentioned in Appendix C.
- Implement and support the adoption and use of VMT as the CEQA metric of transportation impact, such that it promotes GHG reduction, the development of multimodal transportation networks, and a diversity of land uses.
- Continue to develop and explore pathways to implement State-level VMT reduction strategies, such as those outlined in the document "Potential State-Level Strategies to Advance Sustainable, Equitable Communities and Reduce Vehicle Miles of Travel (VMT) – for Discussion"[199] – included in Appendix C – through a transparent and inclusive interagency policy development process to evaluate and identify implementation pathways for additional policies to reduce VMT and promote sustainable communities, with a focus on:
  - Accelerating equitable and affordable transit-oriented and infill development through new and enhanced financing and policy incentives and mechanisms,
  - Promoting stronger boundaries to suburban growth through enhanced support for sprawl containment mechanisms such as urban growth boundaries and transfer of development rights programs,
  - Identifying performance criteria for transportation and other infrastructure investments

199 Refers to the document discussed at the September 2016 Public Workshop on the Transportation Sector to Inform Development of the 2030 Target Scoping Plan Update, also available at: *www.arb.ca.gov/cc/scopingplan/meetings/091316/Potential%20VMT%20Measures%20For%20Discussion_9.13.16.pdf*

    - to ensure alignment with GHG reduction goals and other State policy priorities and expand access to transit, shared mobility, and active transportation choices,
    - Promoting efficient development patterns that maximize protection of natural and working lands,
    - Developing pricing mechanisms such as road user/VMT-based pricing, congestion pricing, and parking pricing strategies,
    - Reducing congestion and related GHG emissions through commute trip reduction strategies, and
    - Programs to maximize the use of alternatives to single-occupant vehicles, including bicycling, walking, transit use, and shared mobility options.
- Finalize analysis of the results of the pilot road usage charge program, implemented pursuant to SB 1077 (DeSaulnier, Chapter 835, Statues of 2014), and evaluate deployment of a statewide program.
- Continue promoting active transportation pursuant to SB 99 (Committee on Budget and Fiscal Review, Chapter 359, Statutes of 2013) – The Active Transportation Program and beyond.
- Continue to build high-speed rail and broader statewide rail modernization pursuant to the funding program in SB 862 (Committee on Budget and Fiscal Review, Chapter 36, Statutes of 2014) and other sources.
- Encourage use of streets for multiple modes of transportation (including public transit and active transportation, such as walking and bicycling), and for all users, including the elderly, young, and less able bodied, pursuant to AB 1358 (Leno, Chapter 657, Statutes of 2008) – Complete Streets policies.
- Support and assist local and regional governments, through technical assistance, and grant and other local assistance programs, to develop and implement plans that are consistent with the goals and concepts in The Second Investment Plan for Fiscal Years 2016-2017 through 2018-2019[200] and its subsequent updates, and Appendix C: Vibrant Communities and Landscapes, including the following:
    - California Climate Investment programs such as Transformative Climate Communities Program, ensuring promotion of GHG reductions from neighborhood-level community plans in disadvantaged communities.
    - AB 2087 (Levine, Chapter 455, Statutes of 2016) – Help local and State agencies apply core investment principles when planning conservation or mitigation projects.
    - High speed rail station area plans.
    - Implementation of updated General Plan Guidelines.
- Per SB 350, implement the recommendations identified in the Barriers Study to accessing ZE/NZE transportation options for low-income customers and recommendations on how to increase access.[201] And, track progress towards these actions over time to ensure disadvantaged communities are getting equal access and benefits relative to other parts of the State.
- Take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining, and investing in State infrastructure, as required under Executive Order B-30-15.

Ongoing and Proposed Measures – Vehicle Technology

- Implement the Cleaner Technology and Fuels Scenario of CARB's Mobile Source Strategy, which includes:
    - An expansion of the Advanced Clean Cars program, which further increases the stringency of GHG emissions for all light-duty vehicles, and 4.2 million zero emission and plug-in hybrid light-duty electric vehicles by 2030,
    - Phase 1 and 2 GHG regulations for medium- and heavy-duty trucks, and
    - Innovative Clean Transit.
- Periodically assess and promote cleaner fleet standards.
- Deploy ZEVs across all vehicle classes, including rail vehicles, along with the necessary charging infrastructure.
- Encourage State and federal incentive programs to continue supporting zero and near-zero pilot and demonstration projects.
- Collaborate with the U.S. Environmental Protection Agency to promulgate more

200 CARB. January 2016. Cap-and-Trade Auction Proceeds Second Investment Plan: Fiscal Years 2016-17 through 2018-19. Available at: *www.arb.ca.gov/cc/capandtrade/auctionproceeds/16-17-updated-final-second-investment-planii.pdf*

201 CARB. 2017. Low-Income Barriers Study, Part B: Overcoming Barriers to Clean Transportation Access for Low Income Residents. *www.arb.ca.gov/msprog/transoptions/draft_sb350_clean_transportation_access_guidance_document.pdf*

stringent locomotives requirements,[202] work with California seaports, ocean carriers, and other stakeholders to develop the criteria to incentivize introduction of Super-Low Emission Efficient Ships, and investigate potential energy efficiency improvements for transport refrigeration units and insulated truck and trailer cargo vans.
- Promote research, development, and deployment of new technology to reduce GHGs, criteria pollutants, and toxics.
- Implement a process for intra-state agency and regional and local transportation coordination on automated vehicles to ensure shared policy goals in achieving safe, energy efficient, and low carbon autonomous vehicle deployment that also contribute to VMT reductions.

Ongoing and Proposed Measures – Clean Fuels

- Continue LCFS activities, with increasing stringency of at least 18 percent reduction in carbon intensity (CI).
- Continue to develop and commercialize clean transportation fuels through renewable energy integration goals, tax incentives, research investments, support for project demonstration, public outreach, setting procurement standards, including updating State and local procurement contracts.
- Per SB 1383 and the SLCP Strategy, adopt regulations to reduce and recover methane from landfills, wastewater treatment facilities, and manure at dairies; use the methane as a source of renewable gas to fuel vehicles and generate electricity; and establish infrastructure development and procurement policies to deliver renewable gas to the market.
- Accelerate deployment of alternative fueling infrastructure pursuant to the following:
  - SB 350 – CPUC to accelerate widespread transportation electrification.
  - Executive Order B-16-2012 and 2016 ZEV Action Plan – call for infrastructure to support 1 million ZEVs by 2020.
  - CEC's Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP).
  - CPUC's NRG settlement.
  - CALGreen Code provisions mandate installation of PEV charging infrastructure in new residential and commercial buildings.[203]
  - IOU electric vehicle charging infrastructure pilot programs.

Ongoing and Proposed Measures – Sustainable Freight

- Implement the California Sustainable Freight Action Plan:
  - 25 percent improvement of freight system efficiency by 2030.
  - Deployment of over 100,000 freight vehicles and equipment capable of zero emission operation, and maximize near-zero emission freight vehicles and equipment powered by renewable energy by 2030.

Ongoing and Proposed Measures – California and Transportation Plan

- Update every five years and implement California Transportation Plan.

Sector Measures

- Implement the post-2020 Cap-and-Trade Program

Potential Additional Actions

The actions below have the potential to reduce GHGs and complement the measures and policies identified in Chapter 2. These are included to spur thinking and exploration of innovation that may help the State achieve its long-term climate goals.

- Develop a set of complementary policies to make light-duty ZEVs clear market winners, with a goal of reaching 100 percent light-duty ZEV sales. This could include the following:
  - Reliable purchase/trade-in incentives for at least 10 years.
  - Dealer incentives for ZEV sales.
  - Policies to ensure operating cost savings for ZEVs relative to internal

---

202 *www.arb.ca.gov/railyard/docs/final_locomotive_petition_and_cover_letter_4_13_17.pdf*
203 Such as raceway and panel capacity to support future installation of electrical vehicle charging stations.

- combustion engines, including low cost electricity.
  - Additional investments in charging and ZEV refueling infrastructure.
  - A broad and effective marketing and outreach campaign.
  - Collaborations with cities to develop complementary incentive and use policies for ZEVs.
  - Targeted policies to support ZEV sales and use in low income and disadvantaged communities.
- Develop a Low-Emission Diesel Standard to diversify the fuel pool by incentivizing increased production of low-emission diesel fuels. This standard is anticipated to both displace consumption of conventional diesel with increased use of low-emission diesel fuels, and to reduce emissions from conventional fuels.
- Continue to develop and explore pathways to implement State-level VMT reduction strategies, such as those outlined in Appendix C through a transparent and inclusive interagency policy development process to evaluate and identify implementation pathways for additional policies to reduce VMT and promote sustainable communities, with a focus on the following:
  - Accelerating equitable and affordable transit-oriented and infill development through new and enhanced financing and policy incentives and mechanisms.
  - Promote infrastructure necessary for residential development in existing communities, and ensure any urban growth boundaries are paired with significant infill promotion strategies and removal of infill development barriers.
  - Identifying performance criteria for transportation and other infrastructure investments, to ensure alignment with GHG reduction goals and other State policy priorities, and improve proximity, expanded access to transit, shared mobility, and active transportation choices.
  - Promoting efficient development patterns that maximize protection of natural and working lands.
  - Developing pricing mechanisms such as road user/VMT-based pricing, congestion pricing, and parking pricing strategies.
  - Reducing congestion and related GHG emissions through programs to maximize the use of alternatives to single-occupant vehicles, including bicycling, walking, transit use, and shared mobility options for commute trips.
- Continue to promote research and standards for new and existing technologies to reduce GHGs, including but not limited to:
  - Low rolling resistance tires in the replacement tire market, subject to certification standards that identify tires as low rolling resistance tires or verify emissions reductions and potential fuel savings.
  - Impacts on VMT of car sharing, ride-sourcing, and other emerging mobility options.
  - Driving behaviors that reduce GHG emissions, such as ecodriving training and real-time feedback mechanisms.

Natural and Working Lands Including Agricultural Lands

In his 2015 State of the State address, Governor Brown established 2030 targets for GHG emissions reductions and called for policies and actions to reduce GHG emissions from natural and working lands, including forests, rangelands, farms, wetlands, and soils. The passage of SB 1386 (Wolk, Chapter 535, Statutes of 2015-16) codified this policy and emphasized the important role natural and working lands play in the State's climate strategy. This Scoping Plan focuses renewed attention on California's natural and working lands and the contribution they make to meet the State's goals for carbon sequestration, GHG reduction, and climate change adaptation.

California's natural and working lands encompass a range of land types and uses, including farms, ranches, forests, grasslands, deserts, wetlands, riparian areas, coastal areas and the ocean-- as well as the green spaces in urban and built environments. These resources can be both a source and sink for GHG emissions. Policy in this sector must balance GHG emissions reductions and carbon sequestration with other co-benefits, such as clean air, wildlife and pollinator habitat, strong economies, food, fiber and renewable energy production, and water supply.[204]

Recent trends indicate that significant pools of carbon from these landscapes risk reversal: over the period 2001–2010 disturbance caused an estimated 150 MMT C loss, with the majority– approximately 120 MMT C–

204 www.sierranevada.ca.gov/our-region/ca-primary-watershed

lost through wildland fire.[205] At the same time, energy use, methane, and N_2O emissions from the agricultural sector accounts for eight percent of the emissions in the statewide GHG inventory.

California's climate objective for natural and working lands is to maintain them as a carbon sink (i.e., net zero or negative GHG emissions) and, where appropriate, minimize the net GHG and black carbon emissions associated with management, biomass utilization, and wildfire events. In order to achieve this objective, this Plan directs the continued development of the broad and growing understanding of carbon dynamics on California's landscapes, statewide emission trends, and their responses to different land management scenarios. Further, in order to build a programmatic framework for achieving this long-term objective to maintain California's natural and working lands as a carbon sink, this Plan directs the State to quantify the carbon impacts of both publicly funded (e.g., bonds, special taxes, general fund) climate intervention activities on California's natural and working lands made through existing programs as well as potential regulatory actions on land management. This Plan proposes an intervention based reduction goal of at least 15-20 million metric tons by 2030 as a reasonable beginning point for further discussion and development based on the State's current preliminary understanding of what might be feasible. This Plan recognizes that achieving an initial statewide goal of sequestering and avoiding emissions in this sector by at least 15-20 million metric tons by 2030 through existing pathways and new incentives would provide a crucial complement to the measures described in this Scoping Plan and will inform the development of longer-term natural and working lands goals. Achieving this ambitious climate goal will require collaboration and support from State and local agencies, which must improve their capacity to participate and benefit from State climate programs, and set the path for natural and working lands to help the State meet its long-range climate goals.

Looking to the Future

This section outlines how the State will achieve California's climate objectives to: (1) maintain them as a resilient carbon sink (i.e., net zero or negative GHG emissions), and (2) minimize the net GHG and black carbon emissions associated with management, biomass disposal, and wildfire events to 2030 and beyond.

Implementation will include policy and program pathways, with activities related to land protection; enhanced carbon sequestration; and innovative biomass utilization. The framework for this section is to:

- **Protect** land from conversion to more intensified uses by increasing conservation opportunities and pursuing local planning processes in urban and infrastructure development patterns that avoid greenfield development.
- **Enhance** the resilience of and potential for carbon sequestration on lands through management and restoration, and reduce GHG and black carbon emissions from wildfire and management activities. This enhancement includes expansion and management of green space in urban areas.
- **Innovate** biomass utilization such that harvested wood and excess agricultural and forest biomass can be used to advance statewide objectives for renewable energy and fuels, wood product manufacturing, agricultural markets, and soil health, resulting in avoided GHG emissions relative to traditional utilization pathways. Associated activities should increase the resilience of rural communities and economies.

To accomplish these objectives, the State, led by California Natural Resources Agency (CNRA), California Department of Food and Agriculture (CDFA), California Environmental Protection Agency (CalEPA) and CARB will complete a Natural and Working Lands (NWL) Climate Change Implementation Plan (Implementation Plan) in 2018 to evaluate a range of implementation scenarios for natural and working lands and identify long-term (2050 or 2100) sequestration goals that can be incorporated into future climate policy. The Implementation Plan will:

- Include a projection of statewide emissions under business-as-usual land use and management conditions and alternative scenarios, as well as a listing and quantitative assessment of conservation and management activities the state may pursue to achieve the NWL climate objectives and the statewide goals of at least 15-20 $MMTCO_2e$ emissions sequestering and avoidance from the NWL sector by 2030;
- Identify state departments, boards, conservancies, and CNRA and CDFA programs responsible for meeting the 15-20 $MMTCO_2e$ goal by 2030; and
- Identify methodologies to be used by State programs to account for the

205 *www.arb.ca.gov/cc/inventory/sectors/forest/forest.htm*

GHG impacts of prior state funded land use and management interventions, and to be used to estimate the GHG impacts of future interventions.

While growing trees and other vegetation, as well as soil carbon sequestration, reduce some of the carbon losses measured, climate change itself further stresses many of these systems and affects the ability of California's landscapes to maintain its carbon sink. The State will continue to rely on best available science to support actions and incentives to slow and reverse these trends, in concert with other production and ecological objectives of land use. The Forest Climate Action Team, Healthy Soils Initiative, State Coastal Conservancy's Climate Ready Program, various California Climate Investment programs, and CARB's compliance offset program already undertake portions of this work. As we move towards and maximize the ability of our land base to serve as a carbon sink, it will also be important to strengthen these individual activities through the coordination and aggregation of ecoregional plans that inform these interventions. These and future additional efforts can not only protect California's natural carbon stocks, they can also improve quality of life in urban and rural communities alike and increase the climate resilience of agricultural, forestry, and recreational industries and the rural communities they support; the State's water supply; biodiversity; and the safety and environmental health of all who call California home.

Research and Policy Needs

Research is ongoing across agencies to advance the state of the science on NWL carbon dynamics, including a number of projects within the Fourth Climate Change Assessment, and a compendium of climate research being managed by the CNRA that will be completed in 2018. Additionally, California needs a well-defined reference case, or "business as usual" scenario to set a comprehensive and strategic path forward for California's lands and ocean environments to contribute to the State's climate goals. Finally, efforts must increase to gather, interpret, and unify best available science on the GHG and carbon sequestration impacts of land use and management practices applied across forests, cultivated agricultural lands, rangelands and grasslands, wetlands, coastal and ocean systems, desert ecosystems, and urban and other settled lands.

The Implementation Plan, as summarized above, will utilize the Protect-Enhance-Innovate framework and employ projections for carbon sequestration and GHG emissions from California's land base under reference case and increased management scenarios. The quantitative outputs of these projections, expressed as carbon dioxide equivalents will drive acreage needs for implementation using CO_2e/acre results from multiple modeling efforts. The Implementation Plan will also identify GHG emissions quantification within and across programs and agencies and describe implementation monitoring and emissions inventories.

Natural and Working Lands Inventory

In order to understand how carbon is released and sequestered by natural and working landscapes, CARB has worked extensively with other State agencies, academic researchers and the public to develop a Natural and Working Lands inventory that will guide this process. As with other sectors, the CARB Natural and Working Lands inventory represents a snapshot of emissions in recent years, using a combination of reported and measured data. A time lag exists between the last year of available data and the completion of the inventory to allow time for reporting and processing the data. For emission sources that are hard to individually measure, the CARB inventory estimates emissions based on "surrogates," such as the typical amount of travel on unpaved roads to estimate particulate matter emissions at the county level. The most recent inventory can also be "forecast" to project prevailing conditions in a future year based on rules and programs currently in place – known as a "business as usual projection" - along with scenarios to explore the benefits of further strategies to reduce emissions. Forecasts of business-as-usual and policy scenarios guide planning efforts.

As discussed below, ongoing research into forecasting emissions from Natural and Working Lands includes a project at Lawrence Berkeley National Laboratory funded by CNRA. CARB is monitoring this and other research activities and will incorporate results into a proposed inventory and forecasting methodology for Natural and Working Lands. CARB will solicit public feedback and review on the resulting product prior to completing the first full Natural and Working Lands Inventory by the end of 2018, as called for in SB 859. The Natural and Working Lands Inventory is spatially-resolved, so it can be segmented by county, watershed, or other regional planning areas. This spatial resolution allows local governments and regional organizations to use the inventory, along with more granular location-specific information, to track progress from projects in their jurisdictions.

CARB plans to update the forest component of the Natural and Working Lands inventory to include 2012 GHG emissions estimates, followed by emissions estimates for soil carbon, urban forestry, and croplands by mid-2018. Work currently in progress applies airborne and space-based technologies to monitor forest health and quantify emissions associated with land-based carbon. California and federal agencies are working with researchers and funding studies to enhance our understanding of the roles of forests and other lands in climate change using rapidly advancing remote sensing technology.[206, 207]

CALAND Carbon Emissions Model

CNRA is managing the development of a CALAND model through Lawrence Berkeley National Laboratory, which will include a projection of business-as-usual emissions as well as a listing and quantitative assessment of conservation and management activities the State may pursue to achieve at least 15-20 MMT sequestration and GHG avoided emissions from the NWL sector by 2030.

CNRA, along with CARB and CDFA, will establish a formal public engagement process to gather external scientific expertise to inform development and finalization of the CALAND model for use in the Implementation Plan. Development of the Implementation Plan itself will also include a formal public process.

Cross-Sector Interactions

Strategies that reduce GHG emissions or increase sequestration in the natural and working lands sector often overlap and result in synergies with other sectors, most notably at intersections with land use, biomass and waste utilization, energy and water. It will be important for the sector to make critical linkages to other sectors, including energy, transportation fuels, and waste, and develop plans to integrate the natural and working lands sector into existing models, such as PATHWAYS and REMI.

Landowner, local, and regional decisions affect land use development patterns and natural and working land conversion rates; conversely, conservation activities can support infill-oriented regional development and related transportation needs. As discussed earlier in the Transportation Sustainability section, under SB 375, Sustainable Communities Strategies (SCSs) aim to link transportation, housing, and climate policy to reduce per capita GHG emissions while providing a range of other important benefits for Californians. Some SCSs include policies, objectives or implementation measures relating to conservation and land protections, and to urban greening.[208] Protecting natural and working lands that are under threat of conversion can promote infill development, reduce VMT, limit infrastructure expansion, and curb associated GHG emissions. An integrated vision for community development, land conservation and management, and transportation is a key component of meeting our transportation and natural and working lands goals.[209]

Agricultural and commercial forestry operations produce biomass as both an objective (i.e., food and fiber production) and a waste by-product. How this material is utilized can either increase or decrease emissions associated with management and restoration activities, turn waste into usable products, displace fossil fuels used in energy and transportation, and increase carbon stored in durable wood products in the built environment. Finding productive ways to use this material offers new opportunities to reduce GHG emissions, promote carbon sequestration, and generate economic resources for forest, agricultural, and waste sectors and communities. California is investigating ways to transform how organic waste from the agricultural and municipal sectors is managed to meet SLCP emissions reductions targets required by SB 1383,[210] and to protect public health. Cross-sector synergies and complete waste inter-cycles, discussed further in the Waste Management section, result from conscientious treatment of these resources, including opportunities to improve soil health, increase renewable energy generation, and enhance market support for non-commercial products and waste. Productive utilization of dead and dying trees is a significant focus of the Governor's Tree Mortality Task Force, and efforts to resolve the current shortfall in utilization capacity is addressed in that State of Emergency Declaration as well as in SB 859.

Natural and working lands stewardship is essential to securing the State's water supply along the entire

206 Asner, G. et al. (2015) Progressive forest canopy water loss during the 2012–2015 California drought. PNAS 113.2: E249-E255

207 Battles, J. et al. (in progress) Innovations in measuring and managing forest carbon stocks in California. Project 2C: 4th California Climate Change Assessment. Natural Resources Agency. resources.ca.gov/climate/fourth/

208 Livingston, Adam. Sustainable Communities Strategies and Conservation. January 2016. Available at: *www.nature.org/ourinitiatives/regions/northamerica/unitedstates/california/sustainable-communities-strategies-and-conservation.pdf*

209 *www.arb.ca.gov/cc/scopingplan/meetings/meetings.htm*

210 SB1383 (Lara, Chapter 396, Statutes of 2016) requires a 50 percent reduction in anthropogenic black carbon emissions by 2030.

supply chain, from protection and management of the forested headwaters to preserving the ability of mountain meadows to retain and filter water ensuring flows and habitat in the Delta and its tributaries, end use efficiencies in agricultural and urban uses, and groundwater infiltration and utilization statewide. For example, more efficient water and energy use in farming operations could support GHG emissions reductions goals in the energy sectors. And improving forest health in the Sierra Nevada, Cascades, and other headwaters protects water quality and availability, in alignment with the California Water Action Plan.

Potential Actions to Enhance Carbon Sequestration and Reduce Greenhouse Gases in NWL

While agricultural and forest lands comprise the greatest acreage of NWL statewide, representing significant opportunity for achieving the State's NWL climate goals, actions on all NWL remain critical. The land management strategies and targets included in these sections are illustrative of the types of actions that will be necessary to maintain all of California's NWL and urban green space as a net sink of carbon, and are being used to aid in development of scenario modeling. The Implementation Plan will use this scenario modeling to scope the scale of action needed to ensure resilient future landscapes and identify key areas for advancement.

Agriculture's Role in Emissions Reductions and Carbon Sequestration

In 2030 and 2050, the agricultural sector must remain vibrant and strong. California's agricultural production is critical to global food security. It is also vulnerable to climate change. A study[211] by the University of California concluded that the drought in 2015 cost the state economy $2.7 billion and 21,000 full time jobs. These losses are expected to ripple through rural communities for another several years. This illustrates the importance of strengthening agriculture while protecting resources and mitigating climate change.

As the State works to meet emissions reductions goals, the agricultural sector can reduce emissions from production, sequester carbon and build soil carbon stocks, and play a role in cross-sectoral efforts to maximize the benefits of natural and working lands.

Climate-smart agriculture is an integrated approach to achieving GHG reductions while also ensuring food security and promoting agricultural adaptation in the face of climate change. Conserving agricultural land, sequestering carbon in agricultural soils, employing a variety of techniques to manage manure on dairies, and increasing the efficiency of on-farm water and energy use are examples of practices that can achieve climate and food production goals across diverse agricultural systems. Climate-smart agriculture can support the Protect, Enhance, and Innovate goals.

Approximately 60 percent of agricultural emissions are methane emissions from the dairy and livestock sectors. Emissions come from the animals themselves, through enteric fermentation, as well as from manure management–especially at dairies. SB 1383 and the resultant SLCP Strategy identify a mix of voluntary, incentive-based, and potential regulatory actions to achieve significant emissions reductions from these sources. A variety of techniques can attain the best results for each specific farming operation; effectively implementing a broad mix of strategies will reduce the GHG emissions from the agricultural sector significantly. CARB and CDFA and other agencies are working together to solicit input from industry, environmental, and community groups to encourage early and meaningful action to reduce emissions from the livestock sector.

Over the last several years, farms have begun to optimize fertilizer applications to protect water quality, maintain high yields, and reduce emissions of N_2O, a greenhouse gas. Farmers are required through the Irrigated Lands Regulatory Program to manage nitrogen fertilizers to protect water quality through the use of nitrogen management plans. Nitrogen management plans are a tool designed to prevent over-applications of nitrogen through an approach that accounts for the nitrogen inputs from water, soil amendments and other sources, and also accounts for nitrogen removed from the field. CDFA's Fertilizer Research and Education Program, in coordination with university researchers and others, has developed fertilization guidelines to optimize the rate, timing and placement of fertilizers for crops that represent more than half of the irrigated agriculture in California. Similarly, innovations in water management and the expansion of high efficiency irrigation methods also are contributing to N_2O reductions.

211 Howitt, Richard E., Duncan MacEwan, Josué Medellín-Azuara, Jay R. Lund, Daniel A. Sumner. 2015. Economic Analysis of the 2015 Drought for California. Davis, CA: Center for Watershed Sciences, University of California – Davis.

California's farms and ranches have the ability to remove carbon from the atmosphere through management practices that build and retain soil organic matter. Adequate soil organic matter ensures the continued soil capacity to function as a vital living ecosystem with multiple benefits, producing food for plants, animals, and humans. The Healthy Soils Initiative, announced by Governor Brown in 2015, offers an opportunity to incentivize the management of farmland for increased carbon sequestration in soil, also augmenting co-benefits including improved plant health and yields, increased water infiltration and retention, reduced sediment erosion and dust, improved water and air quality, and improved biological diversity and wildlife habitat.

SB 859, signed into law in 2016, establishes the Healthy Soils Program at CDFA to provide incentives to farmers. It enables financial support for on-farm demonstration projects that "result in greenhouse gas benefits across all farming types with the intent to establish or promote healthy soils". It defines healthy soils as "soils that enhance their continuing capacity to function as a biological system, increase soil organic matter, improve soil structure and water-and nutrient-holding capacity, and result in net long-term greenhouse gas benefits."

As noted in the Cross-Sector Interactions section, State and local efforts to manage land for carbon sequestration must work in conjunction with existing plans, incentives, and programs protecting California's water supply, agricultural lands, and wildlife habitat. This Scoping Plan fits within a wide range of ongoing planning efforts throughout the State to advance economic and environmental priorities associated with natural and working lands.

The Role of Forests in Emissions Reductions and Carbon Sequestration

Decades of fire exclusion, coupled with an extended drought and the impacts of climate change, have increased the size and intensity of wildfires and bark beetle infestations; exposed millions of urban and rural residents to unhealthy smoke-laden air from wildfires; and threatened progress toward meeting the state's long-term climate goals. Managing forests in California to be healthy, resilient net sinks of carbon is a vital part of California's climate change policy.

More than 100 million trees are dead, and recent wildfires have been among the most destructive and expensive in state history. As many as 15 million acres of California forests are estimated to be unhealthy and in need of some form of restoration, including more than 9 million acres managed by federal land management agencies and 6 million acres of State and privately managed forests.

California's urban forests also face multiple challenges, including drought and invasive exotic insects. Urban forests require maintenance to preserve the multiple values they provide and merit expansion to sequester carbon and secure other benefits to urban dwellers and the State.

The California Forest Carbon Plan (FCP), being developed by the Forest Climate Action Team (FCAT), seeks to establish California's forests as a more resilient and reliable long-term carbon sink, rather than a GHG and black carbon emission source, and confer additional ecosystem benefits through a range of management strategies.[212] The FCP emphasizes working collaboratively at the watershed or landscape scale to restore resilience to all forestlands in the state.

The current draft of the FCP places carbon sequestration and reducing black carbon and GHG emissions as one set of management objectives in the broader context of forest health and a range of other important forest co-benefits. California will manage for carbon alongside wildlife habitat, watershed protection, recreational access, traditional tribal uses, public health and safety, forest products, and local and regional economic development.

212 http://www.fire.ca.gov/fcat/

Federally managed lands play an important role in the achievement of the California climate goals established in AB 32 and subsequent related legislation and plans. Over half of the forestland in California is managed by the federal government, primarily by the USDA Forest Service Pacific Southwest Region, and these lands comprise the largest potential forest carbon sink under one ownership in the state. Several regulatory, policy, and financial challenges have hindered the ability of the Forest Service and Department of Interior agencies (Bureau of Land Management and National Park Service) to increase the pace and scale of restoration needed, such as the current budget structure to fund wildland fire suppression and the procedural requirements of a number of federal environmental and planning statutes. The State of California must continue to work closely and in parallel to the federal government's efforts to resolve these obstacles and achieve forest health and resilience on the lands that federal agencies manage.

Protection of Land and Land Use

California will continue to pursue development and new infrastructure construction patterns that avoid greenfield development, limit conflicts with neighboring land uses, and increase conservation opportunities for NWL to reduce conversion to intensified uses. Success will depend on working through local and regional land use planning and permitting, as well as developing incentives for participation by local governments and individual landowners.

Enhance Carbon Sequestration and Resilience through Management and Restoration

California will increase efforts to manage and restore land to secure and increase carbon storage and minimize GHG and black carbon emissions in a sustainable manner so that the carbon bank is resilient and provides other benefits such as water quality, habitat and recreation.

One tool to demonstrate the potential for greater management and restoration on NWL is the CALAND model. As detailed in the Discussion Draft[213] and discussed above, it considers a variety of management and restoration activities employed across the State. Version 1 of the CALAND model considered two potential scenarios, a "low" and a "high" rate of implementation to 2030, with resulting carbon sequestration outcomes to 2050. The acreages given in the "low" scenario all represent feasible implementation on public and private lands beyond current rates for the listed activity, given availability of additional funding and other supporting resources. The "high" scenario represents a more ambitious approach, requiring new programs and policies, including collaboration with federal partners, to support implementation.

The activities presented in the Discussion Draft and Version 2 of CALAND are not inclusive of all activities under this strategy. Modeling will continue beyond finalization of the Scoping Plan. Agencies and modelers will continue to identify and analyze land management and restoration activities to advance the State's climate goals and improvements in modeling projections or other quantification protocols.

Management and restoration activities under consideration to help reduce GHG emissions beyond those identified in initial modeling include, but are not limited to the following:

- Forest fuel reduction treatments, reforestation, other restoration activities, prescribed fire and managed ignition.
- Restoration of mountain meadows, managed wetlands in the Sacramento San Joaquin Delta, coastal wetlands and desert habitat.
- Increasing the extent of eelgrass beds.
- Creation and management of parks and other greenspace in urban areas, including expansion of the existing urban tree canopy.
- Implementation of U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) management practices suitable for California agriculture including those practices identified in the Healthy Soils Incentive Program.
- Compost application to irrigated cropland.

Additional potential tools to encourage these activities include working with the federal government to fund more management on federal lands, mitigating for land conversion (as modeled by the High Speed Rail Authority), and revisiting the Forest Practices Act to enhance carbon sequestration benefits associated with timber production activities.

---

213 *www.arb.ca.gov/cc/scopingplan/2030target_sp_dd120216.pdf*

Innovate NWL Waste Utilization Pathways

Excess materials generated by commercial agricultural and forestry operations, biomass and wood harvested through forest health and restoration treatments, and material that is generated in response to Tree Mortality Emergency activities, should be used in a manner that minimizes GHG and black carbon emissions and promotes public and environmental health. The Legislature and Governor Brown set an ambitious goal of 75 percent recycling, composting or source reduction of solid waste in landfills by 2020. The State and stakeholders must develop targeted policies or incentives to support durable markets for all of this diverted material. Market opportunities include production of renewable electricity and biofuels, durable wood products, compost and other soil amendments, animal feed and bedding, and other uses. Research, development, and implementation activities in energy, wood products, waste, and soil amendment fields should be spatially-scaled to better link waste generation with infrastructure development.

The goals of this sector, with the potential to reduce GHGs and complement the measures and policies identified in Chapter 2, are described in Looking to the Future. The development of the Implementation Plan will spur thinking and exploration of innovation that may help the State achieve its long-term climate goals.

Waste Management

The Waste Management sector covers all aspects of solid waste[214] and materials management including reduction/reuse; recycling, and remanufacturing of recovered material; composting and in-vessel (anaerobic and aerobic) digestion; biomass management (chip and grind, composting, biomass conversion); municipal solid waste transformation; and landfilling. This sector also includes market development programs, such as the State's recycled-content product procurement program and a range of grant and loan programs. Data from CalRecycle's report, *2014 Disposal Facility-Based Characterization of Solid Waste in California*, shows that materials, such as organics, that decompose in landfills and generate methane comprise a significant portion of the waste stream. Methane is a potent SLCP with a global warming potential 25 times greater than that of carbon dioxide on a 100-year time horizon and more than 70 times greater than that of carbon dioxide on a 20-year time horizon.[215]

Within CARB's greenhouse gas inventory, emissions from the waste management sector consist of methane and nitrous oxide emissions from landfills and from commercial-scale composting, with methane being the primary contributor to the sector's emissions. The sector emitted 8.85 $MMTCO_2e$ in 2014, comprising approximately 2 percent of the State's GHG emissions.

Emissions from recycling and waste have grown by 19 percent since 2000. The majority of those emissions are attributed to landfills, despite the majority of landfills having gas collection systems in place.[216] Landfill emissions account for 94 percent of the emissions in this sector, while compost production facilities make up a small fraction of emissions.[217] The annual amount of solid waste deposited in California landfills grew from 37 million tons in 2000 to its peak of 46 million tons in 2005, followed by a declining trend until 2009 when landfilled solid waste stabilized to relatively constant levels. Landfill emissions are driven by the total waste-in-place, rather than year-to-year fluctuation in annual deposition of solid waste, as the rate and volume of gas produced during decomposition depends on the characteristics of the waste and a number of environmental factors. As a result, waste disposed in a given year contributes to emissions that year and in subsequent years.

In addition to direct emissions, the reduction, reuse, and recycling of waste materials decreases upstream GHG emissions associated with the extraction and processing of virgin materials and their use in production and transport of products. Although many of these upstream GHG emissions happen outside of California, California's waste policies can reduce both local and global GHG emissions and create jobs within the State.

214 In general, the term solid waste refers to garbage, refuse, sludges, and other discarded solid materials resulting from residential activities, and industrial and commercial operations. This term generally does not include solids or dissolved material in domestic sewage or other significant pollutants in water such as silt, dissolved or suspended solids in industrial wastewater effluents, dissolved materials in irrigation return flows or other common water pollutants.

215 Intergovernmental Panel on Climate Change. 2007. Climate Change 2007: Working Group I: The Physical Science Basis. 2.10.2 Direct Global Warming Potentials. Fourth Assessment Report. *www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html*

216 CARB. 2013. California Greenhouse Gas Inventory for 2000–2013 – by Category as Defined in the 2008 Scoping Draft Plan (based upon IPCC Fourth Assessment Report's Global Warming Potentials).

217 CARB. 2016. 2016 Edition California GHG Emission Inventory. California Greenhouse Gas Emission Inventory: 2000–2014. Version June 17, 2016.

While landfills are an effective and relatively safe way to manage some waste, disposal-centric activities result in squandering valuable resources and generate landfill gases as well as other risks. A large fraction of the organics in the waste stream can be diverted from landfills to composting or digestion facilities to produce beneficial products. Moreover, food waste is the largest component of organics disposed in landfills; a portion of this is edible and should be captured at its source and, for example, provided to food banks to feed people in need. A State waste management sector "loading order" should focus more attention on reducing how much waste we generate and recovering and recycling whatever resources we can, using landfills as a last resort.

Landmark initiatives like the Integrated Waste Management Act of 1989 (AB 939) demonstrate California's efforts to build communities that consume less, recycle more, and take resource conservation to higher and higher levels. Statewide, Californians achieved a 49 percent recycling rate in 2014, and recycling programs support an estimated 75,000 to 115,000 green jobs in California. If California were to achieve a 75 percent statewide solid waste recycling rate by 2020–a goal set out by the Legislature in AB 341 (Chesboro, Chapter 476, Statutes of 2011)–by recycling and remanufacturing at in-state facilities, the State could potentially generate an additional 100,000 green jobs.[218] In addition to employment contributions, diversion of organic waste from landfills can generate positive environmental impacts. Compost from organic matter provides soil amendments to revitalize farmland, reduces irrigation and landscaping water demands, contributes to erosion control in fire-ravaged landscapes, and potentially increase long-term carbon storage in rangelands. Production and use of bioenergy in the form of biofuels and renewable natural gas has the potential to reduce dependency on fossil fuels for the transportation sector. For the energy sector, however, renewable natural gas faces safety, feasibility, and cost issues.

The State has a robust waste management system in place, with established programs that reduce air emissions through activities such as gas collection systems from landfills[219] and stringent recycling mandates. AB 939 required cities and counties to reduce the amount of waste going to landfills by 50 percent in 2000, and municipalities have nearly universally met this mandate. Californians dispose about 30 million tons of solid waste in landfills each year. To further reduce landfilled solid waste, the Legislature adopted AB 341 to achieve more significant waste reductions by setting a goal that 75 percent of solid waste generated be reduced, recycled, or composted by 2020, and by mandating commercial recycling. AB 1826 (Chesboro, Chapter 727, Statutes of 2014) added requirements regarding mandatory commercial organics recycling.

Although solid waste management has evolved over the last 27 years and diversion rates (which include more than recycling) have increased more than six-fold since 1989, if no further changes in policy are made, the State's growing population and economy will lead to higher amounts of overall disposal along with associated increases in GHG emissions. The pathway to reducing disposal and associated GHG emissions will require significant expansion of the composting, anaerobic digestion, and recycling manufacturing infrastructure in the State.

To help reduce GHG emissions by 40 percent below 1990 levels by 2030 and meet California's waste reduction goals, California's waste management sector strives to achieve in-state processing and management of waste generated in California. To carry out this vision, we must work with residents and producers to reduce the volume of waste generated overall and capitalize on technology and social changes that might enable waste reduction. Packaging comprises approximately 8 million tons of waste landfilled in California annually, or about one quarter of the State's total disposal stream. To reduce the climate change footprint of packaging, the State is promoting the inclusion of source reduction principles in packaging and product design; fostering recycling and recyclability as a front end design parameter for packaging and products that cannot be reduced; and encouraging recycling markets and market development for recycled-content products and packaging. CalRecycle is developing a packaging policy model containing components necessary for a mandatory comprehensive, statewide packaging program in California; this would need to be legislatively enacted to achieve a packaging reduction goal, such as 50 percent by 2030. CalRecycle is also continuing to work with stakeholder organizations and industry to explore complementary voluntary activities that have the potential to significantly decrease packaging disposal in California. In addition, large-scale shifts in materials management will be necessary, including steps to maximize recycling and diversion from landfills

---

218 CalRecycle. 2013. AB 341's 75 Percent Goal and Potential New Recycling Jobs in California by 2020. July. *www.calrecycle.ca.gov/Publications/Documents/1463/20131463.pdf*

219 CARB approved a regulation to reduce methane from municipal solid waste landfills as a discrete early action measure under AB 32. The regulation became effective June 17, 2010. Additional information is available at: *www.arb.ca.gov/regact/2009/landfills09/landfillfinalfro.pdf*

and build the necessary infrastructure to support a sustainable, low carbon waste management system within California. Working together, State and local agencies will identify ways to increase the use of waste diversion alternatives and expand potential markets, obtain funds and incentives for building the infrastructure and strengthening markets, and evaluate the need for additional research to achieve California's GHG reduction and waste management goals.

Additional legislation codified since the First Scoping Plan Update outlines new opportunities and requirements to reduce GHG emissions from the waste sector, with a focus on reducing organic waste sent to landfills. SB 605 (Lara, Chapter 523, Statutes of 2014) requires that CARB develop a strategy to reduce SLCPs and SB 1383 requires the strategy to be implemented by January 1, 2018. CARB's recently adopted SLCP Reduction Strategy includes organic waste diversion targets for 2020 and 2025 consistent with SB 1383 to reduce methane emissions from landfills. It requires CalRecycle, in consultation with CARB, to adopt regulations to achieve statewide disposal targets to reduce landfilling of organic waste by: (1) 50 percent from the 2014 level by 2020, and (2) 75 percent from the 2014 level by 2025. Under SB 1383, of the edible food destined for the organic waste stream, not less than 20 percent is to be recovered to feed people in need by 2025. The regulations are to take effect on or after January 1, 2022, and CalRecycle, in consultation with CARB, must analyze the progress that the waste management sector, State government, and local government have made in achieving the 2020 and 2025 goals by July 1, 2020. It is estimated that the combined effect of the food waste prevention and rescue programs and organics diversion from landfills will reduce 4 $MMTCO_2e$ of methane in 2030 (using a 20-year GWP), but one year of waste diversion in 2030 is expected to result in a reduction of 14 $MMTCO_2e$ of emissions over the lifetime of waste decomposition.

Looking to the Future

This section outlines the high-level objectives and goals to reduce GHGs in this sector.

Goals

- Take full ownership of the waste generated in California.
- View waste as a resource and convert waste from all sectors to beneficial uses.
- Develop a sustainable, low carbon waste management system that processes collected waste within California and generates jobs, especially in disadvantaged communities.
- Maximize recycling and diversion from landfills.
- Reduce direct emissions from composting and digestion operations through improved technologies.
- Build the infrastructure needed to support a sustainable, low carbon waste management system within California.
- Increase organics markets which complement and support other sectors.[220]
- Capture edible food before it enters the waste stream and provide to people in need.
- Increase production of renewable transportation fuels from anaerobic digestion of waste.
- Recognize the co-benefits of compost application.

Cross-Sector Interactions

The waste management sector interacts with all of the other sectors of the State's economy. Reducing waste, including food waste, is key to reducing the State's overall carbon footprint. Additionally, replacing virgin materials with recycled materials reduces the energy and GHGs associated with the goods we produce and consume.

California leads the United States in agricultural production in terms of value and crop diversity. Soil carbon is the main source of energy for important soil microbes and is key for making nutrients available to plants. Waste-derived compost and other organic soil amendments support the State's Healthy Soils Initiative being implemented by CDFA. In addition, the use of compost to increase soil organic matter in the agricultural sector provides other benefits, including reduced GHG emissions, conserved water, reduced synthetic (petroleum-based) fertilizer and herbicide use, and sequestered carbon.

220 Examples may include renewable energy (biogas to renewable transportation fuels or electricity); soils (application of organics to agricultural soils for building soil organic matter and conserving water; application of organics to mulch for erosion control; application of organics to rangelands for increased carbon sequestration); and forests (support use of forest residues for erosion control; stabilization of fire-ravaged lands).

Efforts to Reduce Greenhouse Gases

The measures below include some required and new potential measures to help achieve the State's 2030 target and to support the high-level objectives for this sector. Some measures may be designed to directly address GHG reductions, while others may result in GHG reductions as a co-benefit. In addition, to move forward with the goals of the waste management sector and achieve the 2030 target, certain actions are recommended to help set the groundwork. These actions affect several broad areas and are necessary for reducing the challenges facing this sector, and they are listed below as supporting actions.

Ongoing and Proposed Measures

- Continue implementation of the Landfill Methane Control Measure.
- Continue implementation of the Mandatory Commercial Recycling Regulation and the Mandatory Commercial Organics Recycling requirements.
- As required by SB 1383:
  - By 2018, CARB will implement the SLCP Strategy.
  - CalRecycle will develop regulations to require 50 percent organic waste diversion from landfills from 2014 levels by 2020 and 75 percent by 2025, including programs to achieve an edible food waste recovery goal of 20 percent below 2016 levels by 2025. The regulations shall take effect on or after January 1, 2022. By July 1, 2020, analyze the progress that the waste sector, State government, and local governments have made in achieving these goals.
  - CEC will develop recommendations for the development and use of renewable gas as part of the 2017 Integrated Energy Policy Report. Based on these recommendations, adopt policies and incentives to significantly increase sustainable production and use of renewable gas.

Potential Additional or Supporting Actions

The actions below have the potential to reduce GHGs and complement the measures and policies identified in Chapter 2. These are included to spur thinking and exploration of innovation that may help the State achieve its long-term climate goals.

- Establishing a sustainable State funding source (such as an increased landfill tip fee and new generator charge) for development of waste management infrastructure, programs, and incentives.
- Working with residents and producers to reduce the volume of waste generated overall and capitalize on technology and social changes that might enable waste reduction.
- Increasing organics diversion from landfills, building on established mandates (AB 341's 75 percent by 2020 solid waste diversion goal, AB 1594,[221] AB 1826,[222] AB 876[223]) and new short-lived climate pollutant targets for 2025 (SB 605, SB 1383) to be accomplished via prevention (including food rescue), recycling, composting/digestion, and biomass options.
- Addressing challenges and issues associated with significant expansion and construction of organics and recycling infrastructure in California that is needed to achieve recycling and diversion goals. Challenges and issues include permitting, grid/pipeline connection, funding, local siting, markets, and research.
- Developing programmatic Environmental Impact Reports (EIRs) and model permit and guidance documents to assist in environmental review and CEQA for new facilities.
- Providing incentives for expanded and new facilities to handle organics and recyclables to meet 2020 and 2030 goals.
- Providing incentives to develop and expand food rescue programs to reduce the amount of edible food being sent to landfills.
- Further quantifying co-benefits of compost products and addressing regulatory barriers that do not provide for consideration of co-benefits.
- Supporting existing and new clean technologies and markets for excess woody biomass from urban areas, forests, and agriculture.
- Supporting the development of transportation fuel production at digestion facilities to generate renewable transportation fuels.

221 Assembly Bill 1594, Waste Management (Williams, Chapter 719, Statutes of 2014).
222 Assembly Bill 1826, Solid Waste: Organic Waste (Chesbro, Chapter 727, Statutes of 2014).
223 Assembly Bill 876, Compostable Organics (McCarty, Chapter 593, Statutes of 2015).

- Resolving issues of pipeline injection and grid connection to make renewable energy projects competitive.
- Supporting the use of available capacity at wastewater treatment plants that have digesters to process food waste.
- Working with local entities to provide a supportive framework to advance community-wide efforts that are consistent with, or exceed, statewide goals.
- Supporting research and development and pathways to market for dairy and codigestion digesters, including pipeline injection and interconnection.
- Supporting research on digestate characterization and end products.

Water

Water is essential to all life, and is vital to our overall health and well-being. A reliable, clean, and abundant supply of water is also a critical component of California's economy and has particularly important connections to energy, food, and the environment. California's water system includes a complex infrastructure that has been developed to support the capture, use, conveyance, storage, conservation, and treatment of water and wastewater. This elaborate network of storage and delivery systems enables the State to prosper and support populations, amidst wide variability in annual precipitation rates and concentration of rain north of Sacramento, through storing and moving water when and where it is needed.

Local water agencies play an important role in delivering water to communities, farms, and businesses. Some purchase water from the major State and federal projects, treat the water as needed, and deliver it to their customers; others act as wholesale agencies that buy or import water and sell it to retail water suppliers. Some agencies operate their own local water supply systems, including reservoirs and canals that store and move water as needed. Many agencies rely on groundwater exclusively, and operate local wells and distribution systems. In recent decades, local agencies have developed more diversified sources of water supplies. Many agencies use a combination of imported surface water and local groundwater, and also produce or purchase recycled water for end uses such as landscape irrigation.[224]

The State's developed surface and groundwater resources support a variety of residential, commercial, industrial, and agricultural activities. California's rapidly growing population–estimated to reach 44 million by 2030[225] – is putting mounting pressure on the water supply system. In the future, the ability to meet most new demand for water will come from a combination of increased conservation and water use efficiency, improved coordination of management of surface and groundwater, recycled water, new technologies in drinking water treatment, groundwater remediation, and brackish and seawater desalination.[226]

One of the State's largest uses of energy is attributed to several aspects of the water life cycle, including end uses such as heating and cooling, and water treatment and conveyance. Ten percent of the State's energy use is associated with water-related end uses, while water and wastewater systems account for 2 percent of the State's energy use.[227] Therefore, as water demand grows, energy demand may increase concurrently. Population growth drives demand for both water and energy resources, so both grow at about the same rates and in many of the same geographic areas.[228] This dynamic is further exacerbated by the precipitation-population mismatch between Northern and Southern California. Since the greatest energy consumption related to water is from delivery to end uses, the potential for energy savings also resides with water end users, where water conservation and efficiency play an important role.

The principal source of GHG emissions from the water sector comes from the fossil fuel-based energy consumed for water end uses (e.g., heating, cooling, pressurizing, and industrial processes), and the fossil fuel-based energy used to "produce" water (e.g., pump, convey, treat). Therefore, emissions reductions strategies are primarily associated with reducing the energy intensity of the water sector. Energy intensity is a measure of the amount of energy required to take a unit of water from its origin (such as a river or aquifer)

224 California Department of Water Resources. Regional Energy Intensity of Water Supplies. *www.water.ca.gov/climatechange/RegionalEnergyIntensity.cfm*

225 *http://www.dof.ca.gov/Forecasting/Demographics/projections/*

226 California Natural Resources Agency, California Department of Food and Agriculture, and California Environmental Protection Agency. California Water Action Plan.

227 California Department of Water Resources. Water-Energy Nexus: Statewide. Web page accessed November 2016 at: *www.water.ca.gov/climatechange/WaterEnergyStatewide.cfm*.

228 Ibid

and extract and convey it to its end use.[229] Within California, the energy intensity of water varies greatly depending on the geography, water source, and end use. The California Department of Water Resources (DWR) subdivides the State into 10 regions corresponding to the State's major drainage basins. An interactive map on the DWR website allows users to see a summary of the energy intensity of regional water supplies, ignoring end-use factors.[230] As the energy sector is decarbonized through measures such as increased renewable energy and improved efficiency, energy intensities will also be reduced. It is also important to note that end user actions to reduce water consumption or replace fresh water with recycled water do not automatically translate into GHG reductions. The integrated nature of the water supply system means that a reduction by one end user can be offset by an increase in consumption by another user. Likewise, use of recycled water has the potential to reduce GHGs if it replaces, and not merely serves as an alternative to, an existing, higher-carbon water supply.

The State is currently implementing several targeted, agricultural, urban, and industrial-based water conservation, recycling, and water use efficiency programs as part of an integrated water management effort that will help achieve GHG reductions through reduced energy demand within the water sector. Appendix H highlights the more significant existing policies, programs, measures, regulations, and initiatives that provide a framework for helping achieve GHG emissions reductions in this sector.

While it is important for every sector to contribute to the State's climate goals, ensuring universal access to clean water as outlined in AB 685 (Eng, Chapter 524, Statutes of 2012), also known as the "human right to water" bill, should take precedence over achieving GHG emissions reductions from water sector activities where a potential conflict exists. AB 685 states that it is the policy of the State that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." As described in this section, water supplies vary in energy intensity and resulting GHGs, depending on the source of the water, treatment requirements, and location of the end user.

Looking to the Future

This section outlines the high-level objectives and goals to reduce GHGs in this sector.

Goals

- Develop and support more reliable water supplies for people, agriculture, and the environment, provided by a more resilient, diversified, sustainably managed water resources system with a focus on actions that provide direct GHG reductions.
- Make conservation a California way of life by using and reusing water more efficiently through greater water conservation, drought tolerant landscaping, stormwater capture, water recycling, and reuse to help meet future water demands and adapt to climate change.
- Develop and support programs and projects that increase water sector energy efficiency and reduce GHG emissions through reduced water and energy use.
- Increase the use of renewable energy to pump, convey, treat, and utilize water.
- Reduce the carbon footprint of water systems and water uses for both surface and groundwater supplies through integrated strategies that reduce GHG emissions while meeting the needs of a growing population, improving public safety, fostering environmental stewardship, aiding in adaptation to climate change, and supporting a stable economy.

Cross-Sector Interactions

Water, energy, food, and ecosystems are inextricably linked, and meeting future climate challenges will require an integrated approach to managing the resources in these sectors.

Water is used in various applications in the energy sector, ranging in intensity from cooling of turbines and other equipment at power plants to cleaning solar photovoltaic panels. In 2003, CEC adopted a water conservation policy for power plants to limit the use of freshwater for power plant cooling, and has since encouraged project

229 A broader definition of energy intensity could consider the "downstream" energy (i.e., wastewater treatment) as well as the upstream components. More robust data are needed, and the State is working to better quantify these upstream and downstream emissions.

230 California Department of Water Resources. Regional Energy Intensity of Water Supplies. *www.water.ca.gov/climatechange/RegionalEnergyIntensity.cfm*

owners proposing to build new power plants in California to reduce water consumption with water-efficiency technologies such as dry cooling and to conserve fresh water by using recycled water. Likewise, energy is used in multiple ways and at multiple steps in water delivery and treatment systems, including energy for heating and chilling water; treating and delivering drinking water; conveying water; extracting groundwater; desalination; pressurizing water for irrigation; and wastewater collection, treatment, and disposal.

Although GHG reduction strategies for the water sector have the closest ties to energy, the water sector also interacts with the natural and working lands, agricultural, waste management, and transportation sectors. Water flows from mountains to downstream regions through natural and working lands, which provide habitat for many species and function to store water, recharge groundwater, naturally purify water, and moderate flooding. Protection of key lands from conversion results in healthier watersheds by reducing polluted runoff and maintaining a properly functioning ecosystem. California is the United States' leading agricultural production state in terms of value and crop diversity. Approximately nine million acres of farmland in California are irrigated.[231] In addition, water use is associated with livestock watering, feedlots, dairy operations, and other on-farm needs. Altogether, agriculture uses about 40 percent of the State's managed water supply.[232] In the end, agricultural products produced in California are consumed by humans throughout the world as food, fiber, and fuel. Wastewater treatment plants provide a complementary opportunity for the waste management sector to help process organic waste diversion from landfills. Treatment plants with spare capacity can potentially accommodate organic waste for anaerobic co-digestion of materials such as food waste and fats, oil, and grease from residential, commercial, or industrial facilities to create useful by-products such as electricity, hydrogen, biofuels, and soil amendments.[233] The water sector is also essential to our community health and long-term well-being, and measures must ensure that we continue to have access to clean and reliable sources of drinking water. Climate change threatens to impact our water supplies, for example, with long-term droughts leading to wells and other sources of water running dry. This can have devastating consequences, especially on communities already vulnerable and sensitive to changes in their water supply and natural hydrological systems, including rural communities who have limited options for water supplies. Water conservation and management strategies that are energy efficient can also ensure a continued supply of water for our health and well-being.

Efforts to Reduce Greenhouse Gases

The measures below include some required and new potential measures to help achieve the State's 2030 target and to support the high-level objectives for this sector. Some measures may be designed to directly address GHG reductions, while others may result in GHG reductions as a co-benefit. In addition, several recommended actions are identified to help the water sector move forward with the identified goals and measures to achieve the 2030 target; these are listed as supporting actions.

Ongoing and Proposed Measures

- As directed by Governor Brown's Executive Order B-37-16, DWR and State Water Resources Control Board (SWRCB) will develop and implement new water use targets to generate more statewide water conservation than existing targets (the existing State law requires a 20 percent reduction in urban per capita water use by 2020 [SBx7-7, Steinberg, Chapter 4, Statutes of 2009]). The new water use targets will be based on strengthened standards for indoor use, outdoor irrigation, commercial, industrial, and institutional water use.
- SWRCB will develop long-term water conservation regulation, and permanently prohibit practices that waste potable water.
- DWR and SWRCB will develop and implement actions to minimize water system leaks, and to set performance standards for water loss, as required by SB 555 (Wolk, Chapter 679, Statutes of 2015).
- DWR and CDFA will update existing requirements for agricultural water management plans to increase water system efficiency.

231 Hanson, Blaine. No date. Irrigation of Agricultural Crops in California. PowerPoint. Department of Land, Air and Water Resources University of California, Davis. *www.arb.ca.gov/fuels/lcfs/workgroups/lcfssustain/hanson.pdf*

232 Applied water use is the official terminology used by DWR. "Applied water refers to the total amount of water that is diverted from any source to meet the demands of water users without adjusting for water that is used up, returned to the developed supply, or considered irrecoverable."

233 An example of a resource recovering project that can help achieve methane reductions includes fuel cells that are integrated into wastewater treatment plants for both onsite heat and power generation and the production of renewable hydrogen.

- CEC will certify innovative technologies for water conservation and water loss detection and control.
- CEC will continue to update the State's Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601–1608) for appliances offered for sale in California to establish standards that reduce energy consumption for devices that use electricity, gas, and/or water.
- California Environmental Protection Agency (CalEPA) will oversee development of a voluntary registry for GHG emissions resulting from the water-energy nexus, as required by SB 1425 (Pavley, Chapter 596, Statutes of 2016).
- The State Water Project has entered long-term contracts to procure renewable electricity from 140 MW solar installations in California.
- As described in its Climate Action Plan, DWR will continue to increase the use of renewable energy to operate the State Water Project.

Overall, these actions will contribute to the broader energy efficiency goals discussed in the Low Carbon Energy section of this chapter.

Potential Additional or Supporting Actions

The actions below have the potential to reduce GHGs and complement the measures and policies identified in Chapter 2. These are included to spur thinking and exploration of innovation that may help the State achieve its long-term climate goals.

- Where technically feasible and cost-effective, local water and wastewater utilities should adopt a long-term goal to reduce GHGs by 80 percent below 1990 levels by 2050 (consistent with DWR's Climate Action Plan), and thereafter move toward low carbon or net-zero carbon water management systems.
- Local water and wastewater utilities should develop distributed renewable energy where feasible, using the expanded Local Government Renewable Energy Bill Credit (RES-BCT) tariff and new Net Energy Metering (which allow for installation without system size limit).
- In support of the Short-Lived Climate Pollutant Strategy, encourage resource recovering wastewater treatment projects to help achieve the goal of reducing fugitive methane by 40 percent by 2030, to include:
  - Determining opportunities to support co-digestion of food-related waste streams at wastewater treatment plants.
  - Incentivizing methane capture systems at wastewater treatment plants to produce renewable electricity, transportation fuel, or pipeline biomethane.
- Support compact development and land use patterns, and associated conservation and management strategies for natural and working lands that reduce per capita water consumption through more water-efficient built environments.

Chapter 5

Achieving Success

Meeting, and exceeding, our mandated GHG reduction goals in 2020 and through 2030 requires building on California's decade of success in implementing effective climate policies. State agencies are increasingly coordinating planning activities to align with overarching climate, clean air, social equity, and broader economic objectives.

However, to definitely tip the scales in favor of rapidly declining emissions, we also need to reach beyond State policy-making and engage all Californians. Further progress can be made by supporting innovative actions at the local level–among governments, small businesses, schools, and individual households. Ultimately, success depends on a mix of regulatory program development, incentives, institutional support, and education and outreach to ensure that clean energy and other climate strategies are clear, winning alternatives in the marketplace–to drive business development and consumer adoption.

Ongoing Engagement with Environmental Justice Communities

CARB continues seek ways to improve implementation of AB 32 and the unique set of impacts facing environmental justice communities. However, CARB's environmental justice efforts reach far beyond climate change. In 2001, the Board approved CARB's "Policies and Actions for Environmental Action,"[234] which expresses a broad commitment to environmental justice and makes it integral to all of CARB's programs, consistent with State directives at the time. Though over the years CARB has taken on a wide array of activities aimed at reducing environmental burdens on environmental justice communities, it has not knitted its various efforts together in a coherent narrative or maximized the impact of these activities by leveraging them off of each other.

This year, CARB appointed its first executive-level environmental justice liaison. Under her leadership, CARB will lay a roadmap for better serving California's environmental justice communities in the design and implementation of its programs, and identifying new actions CARB can take to advance environmental justice and social equity in all of its functions.

The extensive legislative framework addressing climate change, air quality, and environmental justice that has emerged since the passage of AB 32 has prompted CARB to step up its environmental justice efforts and articulate a vision that reflects the current context. CARB will initiate a public process, seeking advice and input from environmental justice advocates and other key stakeholders to inform the development of a new strategic plan for further institutionalizing environmental justice and social equity.

CARB understands that in addition to our programs to address climate change and reduce emissions of GHGs, more needs to be done to reduce exposure to toxic air and criteria pollutants and improve the quality of life in communities surrounding our largest emissions sources. To this end, and consistent with AB 617, AB 197, AB 1071, SB 535 and AB 1550, we will actively engage EJ advocates, communities, and relevant air districts in the development of programs that improve air quality and quantify the burdens placed on air quality in local communities. Measuring and monitoring air quality conditions over time and ongoing community engagement are integral to the success of CARB's efforts. This engagement will include substantive discussions with EJ stakeholders, gathering their input and providing adequate time for review before matters are taken to the Board for decision.

234 *www.arb.ca.gov/ch/programs/ej/ejpolicies.pdf*

CARB's approach to environmental justice will be grounded in five primary pillars: transparency, integration, monitoring, research, and enforcement.

- **Transparency:** CARB must improve communication and engagement with environmental justice stakeholders and deepen partnerships with local communities impacted by air pollution. CARB will continue to prioritize transparency in its decision-making processes and provide better access to the air quality, toxics, and GHG data CARB collects and stewards.
- **Integration:** Besides integrating environmental justice throughout all of CARB's programs, those programs must complement each other. To that end, CARB will endeavor to break down programmatic silos so that it is able to leverage its work and achieve more effective and timely results. Focused resources in individual communities can accelerate reduction in emissions, proliferation of clean vehicles and creation of jobs in the clean energy economy, while concurrently improving public health.
- **Monitoring:** Communities should be engaged in CARB's monitoring work. They can play a critical role in collecting their own data and adding to the coverage of other air monitoring efforts (e.g., CARB, local air districts). CARB has already invested in research on low-cost monitors that are accessible by communities, and it will continue to evaluate how community monitoring can make CARB more nimble in identifying and addressing "hotspots." Mobile monitoring projects similarly will allow CARB to better serve and protect residents of disadvantaged communities. CARB will continue to build partnerships with local communities and help build local capacity through funding and technical assistance.
- **Research:** CARB's research agenda is core to achieving its mission. To ensure that the research done by CARB responds to environmental justice concerns and has the greatest potential to improve air quality and public health in disadvantaged communities, CARB will engage communities groups early in the development of its research agenda and the projects that flow out from that agenda.
- **Enforcement:** Disadvantaged communities are often impacted by many sources of pollution. In order to improve air quality and protect public health, CARB will prioritize compliance with legal requirements, including enforcement actions if necessary, in environmental justice communities to ensure emissions of toxic and criteria pollutants in these communities are as low as possible.

Our inclusive approaches to further environmental justice in California's local communities may include an array of direct regulation, funding, and community capacity-building. CARB will continue to actively implement the provisions of AB 617, AB 197, AB 1071, SB 535, AB 1550, and other laws to better ensure that environmental justice communities see additional benefits from our clean air and climate policies. Our inclusive approaches to further environmental justice in California's local communities may include an array of direct regulation, funding, and community capacity-building.

Enabling Local Action

Local governments are essential partners in achieving California's goals to reduce GHG emissions. Local governments can implement GHG emissions reduction strategies to address local conditions and issues and can effectively engage citizens at the local level. Local governments also have broad jurisdiction, and sometimes unique authorities, through their community-scale planning and permitting processes, discretionary actions, local codes and ordinances, outreach and education efforts, and municipal operations. Further, local jurisdictions can develop new and innovative approaches to reduce GHG emissions that can then be adopted elsewhere. For example, local governments can develop land use plans with more efficient development patterns that bring people and destinations closer together in more mixed-use, compact communities that facilitate walking, biking, and use of transit. Local governments can also incentivize locally generated renewable energy and infrastructure for alternative fuels and electric vehicles, implement water efficiency measures, and develop waste-to-energy and waste-to-fuel projects. These local actions complement statewide measures and are critical to supporting the State's efforts to reduce emissions. Local efforts can deliver substantial additional GHG and criteria emissions reductions beyond what State policy can alone, and these efforts will sometimes be more cost-effective and provide more cobenefits than relying exclusively on top-down statewide regulations to achieve the State's climate stabilization goals. To ensure local and regional engagement, it is also recommended local jurisdictions make readily available information regarding ongoing and proposed actions to reduce GHGs within their region.

Many cities and counties are already setting GHG reduction targets, developing local plans, and making progress toward reducing emissions. The Statewide Energy Efficiency Collaborative recently released a report, *The State of Local Climate Action: California 2016*,[235] which highlights local government efforts, including:

- In California, 60 percent of cities and over 70 percent of counties have completed a GHG inventory, and 42 percent of local governments have completed a climate, energy, or sustainability plan that directly addresses GHG emissions. Many other community-scale local plans, such as general plans, have emissions reduction measures incorporated as well (see Governor's Office of Planning and Research [OPR] Survey questions 23 and 24).[236]
- Over one hundred California local governments have developed emissions reduction targets that, if achieved, would result in annual reductions that total 45 $MMTCO_2e$ by 2020 and 83 $MMTCO_2e$ by 2050.[237]

Local air quality management and air pollution control districts also play a key role in reducing regional and local sources of GHG emissions by actively integrating climate protection into air quality programs. Air districts also support local climate protection programs by providing technical assistance and data, quantification tools, and even funding.[238] Local metropolitan planning organizations (MPOs) also support the State's climate action goals via sustainable communities strategies (SCSs), required by the Sustainable Communities and Climate Protection Act of 2008 (SB 375, Chapter 728, Statutes of 2008). Under SB 375, MPOs must prepare SCSs as part of their regional transportation plan to meet regional GHG reduction targets set by CARB for passenger vehicles in 2020 and 2035. The SCSs contain land use, housing, and transportation strategies that allow regions to meet their GHG emissions reductions targets.

To engage communities in efforts to reduce GHG emissions, CARB has partnered with Energy Upgrade California on the CoolCalifornia Challenge. It is a competition among California cities to reduce their carbon footprints and build more vibrant and sustainable communities. Three challenges have been completed. Most recently, the 2015–2016 Challenge included 22 cities and engaged nearly 3,200 households, each of which took actions to reduce energy use and carbon GHG emissions. In total, the participants reported savings of 5,638 MTCO2 from completed actions, equivalent to emissions from more than 1,000 cars or from electricity used by more than 2,500 California homes in a year.

State agencies support these local government actions in several ways:

- *CoolCalifornia.org* is an informational website that provides resources that assist local governments, small businesses, schools, and households to reduce GHG emissions. The local government webpage includes carbon calculators, a climate planning resource guide, a Funding Wizard that outlines grant and loan programs, and success stories. It also features ClearPath California, a no-cost GHG inventory, climate action plan development, and tracking tool developed through the Statewide Energy Efficiency Collaborative in coordination with CARB and the Governor's Office of Planning and Research (OPR).
- Chapter 8 of OPR's General Plan Guidelines[239] provides guidance for climate action plans and

235 Statewide Energy Efficiency Collaborative. 2016. State of Local Climate Action: California 2016. *californiaseec.org/wp-content/uploads/2016/10/State-of-Local-Climate-Action-California-2016_Screen.pdf*

236 Governor's Office of Planning and Research. 2016. 2016 Annual Planning Survey Results. November. *www.opr.ca.gov/docs/2016_APS_final.pdf*

237 These reductions include reductions from both state and local measures.

238 Examples include: (1) Bay Area Air Quality Management District (BAAQMD). 2016 Clean Air Plan and Regional Climate Protection Strategy. Available at: *www.baaqmd.gov/plans-and-climate/air-quality-plans/plans-under-development*; (2) California Air Pollution Control Officers Association. California Emissions Estimator Model (CalEEMod). Available at: *www.caleemod.com/*; (3) San Joaquin Valley Air Pollution Control District. Grants and Incentives. Available at: *valleyair.org/grants/*; (4) BAAQMD. Grant Funding. Available at: *www.baaqmd.gov/grant-funding*; (5) South Coast Air Quality Management District. Funding. Available at: *www.aqmd.gov/grants-bids/funding*; (6) Sacramento Metropolitan Air Quality Management District. Incentive Programs. Available at: *www.airquality.org/Residents/Incentive-Programs*.

239 *http://opr.ca.gov/planning/general-plan/*

- other plans linked to general plans, which address the community scale approach outlined in CEQA Guidelines Section 15183.5(b), Plans for the Reduction of Greenhouse Gas Emissions.
- OPR hosts the Integrated Climate Adaptation and Resiliency Program, which is developing resources and case studies that outline the co-benefits of implementing emissions reduction strategies and addressing the impacts of climate change.
- CARB is developing a centralized database and interactive map that will display the current statewide status of local government climate action planning. Users can view and compare the details of emission inventories, planned GHG reduction targets and strategies, and other climate action details specific to each local government. This information will help jurisdictions around California identify what climate action strategies are working in other, similar jurisdictions across the State, and will facilitate collaboration among local governments pursuing GHG reduction strategies and goals. This database and map will be featured on the *CoolCalifornia.org* website and are anticipated to be available in 2017.
- Additional information on local government activities is available on Cal-Adapt (*www.cal-adapt.org*) and OPR (*www.opr.ca.gov*)

Further, a significant portion of the $3.4 billion in cap-and-trade expenditures has either directly or indirectly supported local government efforts to reduce emissions, including, for example, the Affordable Housing and Sustainable Communities (AHSC) program and approximately $142 million for project implementation and planning grants awarded under the Transformative Climate Communities program.

Climate Action through Local Planning and Permitting

Local government efforts to reduce emissions within their jurisdiction are critical to achieving the State's long-term GHG goals, and can also provide important co-benefits, such as improved air quality, local economic benefits, more sustainable communities, and an improved quality of life. To support local governments in their efforts to reduce GHG emissions, the following guidance is provided. This guidance should be used in coordination with OPR's General Plan Guidelines guidance in Chapter 8, Climate Change.[240] While this guidance is provided out of the recognition that local policy makers are critical in reducing the carbon footprint of cities and counties, the decision to follow this guidance is voluntary and should not be interpreted as a directive or mandate to local governments.

Recommended Local Plan-Level Greenhouse Gas Emissions Reduction Goals

CARB recommends statewide targets of no more than six metric tons CO_2e per capita by 2030 and no more than two metric tons CO_2e per capita by 2050.[241] The statewide per capita targets account for all emissions sectors in the State, statewide population forecasts, and the statewide reductions necessary to achieve the 2030 statewide target under SB 32 and the longer term State emissions reduction goal of 80 percent below 1990 levels by 2050.[242] The statewide per capita targets are also consistent with Executive Order S-3-05, B-30-15, and the Under 2 MOU that California originated with Baden-Württemberg and has now been signed or endorsed by 188 jurisdictions representing 39 countries and six continents.[243,244] Central to the Under 2 MOU is that all signatories agree to reduce their GHG emissions to two metric tons CO_2e per capita by 2050. This limit represents California's and these other governments' recognition of their "fair share" to reduce GHG emissions to the scientifically based levels to limit global warming below two degrees Celsius. This limit is also consistent with the Paris Agreement, which sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to below 2°C.[245]

CARB recommends that local governments evaluate and adopt robust and quantitative locally-appropriate

240 *http://opr.ca.gov/planning/general-plan/* .

241 These goals are appropriate for the plan level (city, county, subregional, or regional level, as appropriate), but not for specific individual projects because they include all emissions sectors in the State.

242 This number represents the 2030 and 2050 targets divided by total population projections from California Department of Finance.

243 *http://under2mou.org/* California signed the Under 2 MOU on May 19, 2015. See *under2mou.org/wp-content/uploads/2015/05/California-appendix-English.pdf* and *under2mou.org/wp-content/uploads/2015/05/California-Signature-Page.pdf*.

244 The Under 2 MOU signatories include jurisdictions ranging from cities to countries to multiple-country partnerships. Therefore, like the goals set forth above for local and regional climate planning, the Under 2 MOU is scalable to various types of jurisdictions.

245 UNFCCC. The Paris Agreement. *unfccc.int/paris_agreement/items/9485.php*

goals that align with the statewide per capita targets and the State's sustainable development objectives and develop plans to achieve the local goals. The statewide per capita goals were developed by applying the percent reductions necessary to reach the 2030 and 2050 climate goals (i.e., 40 percent and 80 percent, respectively) to the State's 1990 emissions limit established under AB 32.

Numerous local governments in California have already adopted GHG emissions reduction goals for year 2020 consistent with AB 32. CARB advises that local governments also develop community-wide GHG emissions reduction goals necessary to reach 2030 and 2050 climate goals. Emissions inventories and reduction goals should be expressed in mass emissions, per capita emissions, and service population emissions. To do this, local governments can start by developing a community-wide GHG emissions target consistent with the accepted protocols as outlined in OPR's General Plan Guidelines Chapter 8: Climate Change. They can then calculate GHG emissions thresholds by applying the percent reductions necessary to reach 2030 and 2050 climate goals (i.e., 40 percent and 80 percent, respectively) to their community-wide GHG emissions target. Since the statewide per capita targets are based on the statewide GHG emissions inventory that includes all emissions sectors in the State, it is appropriate for local jurisdictions to derive evidence-based local per capita[246] goals based on local emissions sectors and population projections that are consistent with the framework used to develop the statewide per capita targets. The resulting GHG emissions trajectory should show a downward trend consistent with the statewide objectives. The recommendation for a community-wide goal expands upon the reduction of 15 percent from "current" (2005-2008) levels by 2020 as recommended in the 2008 Scoping Plan.[247]

In developing local plans, local governments should refer to "The U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions,"[248] (community protocol) which provides detailed guidance on completing a GHG emissions inventory at the community scale in the United States – including emissions from businesses, residents, and transportation. Quantification tools such as ClearPath California, which was developed with California agencies, also support the analysis of community-scale GHG emissions. Per the community protocol, these plans should disclose all emissions within the defined geographical boundary, even those over which the local government has no regulatory authority to control, and then focus the strategies on those emissions that the jurisdiction controls. For emissions from transportation, the community protocol recommends including emissions from trips that extend beyond the community's boundaries. Local plans should also include the carbon sequestration values associated with natural and working lands, and the importance of jurisdictional lands for water, habitat, agricultural, and recreational resources. Strategies developed to achieve the local goals should prioritize mandatory measures that support the Governor's "Five Pillars" and other key state climate action goals.[249] Examples of plan-level GHG reduction actions that could be implemented by local governments are listed in Appendix B. Additional information and tools on how to develop GHG emissions inventories and reduction plans tied to general plans can be found in OPR's General Plan Guidelines and at *CoolCalifornia.org*.

These local government recommendations are based on the recognition that California must accommodate population and economic growth in a far more sustainable manner than in the past. While state-level investments, policies, and actions play an important role in shaping growth and development patterns, regional and local governments and agencies are uniquely positioned to influence the future of the built environment and its associated GHG emissions. Greenhouse gas emissions reduction strategies in Climate Action Plans (CAPs) and other local plans can also lead to important co-benefits, such as improved air quality, local economic benefits such as green jobs, more mobility choices, improved public health and quality of life, protection of locally, statewide, and globally important natural resources, and more equitable sharing of these benefits across communities.

Contributions from policies and programs, such as renewable energy and energy efficiency, are helping to achieve the near-term 2020 target, but longer-term targets cannot be achieved without land use decisions that allow more efficient use and management of land and infrastructure. Local governments have primary authority to plan, zone, approve, and permit how and where land is developed to accommodate population growth, economic growth, and the changing needs of their jurisdictions. Land use decisions affect GHG emissions associated with transportation, water use, wastewater treatment, waste generation and treatment, energy consumption, and conversion of natural and working lands. Local land use decisions play a particularly

246 Or some other metric that the local jurisdiction deems appropriate (e.g., mass emissions, per service population)
247 2008 Scoping Plan, page 27, *www.arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm*
248 *http://icleiusa.org/publications/us-community-protocol/*
249 *www.arb.ca.gov/cc/pillars/pillars.htm*

critical role in reducing GHG emissions associated with the transportation sector, both at the project level, and in long-term plans, including general plans, local and regional climate action plans, specific plans, transportation plans, and supporting sustainable community strategies developed under SB 375.

While the State can do more to accelerate and incentivize these local decisions, local actions that reduce VMT are also necessary to meet transportation sector-specific goals and achieve the 2030 target under SB 32. Through developing the Scoping Plan, CARB staff is more convinced than ever that, in addition to achieving GHG reductions from cleaner fuels and vehicles, California must also reduce VMT. Stronger SB 375 GHG reduction targets will enable the State to make significant progress toward needed reductions, but alone will not provide the VMT growth reductions needed; there is a gap between what SB 375 can provide and what is needed to meet the State's 2030 and 2050 goals. In its evaluation of the role of the transportation system in meeting the statewide emissions targets, CARB determined that VMT reductions of 7 percent below projected VMT levels in 2030 (which includes currently adopted SB 375 SCSs) are necessary. In 2050, reductions of 15 percent below projected VMT levels are needed. A 7 percent VMT reduction translates to a reduction, on average, of 1.5 miles/person/day from projected levels in 2030. It is recommended that local governments consider policies to reduce VMT to help achieve these reductions, including: land use and community design that reduces VMT; transit oriented development; street design policies that prioritize transit, biking, and walking; and increasing low carbon mobility choices, including improved access to viable and affordable public transportation and active transportation opportunities. It is important that VMT reducing strategies are implemented early because more time is necessary to achieve the full climate, health, social, equity, and economic benefits from these strategies.

Once adopted, the plans and policies designed to achieve a locally-set GHG goal can serve as a performance metric for later projects. Sufficiently detailed and adequately supported GHG reduction plans (including CAPs) also provide local governments with a valuable tool for streamlining project-level environmental review. Under CEQA, individual projects that comply with the strategies and actions within an adequate local CAP can streamline the project-specific GHG analysis.[250] The California Supreme Court recently called out this provision in CEQA as allowing tiering from a geographically specific GHG reduction plan.[251] The Court also recognized that GHG determinations in CEQA should be consistent with the statewide Scoping Plan goals, and that CEQA documents taking a goal-consistency approach may soon need to consider a project's effects on meeting the State's longer term post-2020 goals.[252] The recommendation above that local governments develop local goals tied to the statewide per capita goals of six metric tons CO_2e by 2030 and no more than two metric tons CO_2e per capita by 2050 provides guidance on CARB's view on what would be consistent with the 2017 Scoping Plan and the State's long-term goals.

Production based inventories and emissions reduction programs are appropriate for local communities wanting to mitigate their emissions pursuant to CEQA Section 15183.5(b). Consumption based inventories are complementary to production based inventories and are appropriate as a background setting, disclosure, and as an outreach tool to show how personal decisions may change a person's or household's contribution to climate change. For additional information, see the OPR General Plan Guidelines.[253]

Project-Level Greenhouse Gas Emissions Reduction Actions and Thresholds

Beyond plan-level goals and actions, local governments can also support climate action when considering discretionary approvals and entitlements of individual projects through CEQA. Absent conformity with an adequate geographically-specific GHG reduction plan as described in the preceding section above, CARB recommends that projects incorporate design features and GHG reduction measures, to the degree feasible, to minimize GHG emissions. Achieving no net additional increase in GHG emissions, resulting in no contribution to GHG impacts, is an appropriate overall objective for new development. There are recent examples of land use development projects in California that have demonstrated that it is feasible to design projects that achieve zero net additional GHG emissions. Several projects have received certification from the Governor under AB 900, the Jobs and Economic Improvement through Environmental Leadership Act (Buchanan, Chapter 354, Statutes of 2011), demonstrating an ability to design economically viable projects that create jobs while contributing no net additional GHG emissions.[254] Another example is the Newhall

250 CEQA Guidelines, § 15183.5, sub. (b).

251 Center for Biological Diversity v. California Dept. of Fish and Wildlife (2015) 62 Cal.4th 204, 229–230.

252 Id. at pp. 223–224.

253 *http://opr.ca.gov/planning/general-plan/*.

254 Governor's Office of Planning and Research. California Jobs. *http://www.opr.ca.gov/ceqa/california-jobs.html*

Ranch Resource Management and Development Plan and Spineflower Conservation Plan,[255] in which the applicant, Newhall Land and Farming Company, proposed a commitment to achieve net zero GHG emissions for a very large-scale residential and commercial specific planned development in Santa Clarita Valley.

Achieving net zero increases in GHG emissions, resulting in no contribution to GHG impacts, may not be feasible or appropriate for every project, however, and the inability of a project to mitigate its GHG emissions to net zero does not imply the project results in a substantial contribution to the cumulatively significant environmental impact of climate change under CEQA. Lead agencies have the discretion to develop evidence-based numeric thresholds (mass emissions, per capita, or per service population) consistent with this Scoping Plan, the State's long-term GHG goals, and climate change science.[256]

To the degree a project relies on GHG mitigation measures, CARB recommends that lead agencies prioritize on-site design features that reduce emissions, especially from VMT, and direct investments in GHG reductions within the project's region that contribute potential air quality, health, and economic co-benefits locally. For example, on-site design features to be considered at the planning stage include land use and community design options that reduce VMT, promote transit oriented development, promote street design policies that prioritize transit, biking, and walking, and increase low carbon mobility choices, including improved access to viable and affordable public transportation, and active transportation opportunities. Regionally, additional GHG reductions can be achieved through direct investment in local building retrofit programs that can pay for cool roofs, solar panels, solar water heaters, smart meters, energy efficient lighting, energy efficient appliances, energy efficient windows, insulation, and water conservation measures for homes within the geographic area of the project. These investments generate real demand side benefits and local jobs, while creating the market signals for energy efficient products, some of which are produced in California. Other examples of local direct investments include financing installation of regional electric vehicle (EV) charging stations, paying for electrification of public school buses, and investing in local urban forests.

Local direct investments in actions to reduce GHG emissions should be supported by quantification methodologies that show the reductions are real, verifiable, quantifiable, permanent, and enforceable. Where further project design or regional investments are infeasible or not proven to be effective, it may be appropriate and feasible to mitigate project emissions through purchasing and retiring carbon credits. CAPCOA has developed the GHG Reduction Exchange (GHG Rx) for CEQA mitigation, which could provide credits to achieve additional reductions. It may also be appropriate to utilize credits issued by a recognized and reputable voluntary carbon registry. Appendix B includes examples of on-site project design features, mitigation measures, and direct regional investments that may be feasible to minimize GHG emissions from land use development projects.

California's future climate strategy will require increased focus on integrated land use planning to support livable, transit-connected communities, and conservation of agricultural and other lands. Accommodating population and economic growth through travel- and energy-efficient land use provides GHG-efficient growth, reducing GHGs from both transportation and building energy use.[257] GHGs can be further reduced at the project level through implementing energy-efficient construction and travel demand management approaches.[258] Further, the State's understanding of transportation impacts continues to evolve. The CEQA Guidelines are being updated to focus the analysis of transportation impacts on VMT. OPR's Technical Advisory includes methods of analysis of transportation impacts, approaches to setting significance thresholds, and includes examples of VMT mitigation under CEQA.[259]

255 https://nrm.dfg.ca.gov/documents/ContextDocs.aspx?cat=NewhallRanchFinal

256 CARB provided some guidance on development project thresholds in a paper issued in October 2008, which included a concept utilizing a bright-line mass numeric threshold based on capturing approximately 90 percent of emissions in that sector and a concept of minimum performance based standards. Some districts built upon that work to develop thresholds. For example, Santa Barbara County adopted a bright-line numeric threshold of 1,000 $MTCO_2e$/yr for industrial stationary-source projects, and Sacramento Metropolitan Air Quality Management District adopted a 10,000 $MTCO_2e$/yr threshold for stationary source projects and a 1,100 $MTCO_2e$/yr threshold for construction activities and land development projects in their operational phase. CARB is not endorsing any one of these approaches, but noting them for informational purposes.

257 Robert Cervero, Jim Murakami; Effects of Built Environment on Vehicle Miles Traveled: Evidence from 370 US Urbanized Areas. Environment and Planning A, Vol 42, Issue 2, pp. 400-418, February-01-2010; Ewing, R., & Rong, F. (2008). The impact of urban form on U.S. residential energy use. Housing Policy Debagte, 19 (1), 1-30.).

258 CAPCOA, Quantifying Greenhouse Gas Mitigation Measures: A Resource for Local Government to Assess Emission Reductions from Greenhouse Gas Mitigation Measures, August, 2010.

259 http://www.opr.ca.gov/ceqa/updates/sb-743/

Implementing the Scoping Plan

This Scoping Plan outlines the regulations, programs, and other mechanisms needed to reduce GHG emissions in California. CARB and other State agencies will work closely with State and local agencies, stakeholders, Tribes, and the public to develop regulatory measures and other programs to implement the Scoping Plan. CARB and other State agencies will develop regulations in accordance with established rulemaking guidelines. Per Executive Order B-30-15, as these regulatory measures and other programs are developed, building programs for climate resiliency must also be a consideration. Additionally, agencies will further collaborate and work to provide the institutional support needed to overcome barriers that may currently hinder certain efforts to reduce GHG emissions and to support the goals, actions, and measures identified for key sectors in Chapter 4. Table 17 provides a high-level summary of the Climate Change Policies and Measures discussed in the Scoping Plan, including, but not limited to, those identified specifically to achieve the 2030 target.

Table 17: Climate Change Policies and Measures

Recommended Action	Lead Agency
Implement SB 350 by 2030: • Increase the Renewables Portfolio Standard to 50 percent of retail sales by 2030 and ensure grid reliability. • Establish annual targets for statewide energy efficiency savings and demand reduction that will achieve a cumulative doubling of statewide energy efficiency savings in electricity and natural gas end uses by 2030. • Reduce GHG emissions in the electricity sector through the implementation of the above measures and other actions as modeled in IRPs to meet GHG emissions reductions planning targets in the IRP process. Load-serving entities and publicly-owned utilities meet GHG emissions reductions planning targets through a combination of measures as described in IRPs.	CPUC, CEC, CARB
Implement Mobile Source Strategy (Cleaner Technology and Fuels): • At least 1.5 million zero emission and plug-in hybrid light-duty electric vehicles by 2025. • At least 4.2 million zero emission and plug-in hybrid light-duty electric vehicles by 2030. • Further increase GHG stringency on all light-duty vehicles beyond existing Advanced Clean Cars regulations. • Medium- and heavy-duty GHG Phase 2. • Innovative Clean Transit: Transition to a suite of to-be-determined innovative clean transit options. Assumed 20 percent of new urban buses purchased beginning in 2018 will be zero emission buses with the penetration of zero-emission technology ramped up to 100 percent of new sales in 2030. Also, new natural gas buses, starting in 2018, and diesel buses, starting in 2020, meet the optional heavy-duty low-NO_X standard. • Last Mile Delivery: New regulation that would result in the use of low NO_X or cleaner engines and the deployment of increasing numbers of zero-emission trucks primarily for class 3-7 last mile delivery trucks in California. This measure assumes ZEVs comprise 2.5 percent of new Class 3–7 truck sales in local fleets starting in 2020, increasing to 10 percent in 2025 and remaining flat through 2030. • Further reduce VMT through continued implementation of SB 375 and regional Sustainable Communities Strategies; forthcoming statewide implementation of SB 743; and potential additional VMT reduction strategies not specified in the Mobile Source Strategy but included in the document "Potential VMT Reduction Strategies for Discussion."	CARB, CalSTA, SGC, CalTrans CEC, OPR, Local agencies
Increase stringency of SB 375 Sustainable Communities Strategy (2035 targets).	CARB
By 2019, adjust performance measures used to select and design transportation facilities. • Harmonize project performance with emissions reductions, and increase competitiveness of transit and active transportation modes (e.g. via guideline documents, funding programs, project selection, etc.).	CalSTA and SGC, OPR, CARB, GoBiz, IBank, DOF, CTC, Caltrans
By 2019, develop pricing policies to support low-GHG transportation (e.g. low-emission vehicle zones for heavy duty, road user, parking pricing, transit discounts).	CalSTA, Caltrans, CTC, OPR/SGC, CARB

Recommended Action	Lead Agency
Implement California Sustainable Freight Action Plan: • Improve freight system efficiency. • Deploy over 100,000 freight vehicles and equipment capable of zero emission operation and maximize both zero and near-zero emission freight vehicles and equipment powered by renewable energy by 2030.	CalSTA, CalEPA, CNRA, CARB, CalTrans, CEC, GoBiz
Adopt a Low Carbon Fuel Standard with a CI reduction of 18 percent.	CARB
Implement the Short-Lived Climate Pollutant Strategy by 2030: • 40 percent reduction in methane and hydrofluorocarbon emissions below 2013 levels. • 50 percent reduction in black carbon emissions below 2013 levels.	CARB, CalRecycle, CDFA, SWRCB, Local air districts
By 2019, develop regulations and programs to support organic waste landfill reduction goals in the SLCP and SB 1383.	CARB, CalRecycle, CDFA, SWRCB, Local air districts
Implement the post-2020 Cap-and-Trade Program with declining annual caps.	CARB
By 2018, develop Integrated Natural and Working Lands Implementation Plan to secure California's land base as a net carbon sink: • Protect land from conversion through conservation easements and other incentives. • Increase the long-term resilience of carbon storage in the land base and enhance sequestration capacity • Utilize wood and agricultural products to increase the amount of carbon stored in the natural and built environments • Establish scenario projections to serve as the foundation for the Implementation Plan	CNRA and departments within, CDFA, CalEPA, CARB
Establish a carbon accounting framework for natural and working lands as described in SB 859 by 2018	CARB
Implement Forest Carbon Plan	CNRA, CAL FIRE, CalEPA and departments within
Identify and expand funding and financing mechanisms to support GHG reductions across all sectors.	State Agencies & Local Agencies

A Comprehensive Approach to Support Climate Action

Ultimately, successfully tipping the scales in the fight against climate change relies on our ability to incentivize clean technologies in the marketplace and to make other climate strategies clearly understood and easily accessible. We must support and guide our businesses as they continue to innovate and make clean technologies ever more attractive to ever more savvy consumers. Until the point that clean technologies become the best and lowest cost option–which is clearly on the horizon for many technologies, including renewable energy and electric cars–we must continue to support emerging markets through incentives and outreach efforts. More than just coordinating among agencies and providing institutional support as described above, we will succeed if we tackle climate change from all angles–through regulatory and policy development, targeted incentives, and education and outreach.

Regulations and Programmatic Development

Our decade of climate leadership has demonstrated that developing mitigation strategies through a public process, where all stakeholders have a voice, leads to effective actions that address climate change and yield a series of additional economic and environmental co-benefits to the State. As we implement this Scoping Plan, State agencies will continue to develop and implement new and existing programs, as described herein. During any rulemaking process, there are many opportunities for both informal interaction with technical staff in meetings and workshops, and formal interaction at Board meetings, Commission business meetings, monthly public meetings, and others. Each State agency will consider all information and stakeholder input during the rulemaking process. Based on this information, the agency may modify proposed measures to reflect the status of technological development, the cost of the measure, the cost-effectiveness of the measures, and other factors before presenting them for consideration and adoption.

Further, to achieve cost-effective GHG reductions, California State agencies must consider the environmental impact of small businesses and provide mechanisms to assist businesses as GHG reduction measures are implemented. CARB provides resources and tips for small businesses to prevent pollution, minimize waste, and save energy and water on *CoolCalifornia.org*. California's small businesses and their employees represent a valuable economic resource in the State and "greening" existing businesses is not only achievable, but sets an example for new businesses which will prove significant as California transitions to a low carbon state.

State agencies conduct environmental and environmental justice assessments of our regulatory actions. Many of the requirements in AB 32 overlap with traditional agency evaluations. In adopting regulations to implement the measures recommended in the Scoping Plan, or including in the regulations the use of market-based compliance mechanisms to comply with the regulations, agencies will ensure that the measures have undergone the aforementioned screenings and meet the requirements established in California Health and Safety Code Section 38562(b)(1-9) and Section 38570(b)(1-3).

Incentive Programs

Financial incentives and direct funding are critical components of the State's climate framework. In particular, incentives and funding are necessary to support GHG emissions reductions strategies for priority sectors, sources, and technologies. Although California has a number of existing incentive programs, available funding is limited. It is critical to target public investments efficiently and in ways that encourage integrated, system wide solutions to produce deep and lasting public benefits. Significant investments of private capital, supported by targeted, priority investments of public funding, are necessary to scale deployment and to maximize benefits. Public investments, including through decisions related to State pension fund portfolios, can help incentivize early action to accelerate market transition to cleaner technologies and cleaner practices, which can also be supported by regulatory measures.

Many existing State funding programs work in tandem to reduce emissions from GHGs, criteria pollutants, and toxic air contaminants, and are helping to foster the transition to a clean energy economy and protect and manage land for carbon sequestration. State law, including Senate Bill 535 (De León, Chapter 830, Statutes of 2012) and Assembly Bill 1550 (Gomez, Chapter 369, Statutes of 2016) also requires focused investment in low income and disadvantaged communities.

The State will need to continue to coordinate and utilize funding sources, such as the Greenhouse Gas Reduction Fund (cap-and-trade auction proceeds), the Alternative and Renewable Fuel and Vehicle Technology Program (AB 118), Electric Program Investment Charge (EPIC) Program, Carl Moyer Program, Air Quality Improvement Program, and Proposition 39 to expand clean energy investments in California and further reduce GHG and criteria emissions. Additionally, programs including the Bioenergy Feed-In Tariff, created by Senate Bill 1122 (Rubio, Chapter 612, Statutes of 2012), Low Carbon Fuel Standard, Cap-and-Trade, Self-Generation Incentive Program, Federal Renewable Fuel Standard, utility incentives pursuant to Assembly Bill 1900 (Gatto, Chapter 602, Statutes of 2012), and others provide important market signals and potential revenue streams to support projects to reduce GHG emissions.

These programs represent just a portion of the opportunities that exist at the federal, State, and local levels to incentivize GHG emissions reductions. The availability of dedicated and long-lasting funding sources is critical to help meet the State's climate objectives and help provide certainty and additional partnership opportunities at the national, State, Tribal, regional, and local levels for further investing in projects that have the potential to expand investments in California's clean economy and further reductions in GHG emissions.

Public Education and Outreach Efforts

California State agencies are committed to meaningful opportunities for public input and effective engagement with stakeholders and the public through the development of the Scoping Plan, and as measures are implemented through workshops, other meetings, and through the formal rulemaking process. Additionally, the State has broad public education and outreach campaigns to support markets for key technologies, like ZEVs and energy efficiency, as well as resources to support local and voluntary actions, such as *CoolCalifornia.org*.

In developing this Scoping Plan, there has been extensive outreach with environmental justice organizations and disadvantaged communities. The EJAC launched a community engagement process starting in July 2016, conducting 19 community meetings throughout the State and collecting hundreds of individual comments. To enhance the engagement opportunity, CARB coordinated with local government agencies and sister State agencies to hold collaborative discussions with local residents about specific climate issues that impact their lives. This effort was well received and attended by local community residents and initiated a new community engagement endeavor for CARB. Recognizing the value of the input received and the opportunity to present California's climate strategy to communities across the State, CARB intends to continue this community involvement to generate awareness about California's climate strategy and be responsive to specific community needs as climate programs are implemented.

Education and Environment Initiative

The California Environmental Protection Agency (CalEPA), the California Department of Education, and the California Natural Resources Agency have developed an environmental curriculum that is being taught in more than half of California's school districts. The Education and Environment Initiative (EEI) provides California's teachers with tools to educate students about the natural environment and how everyday choices can improve our planet and save money.

Conclusion

This Scoping Plan continues more than a half-century of California's nation-leading efforts to clean our air, our water and improve the environment. But, climate change poses a challenge of unprecedented proportions that will, in one way or another, impact all Californians whether they are city dwellers in Los Angeles, San Diego or San Francisco, farmers in Salinas or the Central Valley, or the millions of Californians who live in the Sierra or in the desert areas.

This is the State's climate action plan, and in a very real sense it belongs to all those Californians who are feeling, and will continue to feel, the impacts of climate change. Californians want to see continued effective action that addresses climate change and benefits California – this Plan responds to both of these goals. The Plan was developed by the coordinated consensus of State agencies, but it is really California's Plan, because over the coming decades the approaches in this document will be carried out by all of us.

In this Scoping Plan, every sector in our thriving economy plays a crucial role. Tribes, cities, and local governments are already rising to the challenge, and will play increasingly important roles with everything from low-carbon and cleaner transit, to more walkable streets and the development of vibrant urban communities.

We will see a remarkable transformation of how we move throughout the state, away from cars that burn fossil fuels to cleaner, electric cars that will, in some cases, even drive themselves. Freight will be moved around the state by trucks that are vastly cleaner than those on the road now, with our ports moving towards zero- and near-zero emissions technologies. The heavily traveled Los Angeles-San Francisco corridor will be serviced by comfortable, clean and affordable high speed rail.

In addition to reducing GHGs, these efforts will slash pollution now created from using gasoline and diesel fuel statewide, with the greatest benefits going to the disadvantaged communities of our state which are so often located adjacent to ports, railyards, freight distribution centers and freeways. And, thanks to the continued investment of proceeds from the Cap-and-Trade Program in these same communities, we can continue to work on bringing the benefits of clean technology – whether electric cars or solar roofs – to those in our state who need them the most.

Climate change presents us with unprecedented challenges – challenges that cannot be met with traditional ways of thinking or conventional solutions. As Governor Brown has recognized, meeting these challenges will require "courage, creativity and boldness." The last ten years proved to ourselves, and the world, that Californians recognize the danger of climate change. It has also demonstrated that developing mitigation strategies through a public process where all stakeholders have a voice leads to effective actions that address climate change while yielding a series of co-benefits to the state. This Scoping Plan builds on those early steps and moves into a new chapter that will deliver a thriving economy and a clean environment to our children and grandchildren. It is a commitment to the future, but it begins today by moving forward with the policies in this Plan.

Abbreviations

AB	Assembly Bill
AC	air conditioning
AEO	Annual Energy Outlook
AHSC	Affordable Housing and Sustainable Communities
ARFVTP	Alternative and Renewable Fuel and Vehicle Technology Program
BARCT	best available retrofit control technology
BAU	business-as-usual
BC	British Columbia
BEV	Battery-electric vehicle
CARB	California Air Resources Board
CAISO	California Independent System Operator
CalEPA	California Environmental Protection Agency
CALGreen	California Green Building Standards
CalPERS	California Public Employees' Retirement System
CalSTA	California State Transportation Agency
CalSTRS	California State Teachers' Retirement System
CAP	Climate Action Plan
CARE	California Alternate Rates for Energy Program
CDFA	California Department of Food and Agriculture
CDPH	California Department of Public Health
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CFT	Clean Fuels and Technology
CH_4	Methane
CI	carbon intensity
CNRA	California Natural Resources Agency
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COPD	chronic obstructive pulmonary disease
CPUC	California Public Utilities Commission
CSI	California Solar Initiative
dge	diesel gallon equivalent
DWR	California Department of Water Resources
EA	Environmental Analysis
EEI	Education and Environment Initiative
EIR	Environmental Impact Report
EJAC	Environmental Justice Advisory Committee

EO	Executive Order
EPIC	Electric Program Investment Charge Program
F-gases	fluorinated gases
FCEV	Fuel-cell electric vehicle
FERA	Family Electric Rate Assistance
GCF	Governors' Climate and Forests Task Force
GDP	gross domestic product
GGRF	Greenhouse Gas Reduction Fund
GHG	greenhouse gas
GoBiz	Governor's Office of Business and Economic Development
GWP	global warming potential
HCD	California Department of Housing and Community Development
HFC	Hydrofluorocarbon
HVAC	heating, ventilation and air conditioning
ICAP	International Carbon Action Partnership
IEPR	Integrated Energy Policy Report
IOU	investor-owned utility
IPCC	United Nations Intergovernmental Panel on Climate Change
IRP	integrated resource plan
IWG	Interagency Working Group on the Social Cost of Greenhouse Gases
LCFS	Low Carbon Fuel Standard
LCTOP	Low Carbon Transit Operations Program
LDV	light-duty vehicle
LED	light-emitting diode
LIWP	Low-Income Weatherization Program
LOS	level of service
$MMTCO_2e$	million metric tons of carbon dioxide equivalent
MOU	memorandum of understanding
MPO	metropolitan planning organization
MRR	Regulation for the Mandatory Reporting of GHG Emissions
$MTCO_2$	metric tons of carbon dioxide
MW	Megawatt
N_2O	nitrous oxide
NAICS	North American Industry Classification System
NEM	Net-Energy Metering
NF_3	nitrogen trifluoride
NO_X	nitrogen oxide
NZE	near-zero emission
OEHHA	Office of Environmental Health Hazard Assessment
OPR	Governor's Office of Planning and Research

PEV	plug-in electric vehicle
PHEV	Plug-in hybrid electric vehicle
PFC	Perfluorocarbon
PM	particulate matter
$PM_{2.5}$	fine particulate matter
PMR	Partnership for Market Readiness
REMI	Regional Economic Models, Inc.
RES-BCT	Renewable Energy Bill Credit
RNG	renewable natural gas
RPS	renewable portfolio standard
RTP	regional transportation plan
SB	Senate bill
SCS	Sustainable Communities Strategies
$SC\text{-}CO_2$	social cost of carbon
SF_6	sulfur hexafluoride
SGC	Strategic Growth Council
SGIP	Self-Generation Incentive Program
SLCP	Short-lived climate pollutant
SWRCB	State Water Resources Control Board
TBD	to be determined
TCU	Transportation Communications and Utilities
TIRCP	Transit and Intercity Rail Capital Program
UCLA	University of California, Los Angeles
UHI	urban heat island
UIC	International Union of Railways
UNFCCC	United Nations Framework Convention on Climate Change
USDA	U.S. Department of Agriculture
U.S. EPA	United States Environmental Protection Agency
VMT	vehicle miles traveled
WWTP	waste water treatment plant
ZE	zero emission
ZEV	zero emission vehicles

California’s 2030 Vision