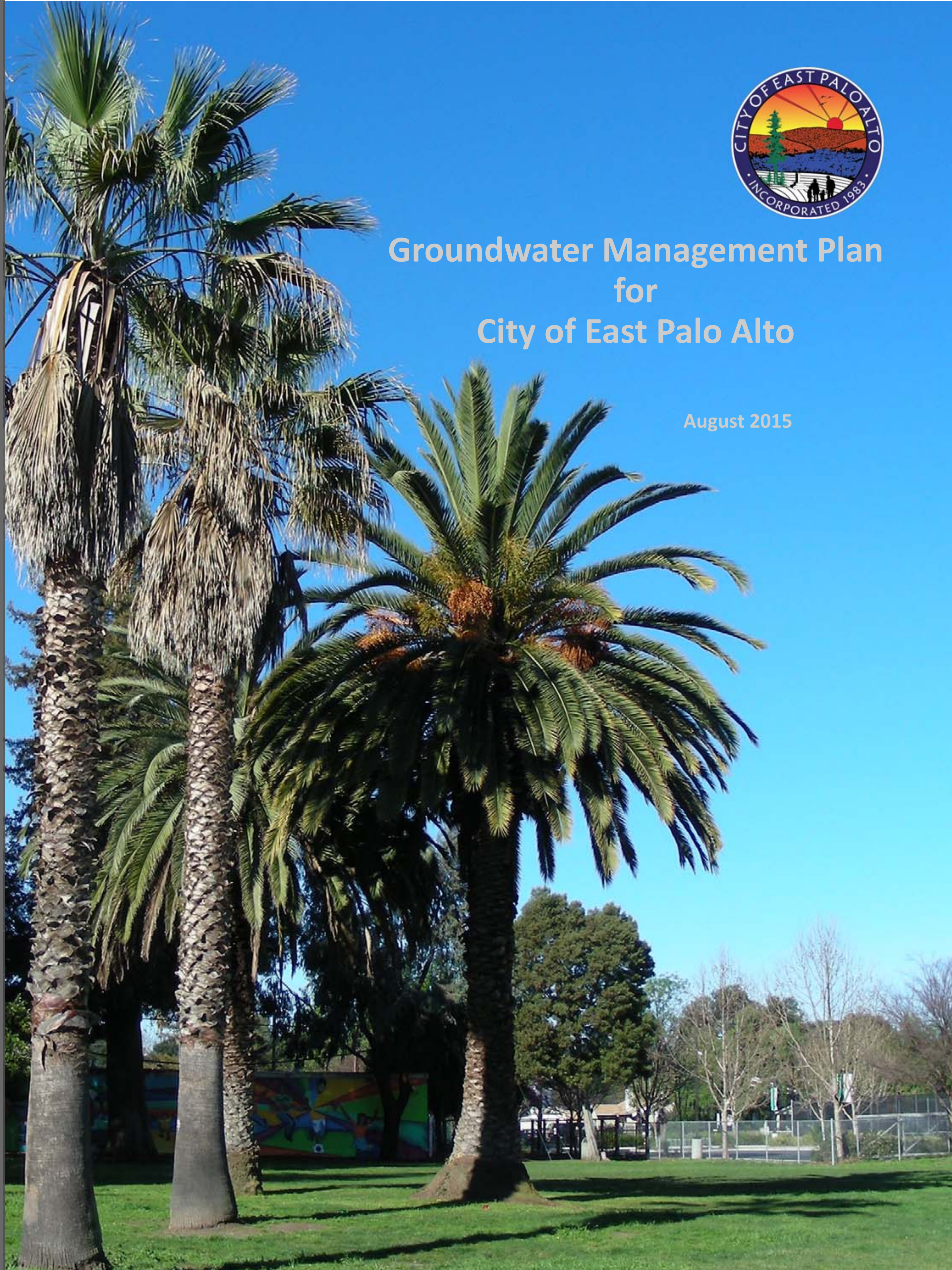

Groundwater Management Plan for City of East Palo Alto

August 2015

TODD GROUNDWATER

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GROUNDWATER MANAGEMENT PLAN

CITY OF EAST PALO ALTO

August 2015

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SIGNATURE PAGE

Iris Priestaf, PhD

President

CERTIFIED HYDROGEOLOGIST

DANIEL J. CRAIG

No. 66

STATE OF CALIFORNIA

Daniel J. Craig, PG, CHG

Senior Hydrogeologist

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1. INTRODUCTION

The City of East Palo Alto has long relied on imported water from the San Francisco Public Utilities Commission. Recognizing the need for water supply reliability, public safety and security in emergencies, and additional supplies to support economic development, the City the City has embarked on groundwater development and management. This Groundwater Management Plan (GWMP) represents an important step toward cooperative management and sustainable development of shared local groundwater resources.

1.1. BACKGROUND

The City of East Palo Alto has a current water supply guarantee of 2,199 acre-feet (AF) annually from the San Francisco Public Utilities Commission (SFPUC). The City's 2010 *Urban Water Management Plan* (UWMP) shows a demand at the time of 2,200 AF rising to 2,658 AF by 2015 and 3,400 AF by 2035 (IRM, 2011). City water demand in 2012-2013 amounted to 2,314 AF. Comparison of these values indicates that the City does not have adequate water supplies to meet current demand, to support further growth and economic development, or to handle emergencies. Moreover, additional guaranteed water is not available from the SFPUC. Accordingly, the UWMP identified potential methods of increasing supply or reducing demand, including water conservation, utilization of recycled water for irrigation, desalination, and development of local groundwater resources.

With regard to future water conservation, East Palo Alto has two important characteristics: a relatively low per capita water demand and limited outdoor irrigation. East Palo Alto already has one of the lowest per capita water consumption rates among the 27 Bay Area Water Supply and Conservation Agency (BAWSCA) municipalities; residential water use was 51.0 gallons per day per capita for Fiscal Year 2013-14 (BAWSCA, 2015, Table 7a). As a result, the potential is limited for reducing water demand relative to available supply.

In addition, there is limited opportunity for the use of recycled water; extensive lawns at parks and school property are typical large uses and these are limited in East Palo Alto. Most of the City's wastewater is treated at the Palo Alto Regional Water Quality Control Plant, and a recycled water network would need to be planned, designed, and constructed as a regional system. Nonetheless, the UWMP provides an overview of potential recycled water opportunities and potential methods to encourage recycled water use. Recycled water is recognized as reliable during drought, when groundwater recharge is reduced.

Similarly, the UWMP outlines transfer and exchange opportunities, which are focused mostly on water shortage conditions. Desalination also is addressed in the UWMP as a potential future opportunity as other San Francisco Bay area agencies explore the feasibility of regional desalination. Accordingly, the most practical alternative assessed in the UWMP is development of local groundwater resources.

The City is progressing toward groundwater development, including reactivation of the existing Gloria Way Well and exploration for additional well sites. A recent milestone was completion of the *Gloria Way Water Well Production Alternatives Analysis & East Palo Alto Water Security Feasibility Study* (herein *Groundwater Feasibility Study*; Todd, 2012), which recommended retrofit the Gloria Way Well, exploration of an additional well site (referred to as Pad D), and development of a GWMP. This study was followed by the *Gloria Way Well Retrofit Project, Joint Initial Study and Environmental Assessment* (herein called *IS/EA*; ESA, 2013); design of a groundwater treatment system for the Gloria Way Well is underway. The City also has progressed with its groundwater exploration as summarized in the *Report on Drilling, Construction, and Testing of the Pad D Test Well* (EKI, 2014).

Based on the *Groundwater Feasibility Study* and the *IS/EA*, the City and stakeholders have recognized the probability of significant local groundwater development and the potential risk of contaminant migration, overdraft, salt water intrusion, and subsidence. This recognition has resulted in collaborative discussions among the City and stakeholders, and a commitment by the City to:

- Develop a Groundwater Management Plan
- Conduct groundwater monitoring
- Conduct baseline surveying for subsidence
- Seek funding for additional numerical modeling and monitoring wells
- Manage initial pumping rates of the Gloria Way Well to assess and manage any adverse impacts.

1.1.1. Authority to Prepare and Implement the GWMP

In 1992, the California Legislature passed the Groundwater Management Planning Act—Assembly Bill (AB) 3030—which was designed to provide local public agencies increased management authority over their groundwater resources. AB 3030 provides a systematic procedure to develop a groundwater management plan, including a list of components that may be addressed (e.g., control of saline water intrusion, mitigation of overdraft, wellhead protection, monitoring, replenishment, contamination clean-up, coordination with other agencies) and procedures for public outreach and hearings.

In 2002 and 2012 new legislation, Senate Bill (SB) 1938 and AB 359 respectively, expanded AB 3030 by requiring groundwater management plans to include certain specific components in order to be eligible for grant funding for various types of groundwater related projects. The Groundwater Management Planning Act (as amended in Water Code §10750) applies to local agencies that provide water service, flood control, or water management and overlie part or all of a groundwater basin defined by the Department of Water Resources (DWR) Bulletin 118.

The City of East Palo Alto is such a public water agency, providing potable water supply to 3,967 connections and a service population of about 26,000 (BAWSCA, 2015)[1]. The City overlies about 2.5 square miles of the San Mateo Plain Subbasin of the Santa Clara Valley

[1] US Census QuickFacts indicate that the City is growing with an estimated 2013 population of 29,143.

Groundwater Basin, designated by DWR as Subbasin No. 2-9.03. As a public water agency overlying a designated groundwater basin, the City is authorized by the current Water Code to develop and implement the GWMP.

In September 2014, the State enacted three legislative bills (AB 1739, SB 1168, and SB 1319) that together are known as the Sustainable Groundwater Management Act (SGMA). This legislation mandates sustainable management of groundwater resources and provides expanded powers to local public water agencies that organize as groundwater sustainability agencies. Sustainability is defined in terms of a basin's yield as the maximum long-term quantity of water that can be withdrawn annually without causing an undesirable result. Undesirable results include:

- Chronic lowering of groundwater levels and reduction of groundwater storage
- Degraded water quality, including seawater intrusion and contaminant migration
- Land subsidence
- Surface water depletion with adverse impacts on beneficial uses.

Compliance with the Sustainable Groundwater Management Act is required for groundwater basins or subbasins that have been designated by CDWR as medium- or high-priority (requirements for adjudicated basins focus on reporting). Prioritization was conducted through the California Statewide Groundwater Elevation Monitoring (CASGEM) program and was based on criteria including:

- Overlying population
- Projected population growth
- Number of public supply wells
- Total number of wells
- Irrigated acreage
- Reliance on groundwater
- Groundwater impacts, including overdraft, subsidence, saline intrusion, and any other water quality degradation, and
- Any other information determined to be relevant by CDWR.

The prioritization is expressed in terms of very low, low, medium, or high; the San Mateo Plain Subbasin underlying the City is very low priority. It is important to note that the prioritization is intended to express the relative importance of groundwater basins statewide. It not intended to diminish the local importance of groundwater in the smaller-size or lower-use groundwater basins, such as the San Mateo Plain Subbasin.

The legislation lays out a process and timeline for local agencies to achieve sustainability, including:

- Local agencies must form local groundwater sustainability agencies (GSAs) within two years; a combination of local agencies may form a GSA; if a portion of a groundwater basin is not included, the county is presumed to be the GSA for that

area. Santa Clara Valley Water District has been deemed an exclusive GSA within its boundaries.
- Local agencies in basins deemed medium- and high-priority must prepare groundwater sustainability plans (GSPs) within five to seven years (depending on the overdraft status of the basin)
- When plans are in place, local agencies must implement the GSPs and achieve sustainability within 20 years.

The legislation also includes requirements and a timeline for DWR to establish a regulatory framework, including its priority list, regulations for basin boundary adjustments, regulations for evaluating GSPs, and groundwater sustainability best management practices.

The 2014 legislation lays out requirements for GSPs, including evaluation and monitoring of groundwater levels, groundwater quality, land subsidence, and groundwater-surface water interaction; these are the four key indicators of sustainability.

In addition, SGMA provides local agencies with additional tools to achieve sustainability, including specific authorities and procedures. For example, agencies may:

- Conduct investigations to carry out the requirements of the Act
- Require registration of wells and measurement of extractions
- Require annual extraction reports
- Impose well spacing requirements and limits on extractions from groundwater wells
- Assess fees to implement local groundwater management plans
- Request a revision of basin boundaries including establishing new subbasins.

The City is authorized under the existing Water Code to prepare a GWMP. It also has been enabled by the Sustainable Groundwater Management Act to become a GSA or join with other local agencies to form a GSA. However, as of early 2015 the DWR regulations and best management practices have not yet been established to guide preparation of a GSP. Given the City's existing water needs and momentum toward groundwater management, it is prudent to proceed with a GWMP and to consider future update of the GWMP as a Groundwater Sustainability Plan with collaboration among local agencies to form one or more GSAs. Update or expansion of a GWMP as a GSP is authorized in the Water Code § 10727(a).

This GWMP document has been prepared in light of the Water Code as of 2015 and addresses the requirements and components of a GSP as appropriate and relevant to the City of East Palo Alto.

1.1.2. Acknowledgements

This report was prepared by Todd Groundwater with Iris Priestaf as Project Manager and Daniel Craig as Project Hydrogeologist. We appreciate the assistance of City staff, notably Kamal Fallaha, Maziar Bozorginia, and Vivian Ma. The City Advisory Panel for the GWMP—representing East Palo Alto citizens, water agencies, water purveyors, and environmental organizations—has provided guidance throughout the GWMP development process.

1.2. PLAN GOAL AND OBJECTIVES

The City of East Palo Alto developed the following goals for this GWMP:

- Provide the City of East Palo Alto with a long-term, reliable and affordable high quality supply;
- Maintain or improve groundwater quality and quantity for the benefit of all groundwater users; and
- Provide integrated water resource management for resilience during droughts, with service interruptions and emergencies, and with long-term climate change effects.

The goals are consistent with the 2014 *Resolution in Support of Sustainable Groundwater Management in the San Francisquito Creek Area* (see Appendix A), of which the City is a signatory. The goals include recognition of the interconnection and multiple beneficial uses of groundwater and surface water in the San Francisquito Creek area. The goals also recognize the City's commitment to collaboration with other agencies and organizations toward better understanding of local hydrology and geology, and to sustainable management of local groundwater, including cooperative water management and conservation.

1.3. MANAGEMENT AREA

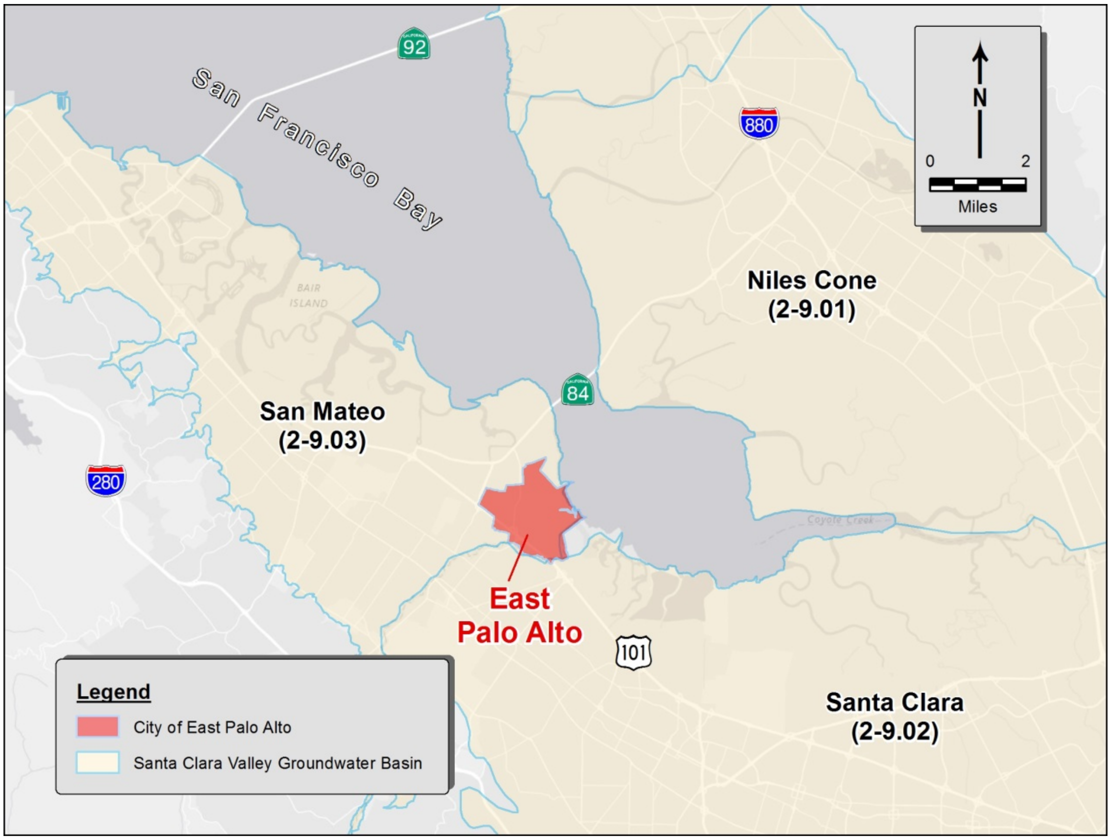
The area for this GWMP is encompassed by the jurisdictional boundary of the City of East Palo Alto. The City overlies a portion of a groundwater basin that has been demarcated differently (for different purposes) by the California DWR and by the United States Geological Survey (USGS).

1.3.1. San Mateo Plain Subbasin

Figure 1 shows the Santa Clara Valley Groundwater Basin as defined by DWR (2003), which has delineated and numbered all 515 groundwater basins across California, plus major subbasins. These basins and subbasins provide the geographic context for GWMPs.

The Santa Clara Valley Groundwater Basin (No. 2-9) occupies a geologic trough that is filled with alluvial and bay sediments, and partially inundated by San Francisco Bay. While understanding that sediments are broadly continuous under the bay, the basin has been divided by DWR into four subbasins: East Bay Plain, Niles Cone, Santa Clara, and San Mateo Plain. As shown, the City overlies the southeastern 2.5 square miles of the San Mateo Plain Subbasin (No. 2-9.03). This subbasin covers approximately 75 square miles on the west side of San Francisco Bay, extending from the West Side Basin north of San Mateo to the boundary with Santa Clara County, which happens to be San Francisquito Creek.

Figure 1. San Mateo Plain Subbasin



The San Mateo Plain Subbasin is composed of alluvial fans formed by a series of streams draining to sloughs along San Francisco Bay. From north to south, major streams include San Mateo, Laurel, Belmont, Pulgas, Cordilleras, Redwood, Atherton, and San Francisquito creeks (Oakland Museum, 2014). All but two of these streams have relatively small watersheds draining mostly the plain and accordingly, have relatively small alluvial fans. In general, the alluvial deposits are thinner and more fine-grained in the northern subbasin relative to the southern portions. However, San Francisquito Creek, with a watershed extending into the foothills, has a relatively extensive and thick alluvial fan also known as the San Francisquito Cone.

1.3.2. San Francisquito Cone Subbasin

The United States Geological Survey (USGS) has conducted several groundwater investigations addressing the southern San Mateo Plain area (e.g., Oliver, 1990; Fio and Leighton, 1995; Metzger, 2002). The 2002 investigation focused on surface water-groundwater interactions along San Francisquito Creek and, for the purposes of the investigation, defined a San Francisquito Creek alluvial fan groundwater basin, called the San Francisquito Cone.

Figure 2 shows the San Francisquito Cone Subbasin and the San Francisquito Creek watershed. As defined, this groundwater sub basin encompasses the hydraulically connected surface water-groundwater system of San Francisquito Creek and its alluvial fan; as such, it has been the basis for hydrologic and water balance studies.

1.4. PUBLIC PARTICIPATION

The City has prepared this GWMP as an open and collaborative process. As described in the Stakeholder Outreach Plan (in Appendix B), the City has participated in ongoing discussions with local groundwater users, neighboring cities, and local landowners, and in regional meetings such as the San Francisquito Creek Subbasin Groundwater Meetings. This paved the way toward an active GWMP stakeholder participation.

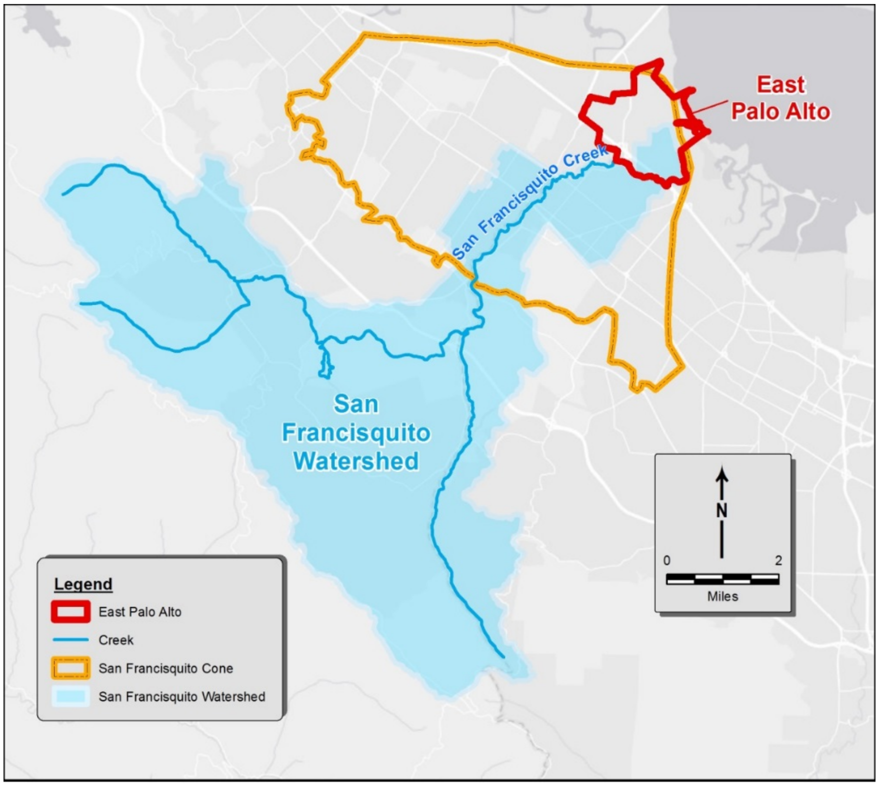
Notice of the City Council's October 21, 2014 public hearing regarding the intent to draft a GWMP was appropriately noticed. Potential stakeholders were identified through lists of participants in local groundwater-focused meetings and through word-of-mouth and website announcements. Stakeholders include a variety of organizations such as the Tuolumne River Trust (which promotes stewardship of the Tuolumne River plus sustainable water use in the Bay Area), Sierra Club, and Menlo Business Park (Tarlton Properties) and local water companies such as American Water Enterprises, California Water Service Company, Palo Alto Park Mutual Water Company and O'Connor Tract Co-op Water Company.

Subsequently, in November 2014 invitation letters (see Appendix B) were conveyed by email, mail, or hand delivery to inform stakeholders of the Stakeholder Outreach Plan and how they can participate in development of the GWMP. The invitation letter also was posted on the City's website.

Citizens Advisory Panel (CAP)
A stakeholder advisory committee, termed the Citizens Advisory Panel (CAP), was established including representatives of local water agencies, stakeholders and members of the public. CAP members were contacted individually in scheduling workshops and provided information materials and the draft GWMP. CAP members were tasked with active participation in workshops and provision of comments on the draft GWMP. Communication occurred primarily through email, but announcements and materials also were available on the City website.

Informational Materials
The City dedicated a portion of its website page, http://www.ci.east-palo-alto.ca.us, for announcements and invitations; workshop agenda, handouts, and summaries; and other materials. Recognizing that the City of East Palo Alto is multi-cultural, the website provides translation to 81 languages and many documents are available in English and Spanish.

Figure 2. San Francisquito Cone Subbasin



Workshops
The Stakeholder Outreach Plan includes three scheduled workshops to guide development of the GWMP. These are listed below and described in their respective tasks. In brief, the workshops addressed the following:

1. **Initial GWMP Workshop** – Introduction to GWMP process, definition of goal of process, introduction of GWMP-Share site, identification of advisory committee, presentation of basin condition and issues.

2. **Basin Management Objectives (BMO) and Actions Workshop** -Review of issues, discussion of basin management objectives and of actions for monitoring and maintaining groundwater within BMOs.

3. **Draft GWMP Workshop** -Present draft GWMP and provide public forum for comments and questions.

Workshops included Powerpoint presentations and provided a forum for questions and answers, with the objective to ensure a shared understanding of basin conditions, issues, objectives, and actions. Workshop agenda, handouts, and meeting summaries were provided to participants. Workshops were held in the Community Room at City Hall, a well-recognized and suitable meeting place that is central to the city. Late-afternoon meeting times allowed attendance by agency representatives and the public.

1.5. AGENCY COLLABORATION

Other local agencies are important because the City encompasses only a portion of the San Mateo Plain Subbasin; consequently, the GWMP may be a stepping-stone for larger-scale planning. **Figure 3** shows water agencies and major water purveyors, while **Figure 4** shows cities and communities with respect to subbasin boundaries.

The GWMP has emphasized collaboration with other water and land use planning agencies in the San Mateo Plain Subbasin, most notably the County of San Mateo and City of Menlo Park among other public agencies. Given the hydrologic significance of San Francisquito Creek, the GWMP also supports collaboration with neighboring agencies in the Santa Clara Subbasin, namely the City of Palo Alto and Santa Clara Valley Water District, and the agencies in the greater Santa Clara Valley Basin such as Alameda County Water District in the Niles Cone Subbasin. Regional agencies including Bay Area Water Supply & Conservation Agency (BAWSCA) and the San Francisco Public Utilities Commission sent representatives to GWMP workshops.

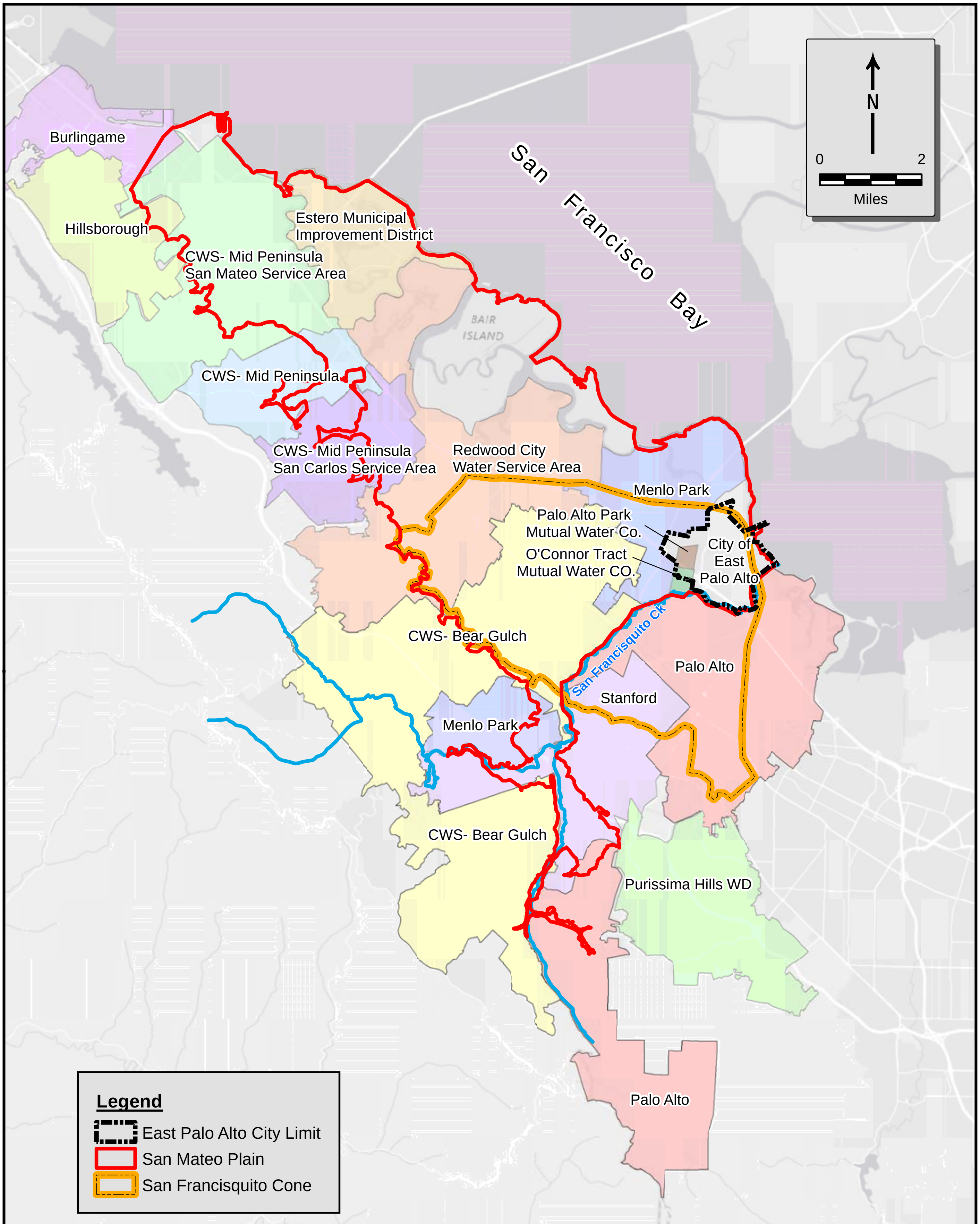


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Figure 3
Water Agencies and Major Water Purveyors

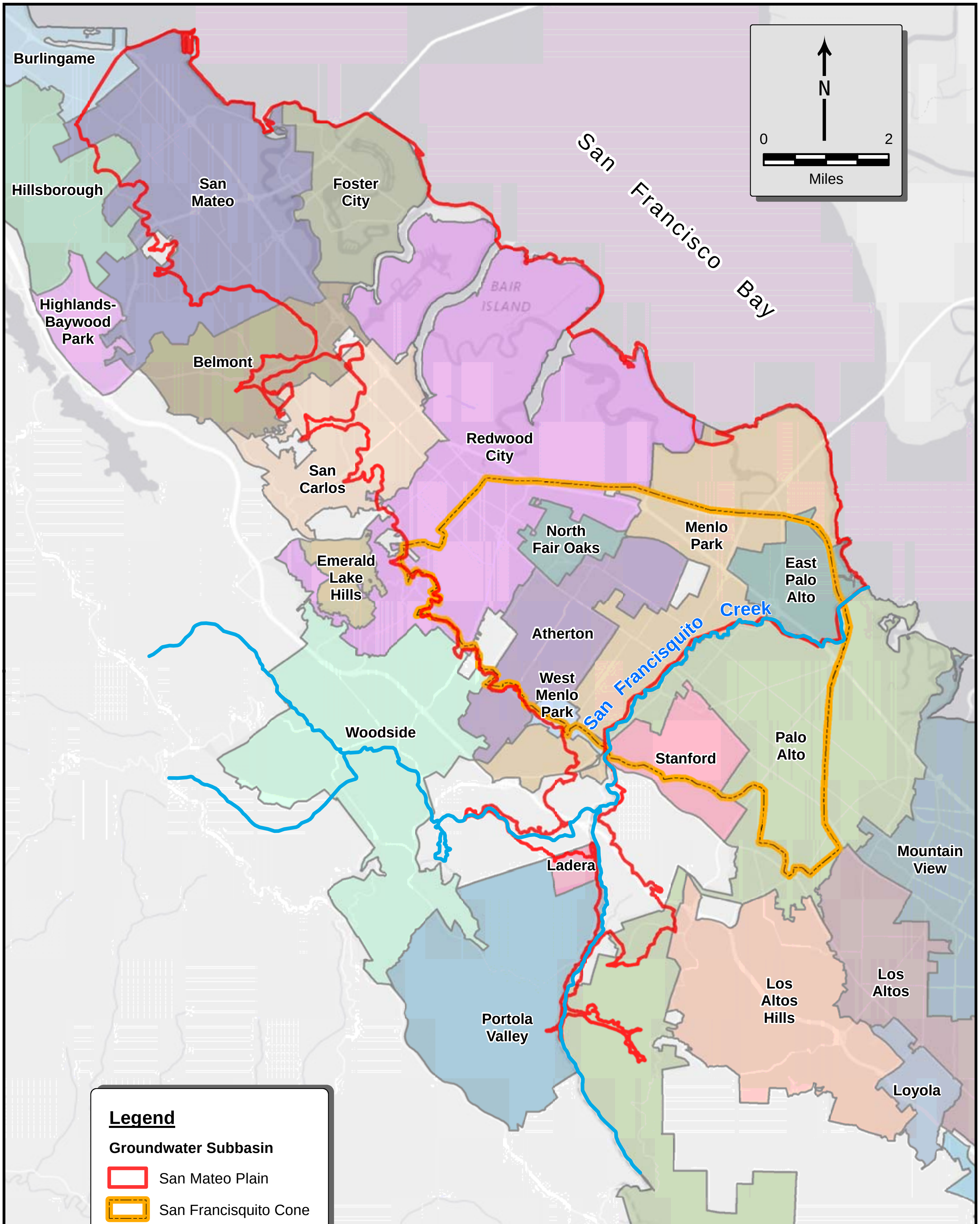

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Figure 4
Cities, Communities, and Groundwater Subbasins

2. LOCAL AND REGIONAL WATER MANAGEMENT

Water resources management is taking place on a city, local and regional basis. It includes City water management, urban water management plans by local cities, groundwater management plans in the Santa Clara Valley Basin, and integrated regional water management planning.

2.1. City Water Management

Historically, water supply for East Palo Alto was provided by the East Palo Alto County Waterworks District, Palo Alto Park Mutual Water Company, and O'Conner Tract Mutual Water Company. The latter two companies still provide water supply to portions of the City, while the district's role was assumed by the City in 2001 (IRM, 2011). Currently, the City of East Palo Alto serves domestic water supplies to approximately 4,200 residential, commercial, and industrial customers within its 2.5-square-mile service area that encompasses most of the City and a portion of Menlo Park east of Highway 101 (ESA, 2013). The City serves approximately 93 percent of the potable water supplies used within the City limits; the remainder is served by the water companies (IRM, 2011).

2.1.1. SFPUC Water Supply Agreement and BAWSCA

The City currently relies for its domestic water supplies on the SFPUC, which provides surface water from Hetch Hetchy Reservoir in the Sierra Nevada, augmented with water from local watersheds in Alameda and San Mateo Counties. Treated SFPUC water enters the City's water system via three turnouts and then flows by gravity through the City's pressurized distribution network. Because the City's municipal water supply system has no storage, any interruption in SFPUC supplies could leave the City without potable water.

SFPUC holds a Water Supply Agreement with its wholesale water customers in Alameda, San Mateo, and Santa Clara Counties. The wholesale customers are largely represented by the Bay Area Water Supply and Conservation Agency (BAWSCA), a regional agency whose goal for its members is to ensure a reliable supply of high quality water at a fair price. Among its services, BAWSCA administers the Water Supply Agreement, develops and implements long-term water supply strategies, supports water recycling and conservation, and encourages preparedness for water shortages. Some of the BAWSCA member agencies have sources of water in addition to what they receive from SFPUC, while others rely solely on SFPUC supply.

In accordance with the Water Supply Agreement, the City of East Palo Alto receives 2,199 AFY of potable water supplies from the Hetch Hetchy system. As shown in **Table 1**, the City exceeded its allocation in four of ten recent years (data from BAWSCA, 2015)[2]. In 2013-2014, City usage was 1,660 AF, reflecting water conservation in response to severe drought.

[2] BAWSCA values may differ from City data for 2012-2013.

Table 1. Historical Potable Water Use (AF)

Fiscal Year	Total Usage	Under or (Over) SFPUC Allocation
2003-2004	2317	(119)
2004-2005	1725	474
2005-2006	2130	69
2006-2007	2242	(44)
2007-2008	2288	(89)
2008-2009	2153	45
2009-2010	1935	264
2010-2011	1982	217
2011-2012	2084	115
2012-2013	2314	(115)

Source: BAWSCA Annual Survey, 2015

In years when other wholesale customers do not use their full contractual supply, the City can purchase water above the City's individual allocation. However, the City cannot rely on these supplies to meet demand. Moreover, the City has planned for additional development and growth, including the Ravenswood/4 Corners Transit-Oriented Development (TOD) Specific Plan with an additional future water demand of 820 AFY at plan buildout in 2035 (ESA, 2013). Accordingly, the City is seeking to develop and manage groundwater as an emergency and supplemental source of municipal supply.

2.1.2. Water System Master Plan

The City's Water System Master Plan (IRM, 2010) provides a description of the City's water supply and demand, water quality issues, future water supply options, and system requirements. It also lays out a capital improvement program. The major findings are that the water system is completely dependent on the Hetch Hetchy system for potable water, with no storage, and that the City needs to explore other water sources to meet future demands and provide service during times of drought and emergencies. Accordingly, the plan recommends that the City:

- install a treatment system for the Gloria Way well and construct additional wells

- negotiate emergency interties with the cities of Palo Alto and Menlo Park
- plan for pipeline upgrades
- install storage facilities
- seek funding sources.

2.1.3. General Plan

A General Plan is a policy document required of cities and counties that provides long-range guidance for land use, development, and other issues such as affordable housing and employment. It establishes policies, goals, and programs for the long-term physical development of a city or county. Currently, City development is guided by the 1999 General Plan Update. With regard to water supply, the 1999 General Plan Update recognizes water service as necessary to support the City, and states a goal to provide effective coordination with public facilities and service providers(at the time including the waterworks district and two water companies).

The City of East Palo Alto currently is updating its General Plan through a process called *Vista2035;* this document will replace the 1999 General Plan. The *Vista2035* process also includes development of a Westside Area Plan and environmental review in compliance with the California Environmental Quality Act (CEQA). The process so far has generated an Existing Conditions Report; two findings of the Existing Conditions Report (Raimi, 2014) relevant to groundwater development and management are:

- Most of East Palo Alto is developed, and the largest amount of potentially developable land in the City is governed by the recently-adopted Ravenswood / 4 Corners TOD Specific Plan.
- Development is constrained by inadequate water availability and reliability.

Next steps are an extensive outreach program and update of the General Plan itself, including goals, policies and implementation. The process is expected to extend through 2015. Information on *Vista2035* is available online http://vista2035epa.org/.

2.2. URBAN WATER MANAGEMENT PLANS

The California Urban Water Management Planning Act (Water Code Division 6, Part 2.6, Sections 10610-10656) requires preparation of an Urban Water Management Plan (UWMP) by all publicly and privately owned urban water suppliers that either have 3,000 or more customers or provide over 3,000 acre-feet of water annually. UWMPs describe the suppliers' service area, water use by customer class, water supply and demand, water service reliability and shortage response options, water transfer and exchange opportunities, water recycling efforts, and conservation measures. UWMPs document historical water supply and demand, and provide projections in five-year increments at least 20 years into the future. Updated every five years, UWMPs provide important information on an urban community's water supply and demand planning. DWR provides an index and access to all adopted UWMPs: http://www.water.ca.gov/urbanwatermanagement/2010uwmps/.

In the San Mateo Plain Subbasin, UWMPs have been prepared by the major water providers (see **Figure 3**); all of these rely primarily (if not entirely) on SFPUC imported water. While acknowledging the existence of private wells in some cities, most of the water providers do not use groundwater and indicate no plans to do so in their respective UWMPs. Exceptions are the City of Redwood City, which has considered installation of wells for irrigation, and the City of Menlo Park, which developed the Emergency Water Supply Project to construct two or three new wells to supplement emergency potable and fire protection uses.

While not located in the San Mateo Plain Subbasin, the City of Palo Alto (in the Santa Clara subbasin) developed a well system consisting of five wells constructed in the 1950s and operated until 1962. These wells have not been used since then (with the exception of brief operation in 1988 and 1991). However, the City has developed Emergency Water Supply and Storage Project. The project consists of the repair and rehabilitation of the five existing wells, and construction of three new wells (Palo Alto, 2011). The Emergency Water Supply and Storage Project's primary goal is to correct the deficiency in the City's emergency water supply, including use during prolonged drought.

In compliance with the Water Code, the City of East Palo Alto prepared and adopted the latest UWMP in June 2011 (IRM, 2011). Comparison of City supply and demand resulted in a key finding that a shortfall will occur between future water supply and demand predictions without the acquisition of new supply sources. As discussed in the Background section, the UWMP identified potential methods of increasing supply or reducing demand and concluded that the most practical alternative is development of local groundwater resources.

2.3. Groundwater Management Planning

DWR maintains a listing and copies of Water Code-compliant GWMPs from throughout California[3]. As of November 2014, no GWMPs have been prepared within the San Mateo Plain Subbasin. However, several local agencies have passed a resolution in support of sustainable groundwater management in the San Francisquito Creek Area.

In addition, in the Santa Clara Valley Groundwater Basin as a whole, GWMPs have been prepared and adopted by the Santa Clara Valley Water District (Santa Clara Subbasin) and East Bay Municipal Utility District (southern East Bay Plain Subbasin). For the Niles Cone, Alameda County Water District provides groundwater management based on other statutory authority. While not in the Santa Clara Valley Basin, the cities of San Bruno and Daly City have prepared a GWMP for the West Side Basin in northern San Mateo County.

2.3.1. Resolutions in Support of Sustainable Groundwater Management

Seven local water agencies— East Palo Alto, Santa Clara Valley Water District, County of San Mateo, Palo Alto, Menlo Park, Atherton and Portola Valley—have passed resolutions in

[3] http://www.water.ca.gov/groundwater/groundwater_management/GWM_Plans_inCA.cfm#GWP%20Info

support of sustainable groundwater management in the San Francisquito Creek Area. While these resolutions are specific to each agency, they state shared concerns including rising SFPUC water prices, population growth, and potential water supply reductions from droughts and climate change. The resolutions also state the potential risks of overdraft, salt water intrusion, and land subsidence if groundwater development occurs without cooperative management.

The resolutions recognize that groundwater and surface water in the San Francisquito Creek area are interconnected. They also confirm that groundwater resources can be managed cooperatively through water conservation/efficiency, use of alternative supplies such as recycled water, storm water infiltration, and groundwater recharge, and also recognize that more information on hydrology and geology of the San Francisquito Creek area is needed to better design and implement sustainable groundwater management.

Accordingly, the agencies resolve to collaborate with other agencies and organizations to better understand the hydrology and geology of the San Francisquito Creek area. They also state their respective commitment to the sustainable management of local groundwater to protect its quality and ensure its availability during droughts and emergencies.

2.3.2. Santa Clara Valley Water District

The Groundwater Management Plan of Santa Clara Valley Water District (SCVWD, 2012) is significant to East Palo Alto given the shared boundary along San Francisquito Creek and history of cooperation on water issues. The SCVWD GWMP has two 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 salt water intrusion.

The SCVWD GWMP also has four basin management strategies to meet the BMOs:

> 1. Manage groundwater in conjunction with surface water through direct and in-lieu recharge programs to sustain groundwater supplies and to minimize salt water 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.

An important element of the SCVWD's GWMP is active monitoring of groundwater elevations and land subsidence across the Santa Clara Groundwater Sub-basin. SCVWD routinely monitors several nested monitoring wells near the Palo Alto-East Palo Alto boarder. SCVWD also routinely surveys a transect of benchmarks aligned south of San Francisquito Creek. These monitoring data prove measures of groundwater and land subsidence conditions in the southeastern portion of the San Francisquito Cone Subbasin.

2.3.3. Alameda County Water District

Alameda County Water District (ACWD) has three primary sources of water supply: State Water Project, San Francisco's Regional Water System, and local supplies including fresh groundwater from the Niles Cone Subbasin, desalinated brackish groundwater, and surface water from Del Valle Reservoir. ACWD developed a Groundwater Management Policy (ACWD, 2001) based on statutory authority granted to it under the Water Code. Objectives of the Groundwater Management Policy are to:

- Increase groundwater replenishment capability.
- Increase the usable storage capacity of the groundwater basin.
- Operate the basin to provide: (1) a reliable water supply to meet baseload and peak distribution system demands, (2) an emergency source of supply, and (3) reserve storage to augment dry year supplies.
- Protect groundwater quality from degradation from any and all sources.
- Improve groundwater quality by removing salts and other contaminants from affected areas, and improving the quality of source water used for recharge.

To achieve these objectives, ACWD conducts several groundwater programs, including:

- Water supply management
- Groundwater replenishment
- Watershed protection and monitoring
- Basin monitoring
- Wellhead protection program
- Aquifer reclamation program
- Groundwater protection program
- Well ordinance administration.

2.3.4. East Bay Municipal Utility District

East Bay Municipal Utility District (EBMUD) provides water supply to customers in Contra Costa and Alameda counties from surface water reservoirs on the Mokelumne River and in the East Bay, from recycled water facilities and groundwater of the East Bay Subbasin. The overarching goal of the South East Bay Plain Basin GMP (EBMUD, 2013) 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 are to:

- Preserve basin storage by maintaining groundwater elevations
- Maintain or improve groundwater quality in the GMP area
- Manage potential inelastic land surface subsidence from groundwater pumping

- Manage the basin through coordination and collaboration.

Components of the GMP include:

- Stakeholder involvement
- Monitoring programs (elevations, quality, subsidence)
- Groundwater basin management tools (groundwater model)
- Groundwater resource protection (well standards, wellhead and recharge area protection, coordination to address contamination, salt/nutrient management)
- Groundwater sustainability (coordinated management).

2.3.5. South Westside Basin Groundwater Management Plan

The South Westside Basin GWMP was prepared by the City of San Bruno in collaboration with the City of Daly City, San Francisco Public Utilities Commission, and California Water Service Company (WRIME, July 2012). 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, with the following objectives:

- Maintain acceptable groundwater levels
- Maintain or improve groundwater quality
- Limit the impact of point source contamination
- Explore need for land subsidence monitoring
- Manage the interaction of surface water and groundwater for the benefit of groundwater and surface water quantity and quality.

2.4. San Mateo County

San Mateo County has three departments involved in groundwater management.

2.4.1. San Mateo County Health System

The Environmental Health division of the San Mateo County Health System (see website at http://smchealth.org/) conducts a Groundwater Protection Program with the goal of protecting underground water supplies and surface waters, such as the creeks, streams, ocean and the Bay, from chemical pollution. The Groundwater Protection Program also administers and issues permits for construction and destruction of all wells including monitoring wells, agricultural wells, and community water supply wells.

2.4.2. San Mateo County Department of Public Works

The San Mateo County Department of Public Works advises the Board of Supervisors on all public works issues, and plans, designs, constructs, operates, and maintains facilities and equipment. The San Mateo County Flood Control District is a Countywide Special District that was created by State legislation to finance flood control projects. It has three active flood control zones; one of these is the San Francisquito Creek Flood Control Zone, which finances creek improvements in cooperation with the Santa Clara County Water District. The Creek overtopped its banks in 1998 and flooded portions of the Cities of Palo Alto, East Palo Alto and Menlo Park.

The San Francisquito Creek Joint Powers Authority (SFCJPA) was created as a result to develop solutions to the flooding problem and provide for a coordinated approach to planning in the San Francisquito Creek Watershed. The SFCJPA members include the cities of Palo Alto, East Palo Alto, Menlo Park and the Santa Clara Valley Water District and San Mateo County Flood Control District. While the SFCJPA does not address groundwater, it is an example of multi-jurisdictional collaboration.

2.4.3. Office of Sustainability

The Office of Sustainability oversees and coordinates countywide sustainability efforts (San Mateo County, 2015). The County developed its Shared Vision 2025 plan that expresses goals and priorities for a healthy and safe, prosperous, livable, environmentally conscious, and collaborative community. The Office monitors and reports on the performance of County programs and services toward achieving Shared Vision 2025 goals.

One of these goals is for an environmentally conscious community that preserves natural resources through environmental stewardship, reducing carbon emissions, and using energy, water and land more efficiently. The Office provides water conservation advice and coordinates with the water-related programs of the Public Works and Environmental Health departments. Future priorities include:

- Reduce water consumption in high use communities
- Collaboratively manage surface water and groundwater quantity and quality
- Ensure all of the county has long term access to adequate potable water supplies.

2.5. INTEGRATED REGIONAL WATER MANAGEMENT PLAN

Integrated Regional Water Management Planning (IRWMP) is a collaborative effort to manage all aspects of water resources in a region. The region of the Bay Area IRWMP includes all or portions of the nine counties around San Francisco Bay. The Bay Area IRWMP:

- Provides a valuable venue for regional collaboration across agencies
- Improves responsiveness to regional needs and priorities
- Helps to effectively integrate water resources management activities and
- Serves as a platform to secure state and federal funding.

Representatives of the City of East Palo Alto have participated as stakeholders in the IRWMP process, including participation in public workshops and submittal of funding applications for proposed projects, including benefits to disadvantaged communities.

3. HYDROGEOLOGIC SETTING AND GROUNDWATER CONDITIONS

3.1. GEOGRAPHIC SETTING

The City of East Palo Alto is situated on an alluvial plain between the eastern foothills of the Santa Cruz Mountains and the tidal wetlands ringing San Francisco Bay. **Figure 5** illustrates the geographic setting of the City in the southern San Francisco Bay area, including the location of selected meteorological (climate) and tide gage stations, and USGS permanent gage station on San Francisquito Creek.

3.1.1. Climate

The San Francisco Bay region has a Mediterranean climate, characterized by dry, warm summers and mild winters. Climate information for the East Palo Alto vicinity is available from a California Irrigation Management Information Systems (CIMIS) weather station in Redwood City and a National Oceanic and Atmospheric Administration (NOAA) National Weather Service station in Palo Alto (see **Figure 5**). The area receives most of its rainfall between November and June and has its warmest temperatures in July and August. Average annual rainfall in the City of East Palo Alto is approximately 15 inches (WRCC, 2013); **Figure 6** documents the annual (water year[4]) totals over time. Rainfall gradually increases with increasing elevation to the west where it averages more than 40 inches per year at the highest elevations.

Review of **Figure 6** reveals the annual variability of rainfall, which was more than 30 inches in 1983 (33.2 inches) and in 1997 (33.0 inches). Periodic droughts have included the extreme two-year drought of 1976-1977, prolonged drought of 1987-1992, and most recent drought that began in 2012. While local rainfall is relevant to local streamflow and groundwater recharge, overall City water supply (provided by the SFPUC Hetch Hetchy system on the Tuolumne River) is affected far more by climatic conditions in the Sierra Nevada. Climate change is addressed in the City's UWMP.

3.1.2. Soils

Information on soils is available from the 1991 Soil Survey of San Mateo County, Eastern Part, and San Francisco County, California prepared by the United States Department of Agriculture Soil Conservation Service (USDA SCS, 1991). Soil mapping data also are available online from SSURGO (Soil Survey Geographic database), which provides digital soils data produced and distributed by the National Resources Conservation Service (NRCS), which succeeded the SCS.

Soils in the East Palo Alto vicinity are classified as Urban Land-Orthents along San Francisco Bay and Botella-Urban Land along San Francisquito Creek and in the Menlo Park-Palo Alto

[4] A water year extends from October 1 through September 30 and is indicated by the ending year.

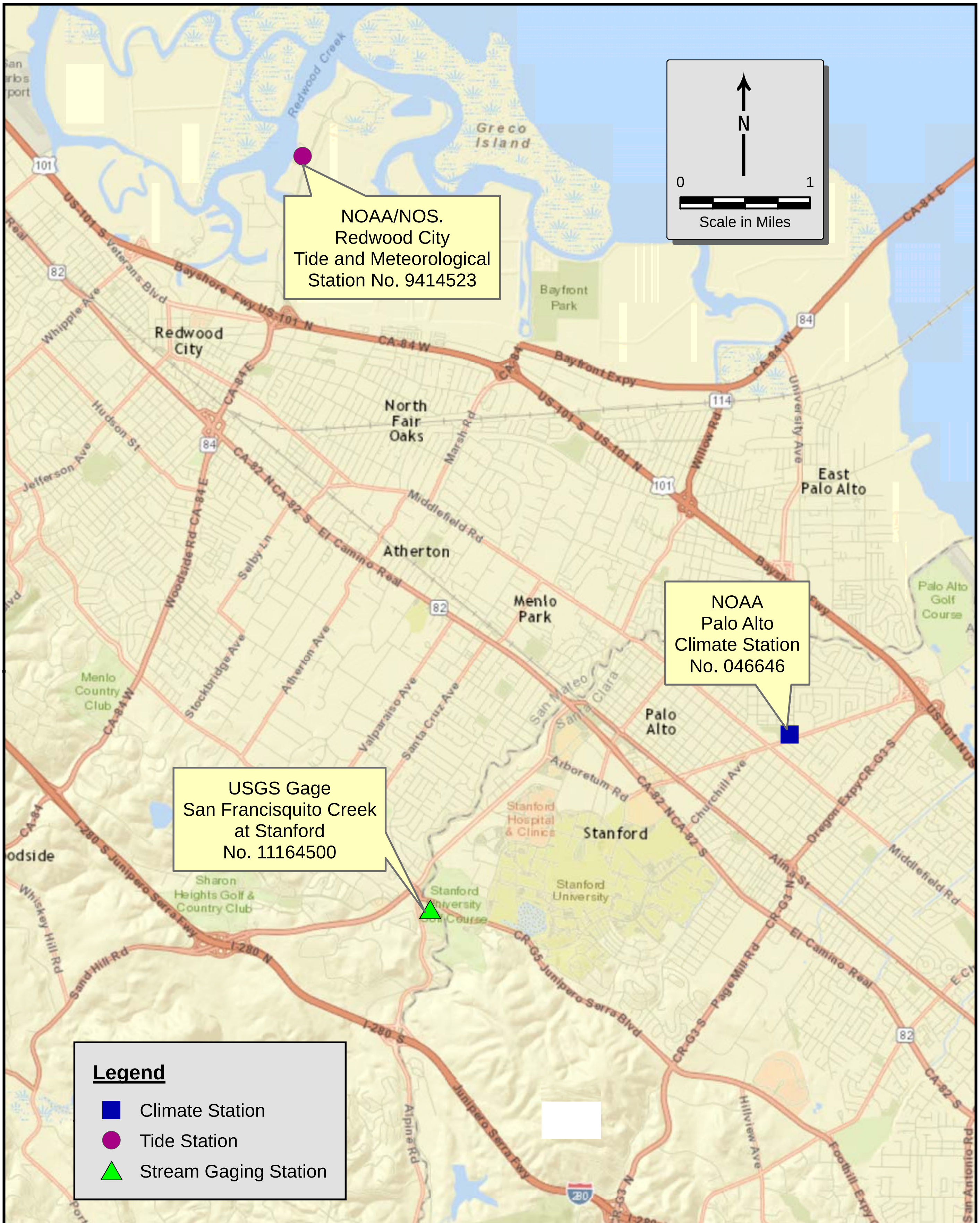

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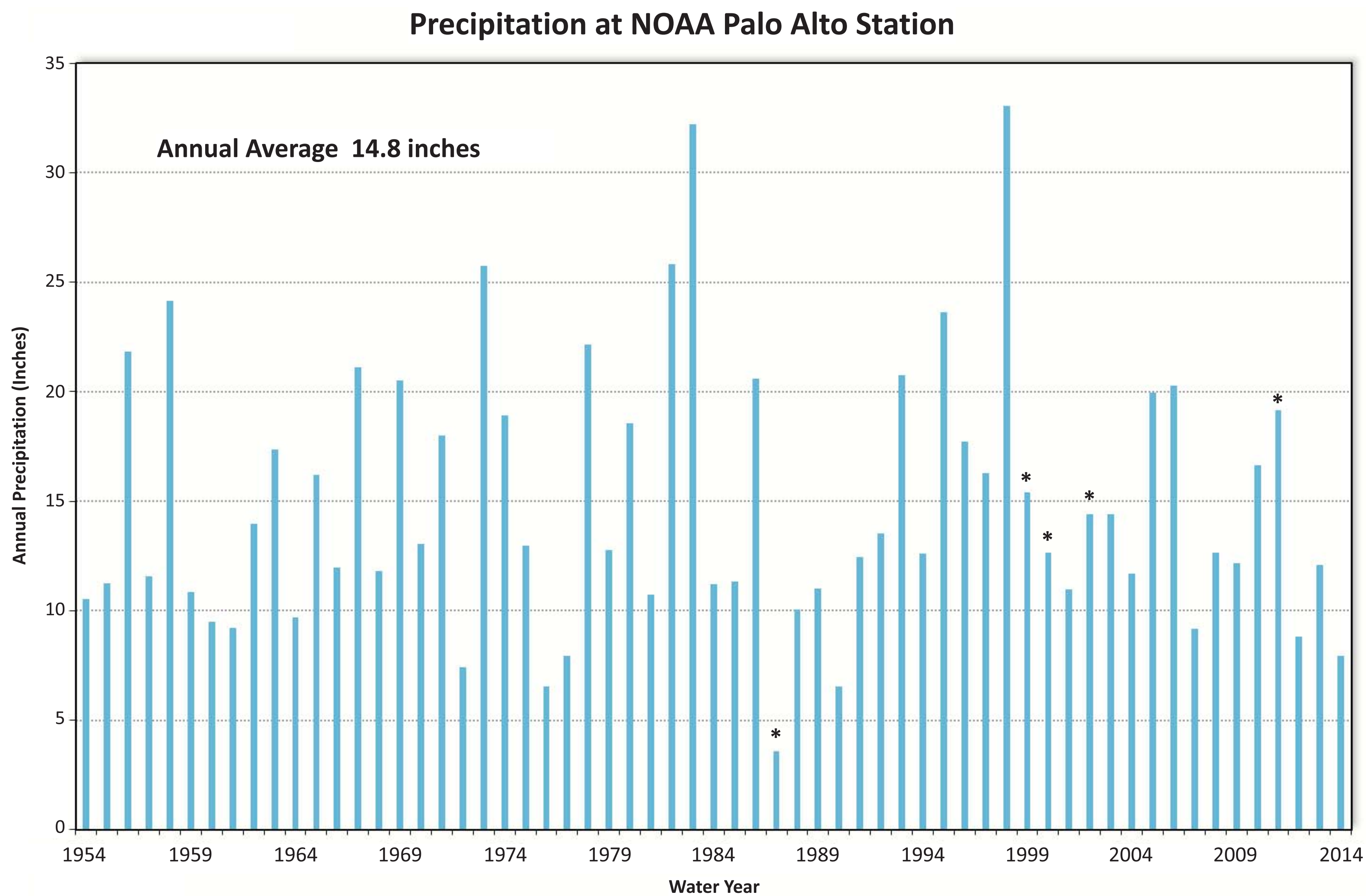
Figure 5
Geographic Setting



* missing 2 months of data or more

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Figure 6
Precipitation at NOAA Palo Alto Station

areas. Urban Land and Orthents include soils that have been graded and built over and soils that have been graded and moved. While these soils developed originally on alluvial fans and floodplains, they are now highly variable in texture. Botella soils, formed in alluvium, have a surficial loam texture and clay subsoil. These urban soils have been modified by assorted landscaping practices and thus are geographically variable.

3.2. SURFACE WATER CONDITIONS

Surface water and groundwater resources in the San Mateo plain are linked, as surface water locally provides recharge to groundwater and as groundwater locally discharges to streams and wetlands and San Francisco Bay. Surface water-groundwater interactions are variable across the plain and dynamic through time—seasonally and over the years. Surface water conditions are important in a groundwater management plan not only because surface water replenishes groundwater, but also because groundwater helps sustain creek flows and associated environmental benefits, particularly in the summer and during drought.

The San Mateo plain is drained by a series of streams; the largest and most significant to the City of East Palo Alto is San Francisquito Creek. The plain also is drained by urban storm drainage systems. Most of the City is served by storm drains discharging to several engineered channels that empty directly in San Francisco Bay. The southeastern portion of the City is drained by stormwater facilities discharging to San Francisquito Creek.

3.2.1. San Francisco Bay

The City's eastern boundary is situated along San Francisco Bay. North of Bay Road and Cooley Landing, the City is bounded by tidal wetlands of the Ravenswood Open Space Preserve. Generally south of Cooley Landing, the City extends to the bay and includes the wetlands of the Faber-Laumeister tract of the Don Edwards National Wildlife Refuge.

San Francisco Bay levels are measured at two gage stations near East Palo Alto, one to the north in Redwood City (see **Figure 5**); another is to the southeast at the mouth of Coyote Creek.

For local streams and groundwater, San Francisco Bay represents base level, the lowest elevation to which streams and groundwater can flow. However, this elevation varies with tides and may be affected by wave events caused by large storms and geologic events (e.g., seiche or standing waves and tsunamis). In addition, long-term (1897 to 2013) sea level rise has been documented at San Francisco at a rate of 0.62 feet in 100 years. This rise in base level is significant mostly to increased risk of flooding.

3.2.2. San Francisquito Creek

San Francisquito Creek originates in the eastern Santa Cruz Mountains and extends about 13 miles to San Francisco Bay at the southeastern corner of the City. The creek has a watershed area of about 45 square miles encompassing upland bedrock terrain and relatively flat alluvial fan deposits. The upland watershed is mostly open space with some development (e.g., Portola Valley, Woodside, Stanford University facilities) and includes three small reservoirs (Searsville Lake, Felt Lake, and Bear Gulch Reservoir). Another reservoir, Lagunita Lake, is on the Stanford Campus.

The lower alluvial fan is intensively urbanized with storm drains that convey flows to the creek or to the bay. Most of the reach across the fan is relatively sinuous, incised and hedged closely by urban development. The lowermost channel (east of Highway 101 and adjacent to the City) was re-routed in the 1920s to turn sharply north and then northeast to discharge into the bay; these straightened reaches are lined by levees.

San Francisquito Creek flows are monitored by USGS at a permanent gaging station (11164500), which is located near the Junipero Serra Boulevard/Alpine Road intersection where the creek flows from the upland watershed onto the alluvial fan (see **Figure 5**). This station has been in operation since the early 1930s. The mean annual flows within San Francisquito Creek have ranged from less than 0.05 cubic feet per second[5] (cfs) recorded in 1961 to 89.1 cfs recorded in 1933 (Stanford University, 2013). During all but the wettest years, significant portions of San Francisquito Creek and its tributaries become dry by mid-summer. In addition, the creek stage (depth) is monitored for flood warning purposes by the City of Palo Alto at three sites (Waverly St., Chaucer St., West Bayshore Road). Creek level information and camera views are available in real time on the Palo Alto website (Palo Alto, 2015).

San Francisquito Creek supports riparian vegetation and fauna, including threatened species such as the red-legged frog and western pond turtle. It is the only free-flowing urban creek on the south Peninsula (USGS, 2015) and the most viable remaining native steelhead population in South San Francisco Bay. Citing concern for steelhead, the creek has been included in the 303(d) listing by the San Francisco Bay Regional Water Quality Control Board (RWQCB) as impaired for sediment (California Coastal Commission, 2006). A habitat assessment in the upland watershed (Jones & Stokes, 2006) concluded that a lack of suitable habitat (e.g., deep pools) is the key factor limiting smolt production and juvenile rearing, while steelhead outmigration is limited by seasonal drying of the channel (a natural phenomenon) and exacerbated by passage impediments. Given its environmental significance, San Francisquito Creek has been the subject of numerous studies (e.g., Jones & Stokes, 2006; USGS 2015), restoration plans focused on bank stabilization and re-vegetation, and active restoration, education and outreach efforts (Acterra, 2015).

The lowermost reach of San Francisquito Creek between Highway 101 and San Francisco Bay (along the East Palo Alto-Palo Alto boundary) is susceptible to overtopping its banks, with severe flooding of low-lying neighborhoods in February 1998 and December 2012. Following the 1998 flood, the cities of Palo Alto, Menlo Park, and East Palo Alto, San Mateo County Flood Control District, and the Santa Clara Valley Water District joined together to create a new regional government agency, the San Francisquito Creek Joint Powers Authority (SFCJPA), which plans, designs, and implements projects along the creek.

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[5] For comparison, 1 cfs for one year amounts to 723 AFY.

A current SFCJPA project will increase creek flood channel capacity and protect people and property from creek and Bay flooding along the urban section from Highway 101 to the bay (SFCJPA , 2015).   This project will also help increase upstream flood protection, benefit habitat of three endangered (and other) species, and improve Bay trails among other benefits. As described on the website (SFCJPA, 2015), the project will:

- Widen the creek to convey a 100-year storm flow, coupled with a 10-year tide and 26 inches of sea level rise;
- Excavate sediment that has built up over several decades and replace it with a marsh plain with higher value vegetation that is naturally more self-sustaining;
- Allow for the future reinstatement of a natural connection between the Creek and the Palo Alto Baylands just to the north of it for the first time in over 75 years; and
- In the area confined by homes and businesses, construct floodwalls aligned to Caltrans' new Highway 101 bridge over the creek.

3.3. GEOLOGY AND AQUIFERS

The City of East Palo Alto overlies a portion of the San Francisquito Cone Subbasin, an area that overlaps the San Mateo Plain and Santa Clara subbasins of the Santa Clara Valley Groundwater Basin (see **Figures 1** and **2**). The groundwater basin and subbasins occupy the San Francisco Bay structural trough between the Diablo Range on the east and the Santa Cruz Mountains on the west. The mountain ranges are composed of older consolidated sedimentary and igneous rocks, where groundwater storage and flow is generally limited to fractures.

The principal groundwater aquifers of the basin and subbasins are composed of interbedded coarse- and fine-grained alluvial fan deposits of San Francisquito Creek, extending from the Santa Cruz Mountains north and under San Francisco Bay, and distal alluvial fan deposits of the Niles Cone (see **Figure 1**), extending from the Diablo Range. Most of the permeable alluvial sediments occurring in the groundwater subbasin and beneath the City originated from the Santa Cruz Mountains to the south-southwest; however, some alluvial sediments from the Niles Cone may interfinger under San Francisco Bay with sediments of the San Francisquito Cone.

The alluvial fan deposits vary in composition with distance from the head of the San Francisquito Cone. Deposits near the head of the fan are characterized as poorly sorted clays and gravels, and deposits near the central portion of the fan and the active stream course are generally cleaner sands and gravels. Deposits near the terminal or distal portion of the fan consist of finer-grained silts, clays and fine sands. Relatively finer-grained materials were deposited laterally away from the stream channel course. Overlying most of the alluvial sediments beneath the City are thick, laterally-extensive fine-grained materials, deposited when the area was below sea level. These Bay Mud sediments form a continuous aquitard or confining layer, thereby producing a multiple aquifer zone system.

3.3.1. Aquifer Zones

The USGS (Metzger, 2002) characterized the groundwater aquifers and aquitards as a generalized three-layer system: an upper unconfined to confined shallow aquifer zone, a fine-grained Bay Mud unit near the Bay, and a deep principal aquifer beneath the confining layer. Most large production wells derive their water from the deep aquifer zone, at depths ranging from 200 to over 800 feet below ground surface (ft-bgs).

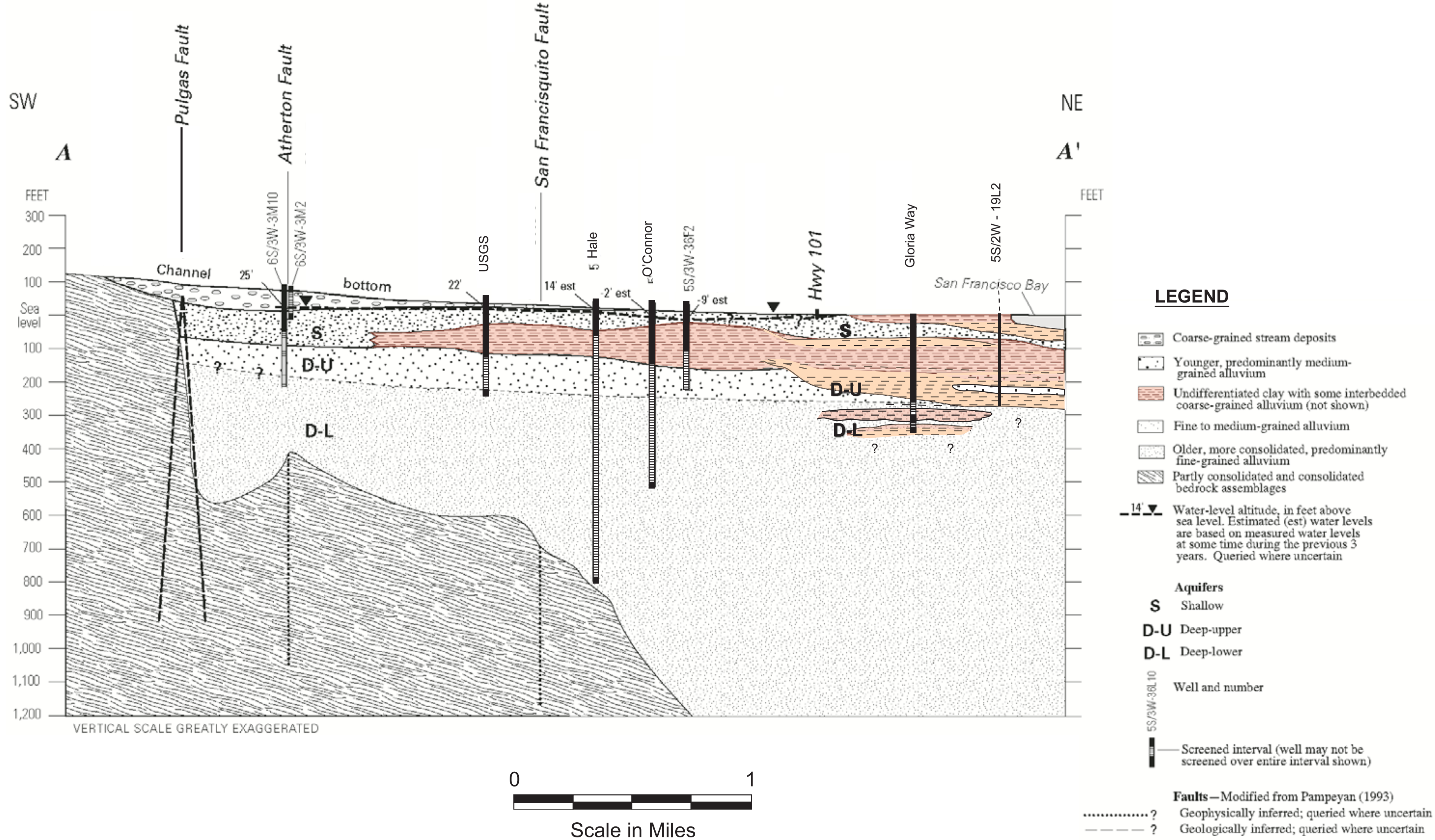
Figure 7 is a regional hydrogeologic cross section that illustrates the aquifer and aquitard system. As shown on **Figure 8**, it extends from the foothills in the southwest to San Francisco Bay in East Palo Alto. The alluvial deposits of the San Francisquito Cone form a wedge that generally thins near the bedrock hills and thickens toward the Bay. Review of water well logs and references indicate that the thickness of the alluvial deposits ranges from zero where bedrock crops out to over 1,000 feet nearer to the bay.

Shallow Aquifer Zone

The shallow aquifer zone underlying East Palo Alto is comprised of localized gravel-filled stream channels etched into a prevailing clayey surface in past geologic time and subsequently buried by younger sedimentary deposits. The shallow aquifer coarse-grained deposits are generally thin (10's of feet thick) localized groundwater bearing zones and form sinuous paths with limited lateral continuity. Some local domestic wells produce groundwater from this shallow aquifer zone, however most municipal groundwater production is from the deeper principal aquifer zone.

Bay Mud Aquitard

The Bay Mud aquitard occurs beneath San Francisco Bay and extends south-southwest under the entire City. There is a clear increase in aquitard thickness (up to 300 ft-bgs) in the northeast closer to the Bay. The unit does not extend to the foothills in the southwest. The southwestern extent of the Bay Mud aquitard has been mapped by USGS and others, and demarcates the unconfined and confined aquifer zones (see **Figure 8**). The confined zone occurs in the subbasin's northern portion. The subbasin's southern portion, south of the aquitard, is an unconfined zone, and is generally characterized by permeable alluvial fan deposits. This portion of the groundwater subbasin is also a groundwater recharge area, where mountain-front recharge, rainfall infiltration, urban landscaping return flows and percolation of San Francisquito Creek water can directly recharge the principal aquifer.



Modified from: Metzger, 2002.

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Figure 7
Regional Hydrogeologic Cross Section A - A'

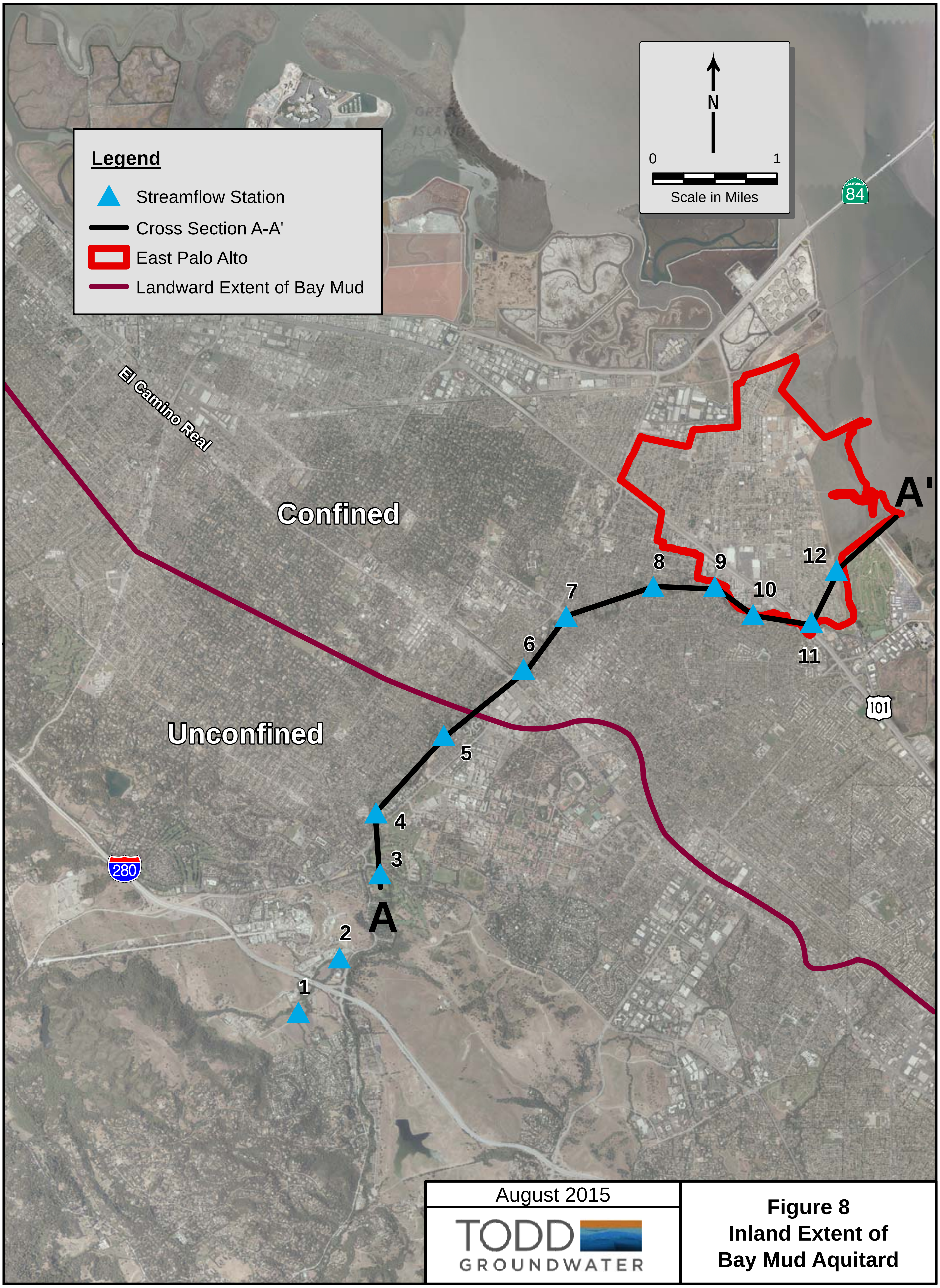

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Figure 8
Inland Extent of
Bay Mud Aquitard

Deep Aquifer Zone

The principal groundwater-bearing aquifer zone comprises unconsolidated to semi-consolidated gravel, sand, silt and non-marine clay that generally has high permeability and thickness compared with the overlying shallow aquifer zone and Bay Mud aquitard. Where the Bay Mud aquitard is present, the principal aquifer zone is confined. The thickness of the principal aquifer zone ranges from less than 100 feet near the Santa Cruz Mountains to almost 1,000 feet near San Francisco Bay (**Figure 7**). The principal aquifer zone underlying the City does not end at the shoreline of San Francisco Bay; rather it extends offshore beneath the Bay and may be hydraulically connected to aquifer zones in the southeast side of the Bay including the Niles Cone aquifer.

3.4. AQUIFER PROPERTIES

Estimates of aquifer hydraulic properties are used to quantify the potential productivity and storage characteristics of water-bearing units and are necessary for predictive modeling efforts. Hydraulic conductivity describes the rate at which water can move through a permeable medium. Transmissivity is the rate at which water is transmitted through a unit width of aquifer under a unit hydraulic gradient. Hydraulic conductivity times the average saturated thickness of aquifer is equal to transmissivity.

Aquifer hydraulic properties can be estimated by performing well pumping tests and measuring the well flow rate and water level drawdown in the well and adjacent wells. With the exception of the Gloria Way Well and Pad D Test Well, no pumping test data are available for other wells in the City and only limited pumping test data are available in adjacent areas. The representative transmissivities for the Gloria Way and Pad D Test Wells, based on single-well constant rate pumping tests are approximately 700 and 1,160 square feet per day (ft^2/day), respectively (HDR, 2004, and EKI, 2014). Slightly higher transmissivities were measured in a few wells in Palo Alto (Todd, 2012).

3.5. GROUNDWATER LEVELS AND FLOW

Currently there is no regional groundwater management in southern San Mateo County, and no maintenance of a centralized database of groundwater elevation measurements by either the County of San Mateo or local municipalities. Some generalized groundwater elevation and flow information has been published by the County of San Mateo, SCVWD, DWR and USGS, and is available from localized groundwater contamination sites. Groundwater elevation data from these reports have been used to develop a conceptual model of historical and current groundwater flow conditions.

Historical flow conditions in the southern subbasin have been characterized in a pair of USGS Reports (Fio and Leighton, 1995; Metzger and Fio, 1997). Under natural conditions, groundwater flow is from the edge of the basin near the bedrock uplands toward San Francisco Bay to the northeast. Groundwater levels in the San Francisquito Cone Subbasin were near and in some areas above the ground surface (artesian) in the early 1900s.

In the early part of the 20th century, increased pumping and periodic drought reduced local groundwater levels to below sea level. By the mid-1920s, an estimated 6,000 acre-feet per year (AFY) were pumped from the San Francisquito Cone. This level of pumping and below normal rainfall in the early and mid-1920s resulted in substantial drawdown of water levels below sea level (more than 90 feet below sea level in the Atherton area). By the early 1960s, groundwater extraction from the San Francisquito Cone was estimated to be about 7,500 AFY. Of this total, approximately 6,500 AFY was by pumped the City of Palo Alto and Stanford University (Sokol, 1964). This amount of pumping resulted in historical overdraft including local subsidence and salt water intrusion.

Groundwater extraction declined significantly with importation of Hetch Hetchy water in the 1960s. As a result, groundwater levels steadily increased over much of the area. Between 1962 and 1987, groundwater levels in the City of Palo Alto rose more than 150 feet to levels comparable to those of the early 1900s (Carollo, April 2003) and then stabilized.

Figure 9 shows groundwater elevations over time in several wells in the sub-basin. The City of Palo Alto's Hale Well located near San Francisquito Creek adjacent to Menlo Park (see **Figure 10** for locations). Prior to 1962, groundwater elevations in the well were over 140 feet below sea level. This condition allowed for brackish water from the Bay to flow inland and degrade groundwater quality. Groundwater levels recovered after regular pumping of the well stopped in 1962. The well was operated briefly during the 1988 drought (total pumping of 398 acre-feet) and an associated decline of about 16 feet was measured. After pumping stopped, water levels recovered to pre-drought levels by early 1996. A similar pattern was observed in the O'Connor Tract well, where groundwater elevations well below sea level in the 1960's recovered to above sea level. A decline in groundwater elevations of 8 to 15 feet has been observed in the Romic and Hale wells since 2010, likely in response to the current drought and reduced sub-basin recharge.

Measurements made between 1993 and 1995 by the USGS have been used to construct a groundwater elevation contour map of the San Francisquito Cone (**Figure 10**). The generalized contours are extended to Palo Alto and East Palo Alto based on water level data in the Hale and Gloria Way wells and a deep monitoring well at the Romic Environmental contamination site. The contour map indicates a hydraulic gradient (0.002 foot per foot) across East Palo Alto and groundwater flow generally toward the bay in the northeast.

3.6. Potential for Subsidence

Land subsidence occurs when groundwater overdraft significantly reduces the fluid pressure in the pores of the aquifer system. This results in compression of clay materials and the sinking of the land surface. This compression may be partially recoverable if pressures rebound, but the recovery is rarely of the same magnitude as the initial compression. Areas having a greater abundance of fine-grained sediments, such as northeastern East Palo Alto, are more susceptible to land subsidence than the southwestern area of the City, because of the greater compressibility of these sediments. Subsidence can exacerbate flooding and damage infrastructure.

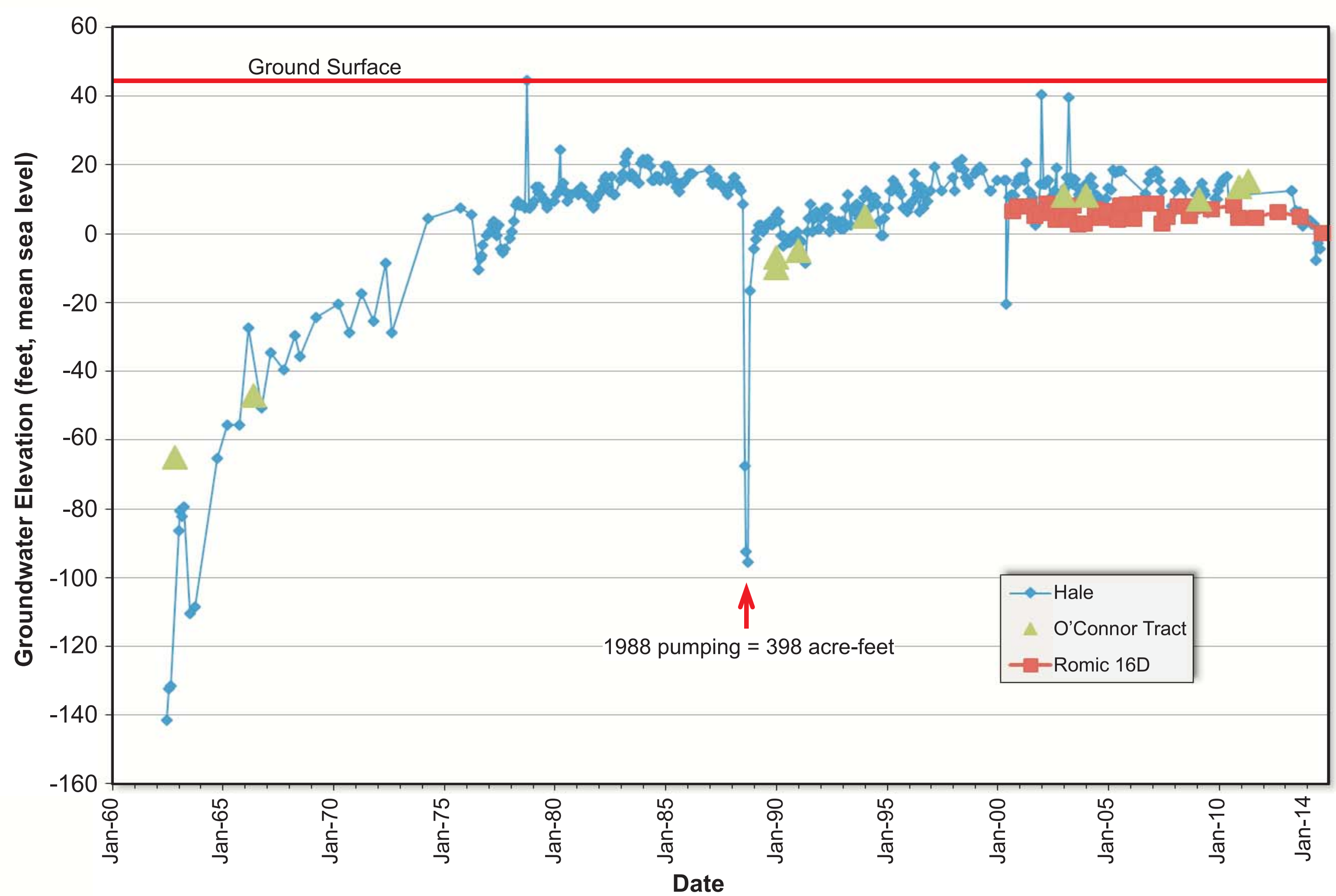

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Figure 9
Historical Groundwater Elevations

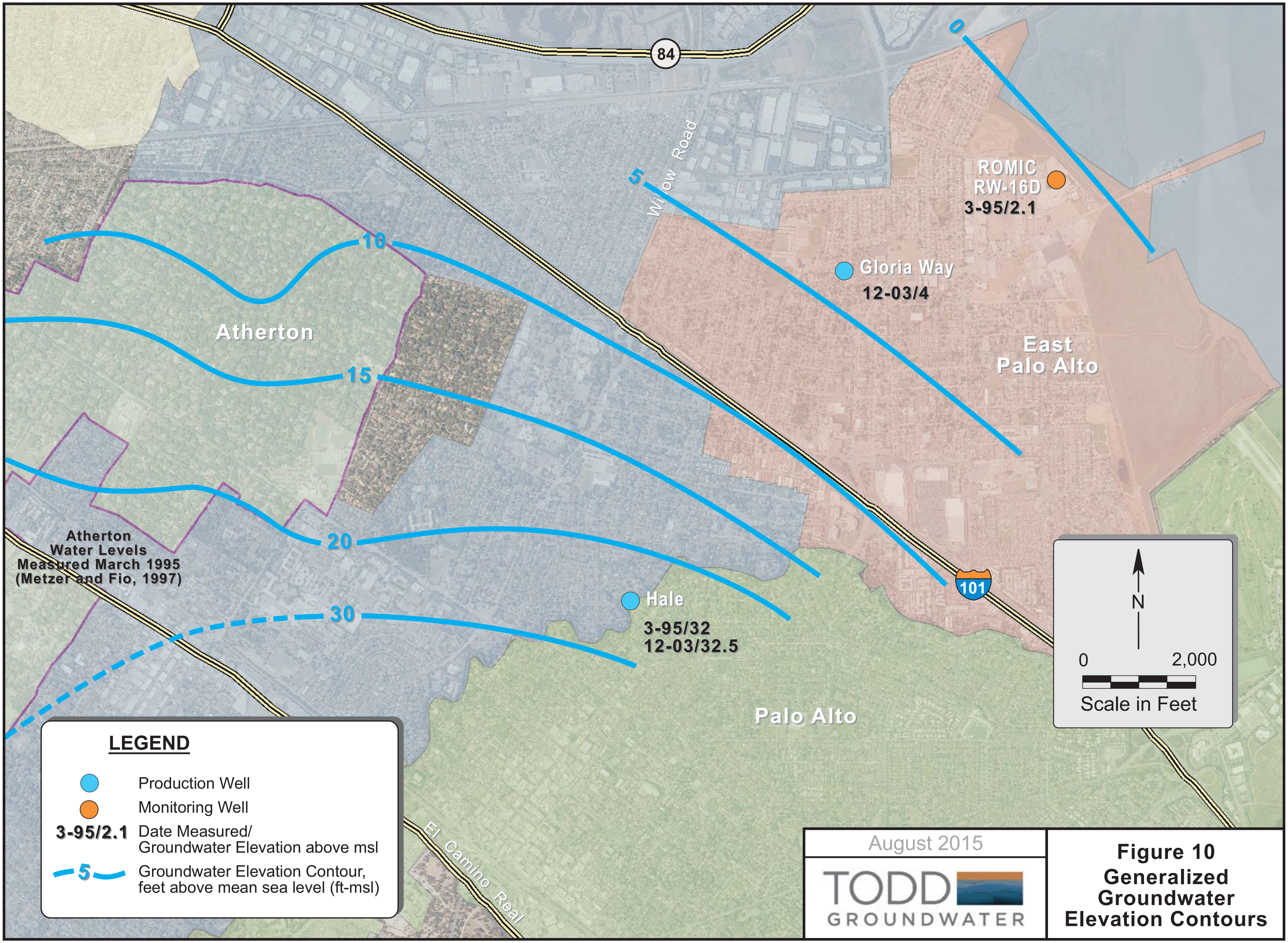

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Figure 10
Generalized Groundwater Elevation Contours

In the first half of the 20th century, portions of the City of San Jose subsided as much as 13 feet as a result of over pumping; this subsidence has been halted with development of surface water sources and improved groundwater management. Similarly in the San Francisquito Cone area prior to the 1960s, groundwater levels were well below sea level; these lowered groundwater levels induced subsidence of the aquifer system. Land subsidence of more than two feet was measured in Palo Alto and East Palo Alto between 1934 and 1967 (Poland and Ireland, 1988). Subsidence in the Atherton area during the same period was reportedly between 0.1 and 0.5 foot (Metzger, 1997).

It is instructive to note the magnitude of groundwater level declines associated with subsidence; for example, groundwater levels in the Hale Well in Palo Alto reached a low elevation of -140 feet mean sea level (ft-msl) or 186 ft-bgs in 1962. The static water level in a well drilled in Atherton in 1950 was about -23 ft-msl (53 ft-bgs). PAPMWC Well No. 5 had a static groundwater level of -31 ft-msl (46 ft-bgs) when drilled in 1950. These observed historical conditions indicate a potential for subsidence, should intensive pumping resume with large drawdowns.

Because of the economic cost that subsidence incurs, the SCVWD and USGS have initiated a program of surveying the Santa Clara Valley to determine the extent of the problem. SCVWD monitors subsidence with a network of index wells, survey benchmarks, and two deep extensometers that measure the rate and magnitude of compression that occurs between the land surface and bottom of the well (SVCWD, January 2005). SCVWD has established subsidence thresholds, or groundwater elevations below which significant subsidence will likely occur for its index wells based on the PRESS (Predictions Relating Effective Stress and Subsidence) model (SCVWD, January 2005). The SCVWD has established a tolerable continuing rate of subsidence of 0.01 feet per year. Based on the modeling, if groundwater levels do not drop below the threshold level, the tolerable subsidence rate will not be exceeded. The nearest subsidence monitoring well (located in Mountain View) has a subsidence threshold of -26 ft-msl. Some of these techniques require surface and subsurface survey equipment to measure horizontal and vertical displacement. Although such surveys are very precise (e.g., borehole extensometers), they are expensive to install and maintain.

Mitigation measures by the SCVWD in the late 1960s and early 1970s have stopped and even reversed subsidence in the Santa Clara subbasin. These measures have included provision of surface water supplies in lieu of groundwater, artificial recharge of the groundwater basin through stream channels and recharge basins, and careful monitoring and management of groundwater levels to avoid further subsidence (Borchers, et al., 1999; Ingrebritsen and Jones, 1999; Schmidt and Bürgmann, 2003).

Satellite Interferometric Synthetic Aperture Radar (InSAR) is a relatively new technique allowing measurement and mapping of changes on the Earth's surface as small as a few millimeters (mm). This is accomplished by reflection of satellite-born radar signals from space to the ground with return to the same point in space but at different times. Therefore, the radar satellite measures changes in distance between the satellite and ground as the land surface uplifts or subsides. These data are then converted into interferograms that are used to construct maps of relative ground-surface changes. Such maps are used to understand the effects of groundwater and petroleum withdrawals, or other human-induced land deformation (Bawden, et al., 2003).

To evaluate seasonal and multi-year deformation patterns, the USGS used European Observation Satellites (EOS) 5-year InSAR data from September 1992 through August 1997. The data showed small amounts (5 to 10 mm) of regional uplift that corresponded with water-level recovery throughout the Santa Clara Valley. An 8-month interferogram (January to August 1997) showed seasonal subsidence of about 30 millimeters near San Jose that corresponded to about a 10 meter decline in water levels. In the Palo Alto and East Palo Alto area, significantly less seasonal declines were noted (Galloway, et al., 2000; Bawden, et al., 2003). InSAR can be used effectively to determine both long- and short-term land subsidence and recovery.

3.7. SURFACE WATER-GROUNDWATER INTERACTIONS

Consideration of local surface water-groundwater interactions is focused on San Francisquito Creek, which has been the subject of various studies that are revealing about surface water-groundwater interactions. These include a number of water balance studies (e.g., Sokol, 1963; Todd 2005) that indicate that the creek loses flow along portions of its channel and thereby provides recharge to the groundwater subbasin. The most significant investigation was conducted by USGS in 1996-1997 (Metzger, 2002). This study included a series of synchronized streamflow measurements at 13 sites along the creek to estimate gains and losses along selected reaches.

Figure 11 reproduces Figure 8 from the USGS study; this figure shows ten of the gage sites along the creek and summarizes the findings. (For a map of the creek and gaging sites, refer to **Figure 5**.)

The lower portion is a cross-section illustrating the hydrogeology, including the bedrock on the southwest, and major aquifer zones (indicated by various stippling). These include the shallow (S) and upper and lower deep zones (D-U, D-L). The regional aquitard is shown by the dashed fill, particularly the Bay Mud that separates the shallow and deep zones.

The upper portion of **Figure 11** depicts the average streamflow losses and gains by reach. As indicated, the greatest streamflow losses (representing recharge to groundwater) occur between sites 4 and 7; this generally corresponds to the reach where aquifers extend to the ground surface and the aquitard is absent. A gaining reach between sites 7 and 8 was attributed to unmeasured inflow from storm drains; this inflow could mask streamflow losses. Another losing (recharge) reach was documented between sites 8 and 10 (i.e., just west of Highway 101), but with lesser recharge rates. The lowermost reach along the City boundary is indicated as a net gaining reach, attributed mostly to unmeasured inflow from storm drains plus lack of recharge due to high groundwater, and probable tidal influences.

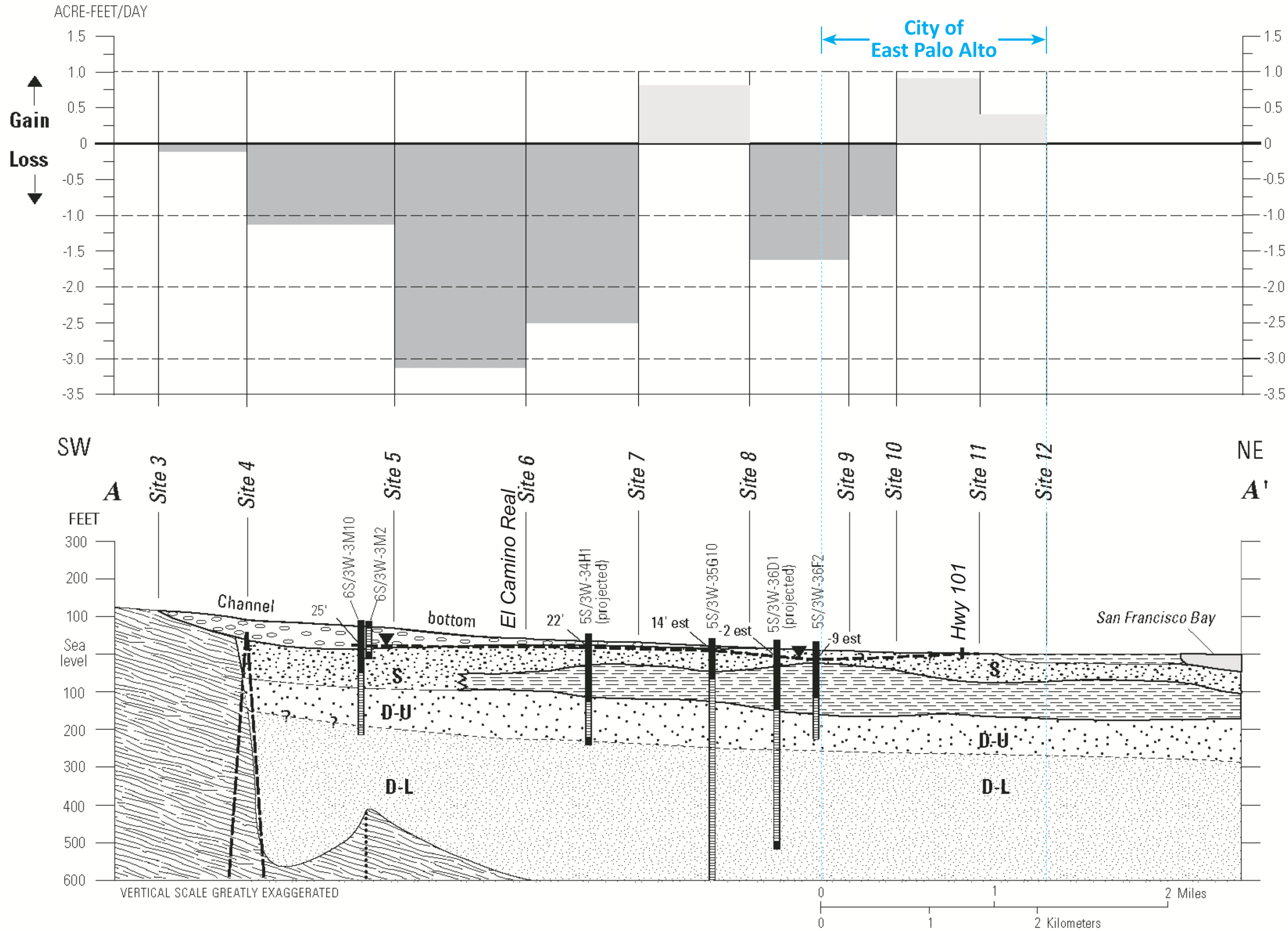

Figure 8. Average streamflow gains or losses by reach between sites 3 and 12 along San Francisquito Creek, southern San Mateo and northern Santa Clara Counties, California. (Geologic section modified from figure 5; refer to that figure for the explanation of this figure.)

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Figure 11
Average Streamflow Gains and Losses Along San Francisquito Creek

While the information is limited, it is consistent with a general conceptual model of groundwater recharge along the upper reaches of San Francisquito Creek as it crosses the alluvial fan. Given the absence of the Bay Mud, this recharge can readily replenish the shallow and deep zones. Recharge to the shallow zone occurs along the lower reaches of the creek, but may be limited by high groundwater levels in the shallow aquifer and/or masked by urban runoff and tides.

As part of the USGS study, water quality sampling and analysis were also conducted from wells and surface water sites. This was intended to help characterize surface water and groundwater quality and to evaluate sources of recharge to groundwater. Some findings of the water quality study include:

- Urban runoff constitutes most of the streamflow in some reaches during low flow.
- The most pronounced difference in groundwater composition between the shallow and deep aquifers occurs in the lower alluvial fan owing to extensive deposits of bay mud and clay separating the two aquifers.
- Water in wells completed in the shallow aquifer and located close to residential streets may be a mixture of native groundwater and imported water from leaking public water supply and sewage lines and return flow from excess irrigation of landscaping.

3.8. WELLS AND PRODUCTION

In the early 1900s, most of the groundwater extraction in the area was from large capacity municipal wells, such as those operated by the City of Palo Alto and Stanford University. It is estimated that total extraction from the San Francisquito Cone was about 6,000 acre-ft per year (AFY) by the mid-1920s (Metzger and Fio, 1997).

With the importation of Hetch Hetchy water, groundwater pumping from these municipal wells was discontinued in the early 1960s. As the cost of imported water has increased, a number of private homeowners in the area (primarily in Atherton and Palo Alto) have installed wells, primarily for irrigation, to supplement their water supply. The installation of private wells tends to correlate with periods of drought or below average rainfall (1976 - 1977 and 1987 – 1992) when concerns over rationing and water costs increase.

Generally, the most productive wells are located near San Francisquito Creek in the medial portion of the alluvial fan. Wells tend to be less productive near the bay and near the southeast and northwest edges of the subbasin (CH2MHill, July 1992; Well logs).

Well logs indicate that well yields in the San Francisquito Cone area vary from 1 to 1,800 gallons per minute (gpm), with an average yield of 130 gpm. Most of the wells drilled in the City and surrounding cities are small diameter (less than 8 inches) domestic and irrigation wells, with fewer larger diameter (10 to 30 inch) municipal and industrial wells. Generally, municipal wells with larger diameter casings yield between 100 and 1,800 gpm, with an average of 650 gpm.

Figure 12 shows the locations of known or planned groundwater production wells in and adjacent to the City. The cities of Menlo Park and Palo Alto have also proposed or have already developed additional emergency short-term groundwater supplies. Information on existing or proposed groundwater use in and around the City is discussed in the Water Balance section.

3.8.1. Municipal/University/Industrial Wells

Municipal water users in and around East Palo Alto include two water companies. The O'Connor Tract Cooperative Water Company operates two wells in Menlo Park. The company serves 1,117 dwelling units and has approximately 340 connections. In 2013, the wells produced an average of 274,000 gallons per day or 307 AFY. Of this total approximately 154 AFY was used by customers in East Palo Alto (O'Conner Tract Cooperative Water Company, 2014).

The Palo Alto Park Mutual Water Company (PAPMWC) currently provides groundwater from five wells located in East Palo Alto. The well field reportedly pumps about 1,300 gpm in the summer and about half this amount in the winter (GeoMatrix and Papadopulos, September 1989).The PAPMWC is owned by 650 property owners (PAPMWC Website). Given its 650 connections, and using O'Connor's water usage rate of 307 acre ft/year for 1117 dwelling units, the average PAPMWC production is estimated to be 182 AFY.

Stanford University currently has wells and has used groundwater for irrigation totaling 342 AFY (BAWSCA, May 2011). In Menlo Park, the Veterans Hospital, St. Patrick's Seminary, Menlo College, and USGS operate larger capacity wells for irrigation, domestic, or industrial uses. The annual volume of water pumped from these wells is unknown but estimated at 500 AFY for the water balance.

Three industrial wells have been identified in Redwood City. Their status is unknown.

3.8.2. Potential Future Municipal Wells (Emergency and Long-Term Supply)

The City has one well (Gloria Way) that has been identified as a potential source of water supply. It is estimated that the well could produce between approximately 350 and 450 gpm or 564 to 735 AFY (HDR, April 2004). A second production well is planned for installation at the Pad D test well site (**Figure 12)** in the future. The City would like to increase the yield from the Gloria Way Well and/or another well(s) to yield 1,120 AFY.

The City of Palo Alto currently maintains eight wells for emergency standby supply (**Figure 12**). Wells were last used in 1988 during the extended drought (Carollo, April 2003). It has been estimated that the wells could produce at least 500 AFY on a continuous basis or 1,500 AFY on an intermittent basis without causing excessive declines in groundwater levels (Carollo, April 2003).

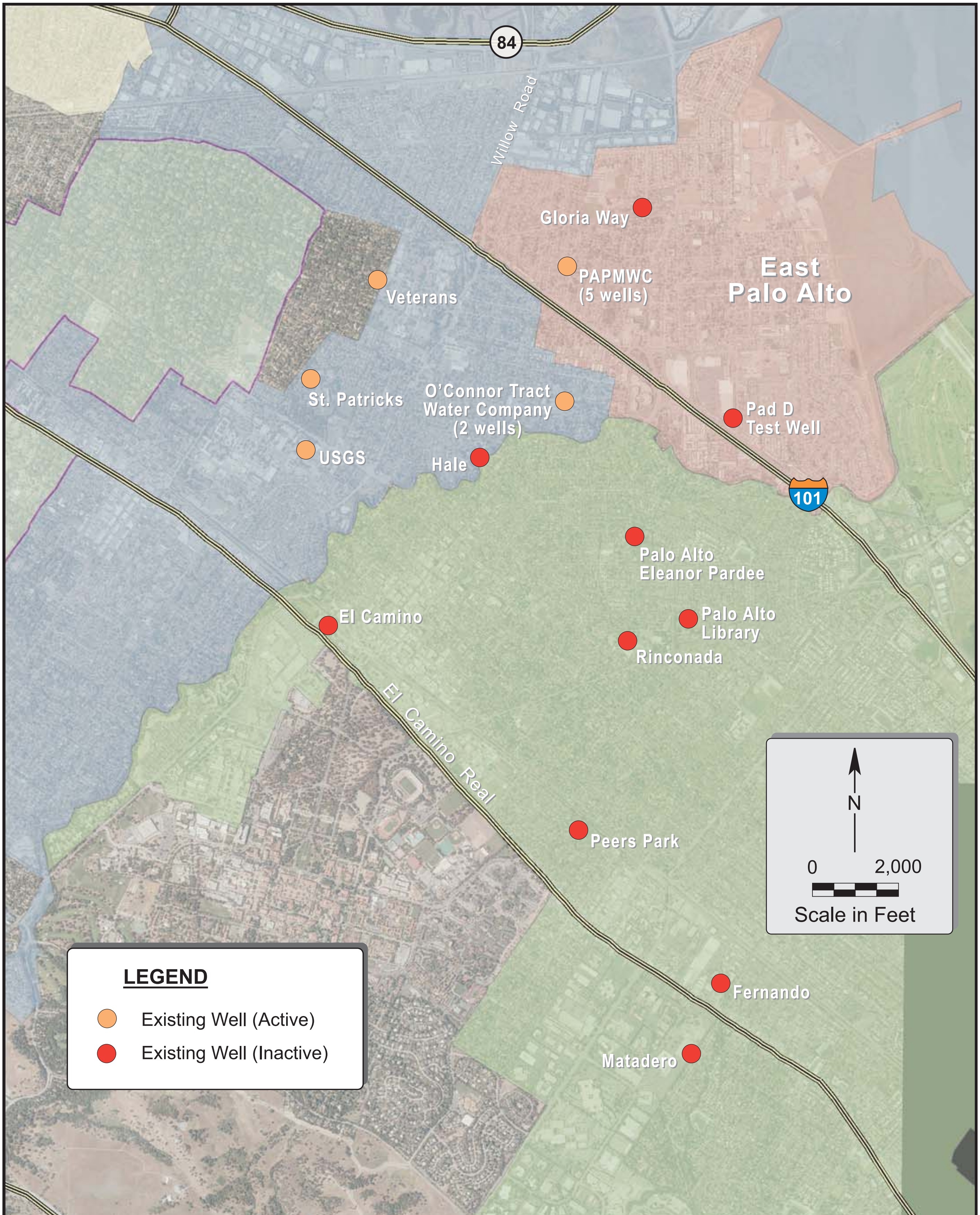

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Figure 12
Known Production Well Locations

Since 2002, the City of Menlo Park has been investigating the potential for groundwater development as a supplemental or emergency supply. An Emergency Water Supply Project is currently underway to identify alternative sites for two to three production wells. These would be capable of an emergency supply of 3,100 gpm to meet the average day demand of 1,600 gpm and fire flow of 1,500 gpm. Recently, seven sites were identified as most promising (Gnesa and Buising, November 2011). In January 2012, an exploratory boring was drilled at the Willow Road Site on the northwest corner of Willow Road and Highway 101 (actually located in East Palo Alto). In 2012 Menlo Park also drilled a test boring at the City Corporation Yard site. Menlo Park has also considered installation of an irrigation well at Nealon Park to offset Sharon Heights Golf and Country Club water supply. The well would reduce the City's overall demand and provide a potential irrigation source for other nearby parks.

The City of Redwood City has considered development of groundwater to augment groundwater supplies (Redwood City, June 2011). However, Redwood City is located near the northwestern extent of the Subbasin where alluvial deposits are thinner and more fine-grained than deposits further to the south; thus the groundwater development in this area appears less economically feasible at this time. Nonetheless, a network of properly sited and designed wells could yield between 500 and 1,000 AFY. To date, acceptable sites have not been identified, nor have yield, schedule, and costs been confirmed. Currently (2015) Redwood City is not actively planning groundwater development.

3.8.3. Domestic and Irrigation Wells

DWR and San Mateo County records indicate that a large number of private domestic and/or irrigation wells have been installed in the San Francisquito Cone area. The USGS performed a comprehensive survey of wells in the City of Atherton and identified at least 278 likely active wells as of 1993-1995 (Metzger and Fio, 1997). Metzger and Fio estimated the total pumping from these wells at approximately 710 AFY or about 19 percent of the City of Atherton's total water supply.

Estimation of pumping from local domestic and irrigation wells in the area is hampered by lack of information on the well operations and usage. It is assumed that most usage is for landscape irrigation purposes. Using the average annual pumping of 1.9 AFY per well estimated by Metzger and Fio for the Atherton area and multiplying that value by the identified domestic and irrigation wells installed since 1962 in the remaining cities (100 wells) yields approximately 190 AFY.

3.9. WATER BALANCE

A water balance is a key element in defining sustainable yield of a basin, or the maximum long-term quantity of water that can be withdrawn annually without causing an undesirable result (e.g., chronic groundwater level decline, seawater intrusion, land subsidence, surface water depletion). A basin's yield is estimated through a water balance study that examines inflow into a defined basin, outflow from the basin, and change in groundwater storage in the basin, recognizing the following relationship:

Inflows – Outflows = Change in Storage

No water balance studies have been conducted for the San Mateo Plain Subbasin as a whole. Nonetheless, some studies have addressed local areas such as Redwood City (Todd, 2003), BAWSCA Brackish Groundwater Feasibility Study focus areas along the bayshore (CDM Smith, 2013), and the San Francisquito Cone, which has been the subject of several water balance estimates (e.g., Todd, 2005). The most recent of these studies was part of the *Groundwater Feasibility Study* (Todd, 2012), which provided a general water balance with rough estimates on an average annual basis. A *detailed* evaluation of the San Francisquito Cone Subbasin water balance has not yet been conducted that accounts for average, wet and especially dry years.

It should be noted that a water balance is inherent to a numerical groundwater flow model or linked surface water/groundwater model. Accordingly, development of a model would include detailed evaluation of the water balance. Moreover, it would yield a dynamic tool for defining sustainable yield, assessing the response of the groundwater system to drought and climate change, and evaluating different management scenarios for the basin and/or watershed.

3.9.1. Inflows

Acknowledging the uncertainty of available information, the *Groundwater Feasibility Study* provided a wide range of estimated total recharge from about 5,000 to 10,000 AFY for the San Francisquito Cone Subbasin. This range was based on low and high estimates for the following sources of inflow (recharge):

- Percolation from landscape irrigation and leaking water and sewer pipelines
- Surface water inflow including infiltration from San Francisquito Creek and Lake Lagunita
- Infiltration of precipitation on the alluvial basin
- Subsurface groundwater inflow from the upland drainage basin

To estimate percolation from irrigation, the estimated volume of water supplied to each of the major water users within the subbasin was multiplied by a low (30 percent) and high (50 percent) irrigation usage percentage (BAWSCA, May 2011; Metzger and Fio, 1997). These two values were in turn multiplied by a low (10 percent) and high (15 percent) percolation percentage. These computations resulted in a range of irrigation return flow from 1,000 and 2,700 AFY.

An assumption of water supply pipeline leakage losses from 3 to 5 percent of total water supplies resulted in a range of recharge from approximately 1,500 to 2,500 AFY. Similarly, the range in estimated sewer line leakage losses to groundwater was estimated from 250 to 1,000 AFY.

The USGS has estimated average streamflow losses from San Francisquito Creek at 1,050 AFY. After accounting for evapotranspiration, recharge to groundwater from San Francisquito Creek is estimated to average approximately 950 AFY (Metzger, 2002). This was based on the streamflow gaging conducted by the USGS at the 13 temporary stations between April 1996 and May 1997. The recharge value for Lake Lagunita of 700 AFY was taken from Sokol (1964).

Infiltration of precipitation falling on the alluvial basin was estimated as 5 to 10 percent of total rainfall, resulting in annual recharge between 880 and 1,760 AFY. Precipitation will also percolate into the subsurface in the drainage basin upland. The portion of this water that moves into the alluvial groundwater basin as subsurface flow has been estimated to be between 25 and 50 percent of rainfall percolation, yielding a range of annual subsurface recharge from approximately 600 to 1,200 AFY.

3.9.2. Outflows

Similarly, the 2012 *Groundwater Feasibility Study* provided an evaluation of major components of groundwater outflow (discharge) from the San Francisquito Subbasin:

- Groundwater pumping and consumptive use
- Subsurface outflow to San Francisco Bay
- Stream baseflow

For this GWMP (Section 3.7), the estimates of groundwater pumping was updated from the 2012 value (2,329 AFY) to 2,211 AFY, while consumptive use is estimated as 95 percent of groundwater extraction or approximately 2,100 AFY. Subsurface outflow to San Francisco Bay and adjacent areas was estimated in the 2012 *Groundwater Feasibility Study* at 700 AFY, but indicated as highly uncertain because of the significant extent of the bayshore where discharge occurs and the lack of data on aquifer characteristics and groundwater gradients. Groundwater discharge (baseflow) to lower San Francisquito Creek or other drainages was acknowledged as possible, but was not quantified. Total discharge from groundwater pumping/consumptive use and subsurface outflow is estimated at about 2,800 AFY.

3.9.3. Change in Storage

Change in storage can be estimated as the residual of the water balance equation; as estimated in the 2012 *Groundwater Feasibility Study* and herein, the water balance equation indicates that estimated recharge (5,000 to 10,000 AFY) currently exceeds reasonably *known* discharge (2,900 AFY). However, the limited available groundwater level data (e.g., **Figure 9**) indicates that recent groundwater levels are relatively stable and thus change in storage is about zero. This suggests that the low estimate of inflows may be more reliable and/or that subsurface outflow is greater to the bay and to the lower portions of streams.

Review of the water balance reveals the following:

- Review of the recharge estimates indicates that municipal water supplies, providing recharge as landscaping return flows and pipeline leakage, account for about half of the total recharge. Local municipal supplies are predominantly SFPUC water (BAWSCA, 2014, Table 3c) and represent importation to the groundwater system.
- The importance of return flows suggests that substantial water conservation in recharge areas potentially could have an adverse impact on groundwater supply. Replacement of imported water with other sources (e.g., recycled water or gray water) should be considered, with due consideration of water quality impacts.
- Review of the discharge estimates indicates that natural outflows to the bay and streams are not well known; understanding these outflows as they occur along miles of bayshore is critical in developing groundwater supply while preventing saltwater intrusion.
- Review of the recharge and discharge reveals the importance of human activities (e.g., importing water and pumping groundwater) in the groundwater system.
- The water balance estimates are uncertain and could be improved with additional monitoring data and a detailed water balance investigation. Hydraulic gradients in the deep aquifer zone accounting for tidal influence could be evaluated, and rates of groundwater outflow estimated. Given the uncertainty of subsurface outflows (and their importance in preventing saltwater intrusion) development of a subbasin-wide three-dimensional groundwater flow model would be most useful.

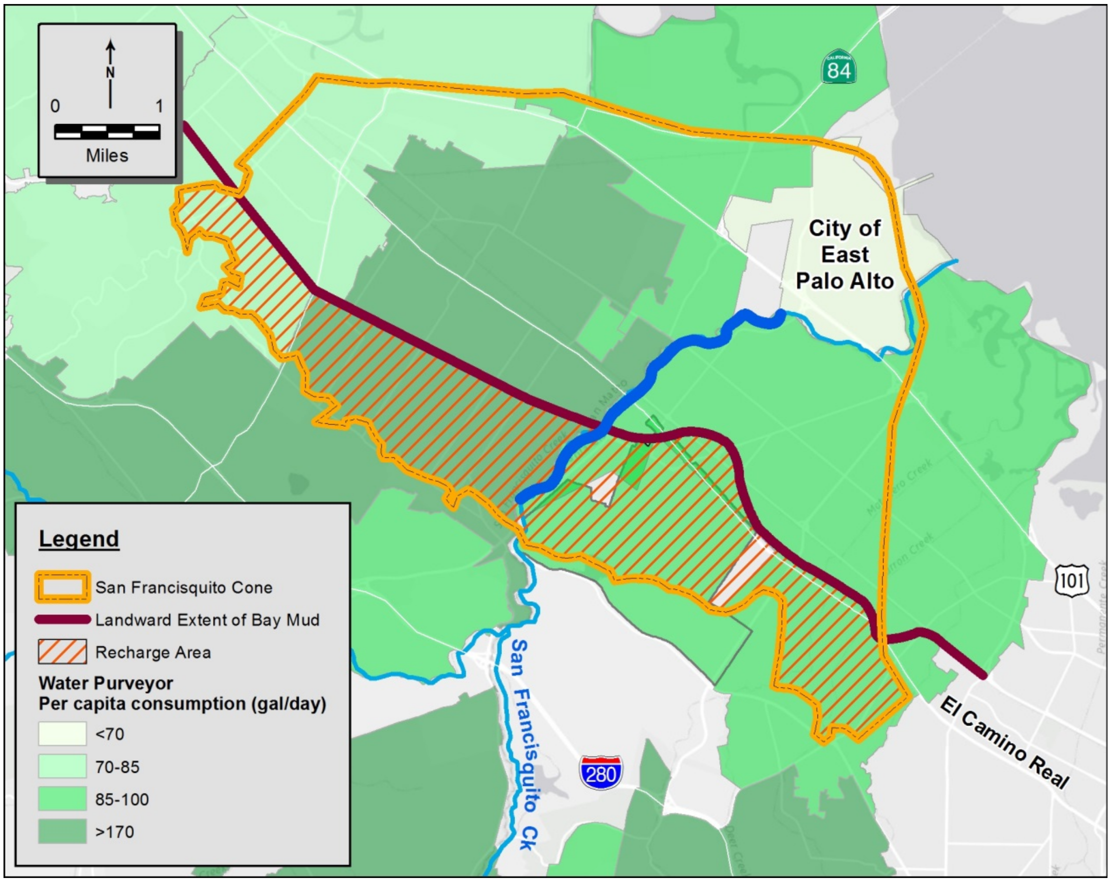
3.10. Recharge Areas

The water balance identified sources of recharge to the San Francisquito area; significant sources with geographic distributions are discussed below. While detailed analysis is lacking, available information indicates that the recharge areas contributing significantly to basin replenishment are located as a band along on the upper portions of the San Francisquito Creek alluvial fan and along the creek channel above the Bayshore Freeway. These are shown on **Figure 13.** How these recharge areas contribute to basin replenishment is described below.

3.10.1. Infiltration of Precipitation

Geographic factors influencing the portion of precipitation becoming groundwater recharge include the regional distribution of rainfall, characteristics of soil and shallow geology (e.g., slope and permeability), occurrence of shallow groundwater, and land use. With regard to land use, major factors are the portion of the land surface covered by buildings and paving and local stormwater management practices, namely the portion of rainfall runoff discharged to storm drains and the bay and the portion directed to permeable ground (e.g., lawns and swales) and reaches of the creek where infiltration can occur.

Figure 13. Recharge Areas



No analysis has been conducted of these factors; nonetheless, a number of factors suggest a higher rainfall recharge on upper portions of the San Francisquito alluvial fan relative to lower portions west of the Bayshore Freeway including most of East Palo Alto. In these upper areas, rainfall is somewhat higher, slopes are gentle, soils and shallow geology are relatively permeable, depths to shallow groundwater are greater, and building densities are lower than East Palo Alto. Areas west of the landward extent of the Bay Mud provide direct rainfall recharge to the shallow and deep aquifer zones.

3.10.2. Percolation from Urban Uses

Review of the water balance indicates that imported water, providing recharge as landscaping return flows and pipeline leakage, accounts for about half of the total recharge across the San Francisquito Cone. The relative distribution of this recharge likely reflects the overall rate of water use in local urban areas.

Residential per capita water use rates are reported by BAWSCA for its members (BAWSCA, 2014, Tables 7A and 7B), including those in the San Francisquito Creek watershed and alluvial cone areas. For example in fiscal year 2012-2013, these rates ranged from a low of

51.6 gallons per capita per day (gpcpd) in East Palo Alto to a high of 290.4 gpcpd in Purissima Hills Water District, in which overlaps part of the San Francisquito watershed. In general, low per capita water use rates reflect mostly indoor use (most of which is routed to wastewater treatment facilities), while high water use rates reflect substantial landscape water use, which contributes to return flows and recharge.

The recharge map, **Figure 13,** illustrates the 2012-2013 residential water use rates for local BAWSCA members, with the relatively darker colors indicating higher water use rates. The San Francisquito Cone and the general landward extent of the Bay Mud also are shown. As indicated, relatively high water use rates occur in the San Francisquito watershed. These likely contribute to upper San Francisquito Creek baseflow through shallow fractured and weathered bedrock. Relatively high water use also extends across the San Francisquito Cone.[6] Residential water use landward of the Bay Mud contributes recharge to the shallow and deep aquifer zones, while water use in areas underlain by Bay Mud more likely contributes to shallow aquifer zones.

Given its relatively low water use and its position overlying the Bay Mud, the City of East Palo Alto is not an area of significant recharge from landscaping return flows. Such recharge occurs mostly in residential areas located higher on the alluvial cone.

3.10.3. Surface Water Infiltration

The 1996-1997 USGS study (Metzger, 2002) documented reaches of San Francisquito Creek that were losing and gaining at the time (see **Figure 11**). In brief, streamflow losses (representing recharge to groundwater) were documented west of Bayshore Freeway/Highway 101. While the information is limited and masked locally by storm drain inflows, it is consistent with a general conceptual model of groundwater recharge along the upper reaches of San Francisquito Creek, indicating the creek channel as an important recharge area.

3.11. GROUNDWATER QUALITY

Natural groundwater quality within the City and San Francisquito Cone Subbasin varies spatially and with depth. Shallow groundwater tends to be similar in composition to recharge water (surface water, precipitation, imported water). Deeper groundwater varies in composition as a result of contact and residence time with formation sediments (Metzger, 2002).

3.11.1. Historical Conditions

Under natural and early historical conditions, groundwater levels were more or less stationary above the level of San Francisco Bay and areas around the Bay were characterized by free-flowing (artesian) wells (Clark, 1924; Lee, 1924-1926).

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[6] BAWSCA provides similar water demand data on a gross basis (for example, for Stanford), which includes unaccounted water and pipeline leakage. The geographic distribution of gross per capita water demand is similar to residential per capita water demand.

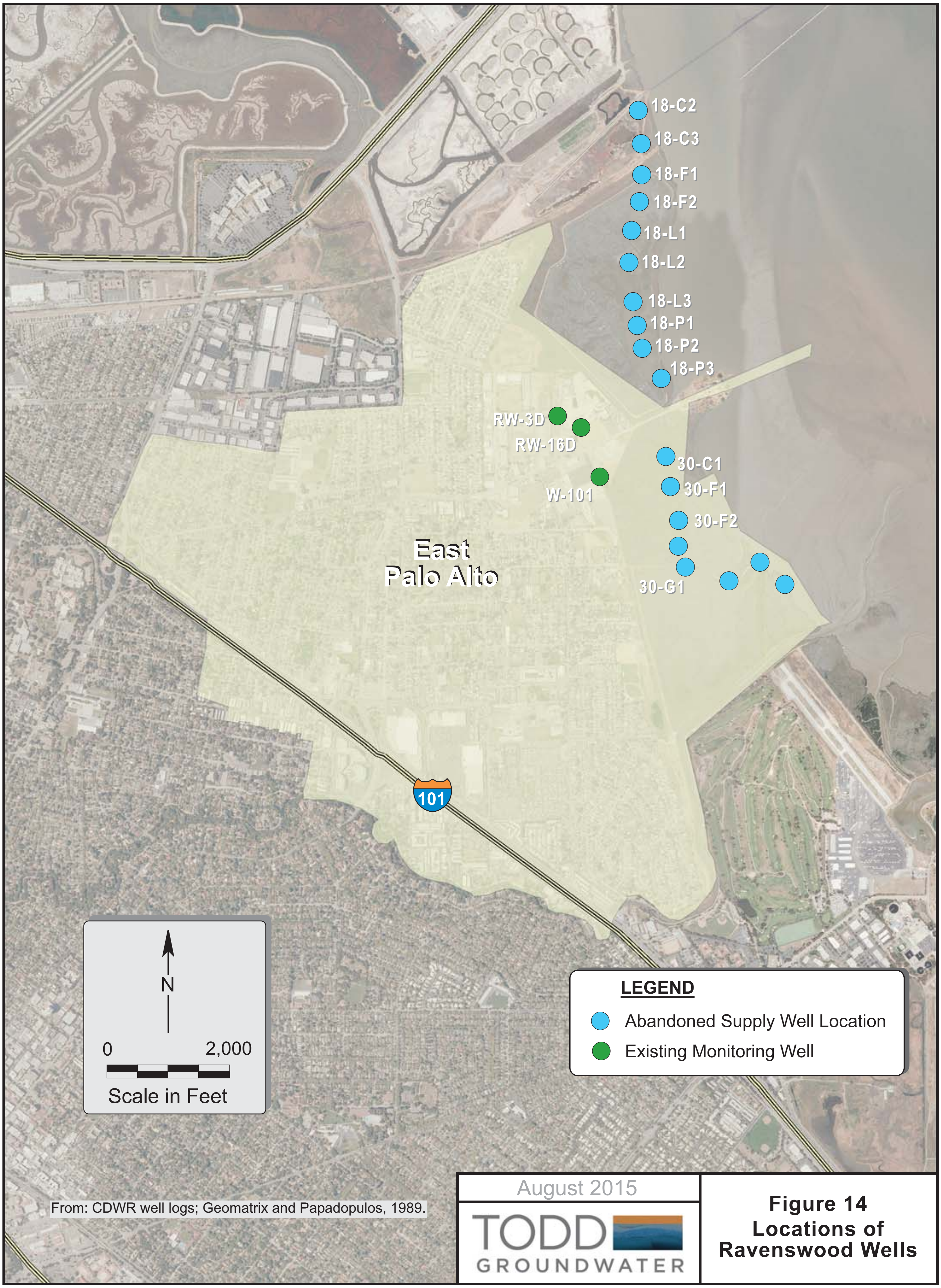
Intensive pumping in the 1920s (exacerbated by drought) caused lowering of groundwater levels, a reversal of the normal groundwater flow toward the Bay, and saline water intrusion that degraded groundwater quality in the subbasin. As of the 1960s, total pumping from the San Francisquito Cone was about 7,500 AFY (Sokol, 1964). With that rate of pumping, groundwater levels remained low and saline water intrusion in the area of Palo Alto, Menlo Park, and Atherton reportedly extended two to three miles inland (Iwamura, 1980).

After about 1965 and increased importation of Hetch-Hetchy water, reduced pumping resulted in recovery of groundwater levels, and return of the natural groundwater flow direction from the Santa Cruz Mountains toward the Bay. This resulted in resumption of groundwater discharge and “flushing” of the intruded saline water back to the Bay. The SCVWD monitors groundwater quality in a network of wells near San Francisco Bay in Santa Clara County to assess saline water intrusion from the bay[7]. Recent monitoring in Palo Alto does not indicate increasing saline water intrusion in the shallow or deep aquifer; on the contrary, data suggest downward trends in chloride levels over time (SCVWD, March 2010). Chloride concentrations in the Hale well peaked at 215 mg/L in 1958 during the period when this well was actively pumped prior to 1962. Similarly, the Rinconada well had a chloride concentration as high as 250 mg/L in 1972.

Concern exists regarding saline water intrusion via abandoned wells located near the Bay. **Figure 14** shows the locations of some of the approximately 45 wells drilled by the Spring Valley Water Company (a private predecessor to San Francisco Public Utility Commission) between 1904 and 1905 along the East Palo Alto bay front. These wells are also referred to as the Ravenswood or Cooley Landing wells. The wells were left uncapped and their casings rusted and saline water may have entered some of the wells at high tide. These abandoned wells could create a conduit for flow of saline water from the Bay into the aquifer. In response to these conditions, some of the wells were reportedly filled and sealed by the SCVWD in 1989. However, the well sealing and integrity of the seals are not known (Geomatrix and Papadopulos, September 1989).

Subsequent work in the Cooley Landing Salt Pond identified at least one artesian flowing well in 2000/2001 (Papadopulos, February 2001). As long as bayward and upward hydraulic gradients are maintained, the probability of saline water intrusion occurring via conduits is low. However, if water levels in the deep aquifer fall below sea level and downward and landward hydraulic gradients are reversed, these conditions could result in saline water intrusion via the conduits.

[7] No comparable monitoring program exists in San Mateo County.



From: CDWR well logs; Geomatrix and Papadopulos, 1989.

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Figure 14
Locations of Ravenswood Wells

3.11.2. Current Conditions

In general, groundwater in the San Francisquito Cone Subbasin tends to be somewhat hard (i.e., high in calcium carbonate) with levels in some wells of chloride, iron, manganese, specific conductance, and TDS that exceed secondary drinking water standards (also termed maximum contaminant levels or MCLs). Elevated levels of these constituents make groundwater undesirable for potable use for aesthetic (rather than health) reasons and thus secondary MCLs apply. Aesthetic concerns include problems with soap lathering, taste, odor, and plumbing/clothing staining. Primary MCLs are health-based water quality criteria.

Generally, groundwater in the area is acceptable for both potable and irrigation uses. However, consumers may find untreated groundwater to be less desirable when compared with Hetch Hetchy water. Groundwater from wells operated by the O'Connor Tract Cooperative Water Company in Menlo Park meets drinking water quality standards (except manganese at times) without the need for additional treatment. Groundwater from wells operated by the PAPMWC in East Palo Alto is chlorinated and blended to meet primary drinking water standards. Water quality in the PAPMWC wells varies with depth of construction. It is noted that many residences served by these private companies have in-home water softeners to address water hardness.

The City's Gloria Way Well exhibits marginal groundwater quality. Historical and recent sampling confirms that the total dissolved solids (TDS), chloride, and manganese concentrations are above the secondary MCLs for those parameters. The City has begun design of a wellhead treatment system to reduce manganese concentrations in groundwater produced from the Gloria Way Well.

The following summarizes general groundwater quality conditions in the City and San Francisquito Cone Subbasin. Additional information on groundwater quality can be found in the Gloria Way *Groundwater Feasibility Study* (Todd, 2012).

3.11.3. Total Dissolved Solids

TDS (the sum of dissolved anions and cations in water) is used as a general representation of inorganic water quality. TDS reflects the effect of many water quality influences, including surface sources (e.g., nitrate from fertilizer) and subsurface sources (e.g., mixing with deep groundwater sources).

The recommended secondary MCL (SMCL) for TDS is 500 mg/L with an upper limit (primary MCL – PMCL) of 1,000 mg/L. Several wells in the San Francisquito Cone area have historically exceed the SMCL of 500 mg/L, including the City's Gloria Way Well, which had concentrations of 840 and 820 mg/L in 2003 and 2012, respectively. The nearby PAPMWC wells have slightly lower TDS concentrations. In August, 2014, the City's Pad D Well had a concentration of 359 mg/L.

In general, there is a trend of increasing TDS concentrations with depth and from upgradient to downgradient areas within the subbasin (Todd, 2012 – Figure 12).

3.11.4. Chloride

Along with TDS, chloride concentrations often are used as an indicator of salt water intrusion, for example from San Francisco Bay. The secondary MCL for chloride is 250 mg/L. The City's Gloria Way Well had chloride concentrations of 280 and 350 mg/L in 2003 and 2012, respectively. In August, 2014, the City's Pad D Well had a concentration of 33.3 mg/L. The deeper screened intervals of the Eleanor Park multiple-completion monitoring wells also show elevated chloride concentrations, which increase significantly with depth.

3.11.5. Iron and Manganese

Iron and manganese are inorganic constituents in groundwater; elevated concentrations cause staining of plumbing and laundry. The SMCL for iron is 300 micrograms per liter (ug/L) and for manganese is 50 ug/L. Some wells have manganese concentrations exceeding the SMCL. The City's Gloria Way Well had manganese concentrations of 190 and 160 ug/L in 2003 and 2012, respectively. Some of the nearby PAPMWC and O'Connor Tract wells also have had manganese concentrations above the SMCL. In August 2014, the City's Pad D Well had a manganese concentration of 38 ug/L.

High iron concentrations also have been found monitoring wells near the East Palo Alto bay front (Todd, 2012). Historical iron concentrations in the Gloria Way Well ranged from 140 ug/L in 2003 to 130 ug/L in 2012. Iron was not detected in the 2014 water quality sample from the Pad D well.

3.11.6. Contamination Sites

Groundwater contamination related to human activity has occurred from leaking underground petroleum storage tanks and discharge of heavy metals and chlorinated solvents in commercial/industrial areas. Some human-caused contaminants are carcinogenic and many are hazardous to human health at elevated concentrations. Thus primary drinking water MCLs are the water quality standards applied to these contaminants.

Several sites have known high concentration of solvents and heavy metals, including the Romic Chemical and Rhone-Poulenc (1990 Bay Road) sites. However contamination at these sites is limited in lateral and vertical extent, and does not currently threaten water quality at Gloria Way or other production well locations. The regional confining layer restricts the rate of contaminant transport at these sites and provides a degree of protection for deep production wells from surface releases. It also reduces the potential for production well pumping to affect remediation activities.

Currently, no contamination sites have been identified in close proximity to the Gloria Way Well, Pad D site, O'Connor or PAPMWC wells. In addition, historical water quality sampling has not indicated petroleum or solvent contamination in the Gloria Way and Pad D Wells.

3.12. GROUNDWATER ISSUES

Public workshops were convened on December 4, 2014 and February 24, 2015 to discuss the goals of the City's GWMP, review groundwater conditions, define groundwater issues, discuss basin management objectives (BMOs) and identify management activities to achieve BMOs. Through this public process, the following four GWMP goals were defined:

1. Provide the City of East Palo Alto with a long-term, reliable and affordable high quality supply;
2. Maintain or improve groundwater quality and quantity for the benefit of all groundwater users;
3. Promote integrated water resource management for multiple beneficial uses, and
4. Engage in cooperative and sustainable groundwater management in local subbasins.

In light of these goals, the workshop process also identified three major concerns:

- Potential adverse impacts of pumping on other wells, groundwater levels and storage, subsidence potential, surface water (San Francisquito Creek), and groundwater quality (including saltwater intrusion and contamination)
- Lack of data to assess groundwater levels, groundwater quality, the water balance, subsidence, wells, pumping amounts and impacts, etc.
- Need for collaboration among local agencies/groundwater users/residents, public outreach/education, and regional management for sustainability.

To address these issues, BMOs and management actions (including monitoring and regional planning collaboration) have been defined, as presented in the next sections.

4. BASIN MANAGEMENT OBJECTIVES

Basin management objectives (BMOs) express the desired achievements for a GWMP, consistent with management goals and linked to specific issues. The BMOs identified as part of this GWMP process are measurable and achievable, with linked management actions as described in the next section. These BMOs are also intended to be adaptive and subject to regular re-examination and update as more information becomes available and as conditions change.

The GWMP workshops identified major concerns, summarized below:

- Potential adverse impacts of pumping
- Lack of data and understanding of the groundwater system
- Need for collaboration, education, and regional management for sustainability.

The workshops also identified four major potential adverse impacts of pumping (listed below). Viewed another way, these are the key indicators for groundwater sustainability.

- Groundwater levels
- Subsidence
- Groundwater quality
- Groundwater-surface water interactions

BMOs for the major concerns and impacts are described in this section. Management actions to achieve the BMOs are presented in Section 5.

4.1. MAINTAIN ACCEPTABLE GROUNDWATER LEVELS

This BMO is responsive to all four GWMP goals. It directly addresses the issues of potential adverse impacts of pumping on other wells and groundwater levels and storage; it also is relevant to issues of subsidence, saltwater intrusion, and interactions with San Francisquito Creek. While data are limited, the historical record (**Figure 9**) shows that groundwater elevations were low in the 1960s (prior to water importation) and when pumping diminished, recovered by the late 1970s. Groundwater elevations have generally stabilized with variations due mostly to wet and dry conditions.

At this time, additional groundwater development on a sustained basis is known to be planned only by the City. Initiation of groundwater pumping by the City (e.g., at Gloria Way Well) will result in a decrease of local groundwater levels with stabilization at lower levels (see Todd, 2012 and ESA, 2013). For perspective, preliminary groundwater flow modeling of the Gloria Way Well pumping at 300 gpm for 5 years could lower groundwater levels by 35 feet at distances of about 500 feet, with drawdown impacts diminishing with increased distance from the well.

This BMO is intended to maintain acceptable groundwater levels in terms of overall groundwater storage and potential impacts on nearby wells. Considerations for subsidence and saltwater intrusion are addressed in subsequent sections. With regard to potential impacts on wells, this BMO is defined as:

- Maintaining groundwater levels above the bottom of a well screen or existing pump intake at all times insofar as groundwater levels in a well are affected by local pumping.
- Maintaining groundwater levels above the top of the existing well screens as much as possible insofar as groundwater levels in a well are affected by local pumping. This helps maintain cost-effective pumping and the efficiency of a well by reducing problems such as well incrustation, cascading water, and reduced hydraulic efficiency.

Groundwater levels will be measured in wells owned by the City and cooperating organizations. Should groundwater levels decline significantly in a participating production well, the City and well owner will cooperate in investigating the cause and implementing actions as described in the City's environmental documents (e.g., ESA, 2013).

4.2. AVOID SUBSIDENCE

This BMO addresses the potential for subsidence as an adverse impact of pumping. As documented in Section 3.6, pre-1970 pumping from the San Francisquito Cone was about 7,500 AFY and groundwater levels were below sea level, resulting in land subsidence of more than two feet in Palo Alto and East Palo Alto between 1934 and 1967. Groundwater level declines associated with subsidence reached low elevations of -60 to -140 feet msl as shown in **Figure 10**. This BMO is intended to avoid irrecoverable land subsidence caused by groundwater drawdown by monitoring subsidence and groundwater levels and by managing groundwater levels.

Review of selected groundwater management plans[8] indicates that many agencies evaluate the potential for subsidence using numerical modeling and conduct subsidence monitoring as a precautionary measure, but have not identified subsidence thresholds (groundwater levels) or defined unacceptable rates of subsidence. In some basins with significant subsidence (e.g., Madera), the BMO is defined in terms of reducing (e.g., halving then eliminating) subsidence over specified periods of time. For the SFPUC's Regional Groundwater Storage and Recovery Project (San Francisco Planning Department, 2013), land subsidence due to project pumping was estimated for selected sites using numerical modeling to predict groundwater level declines. For evaluation of significant subsidence, a threshold of six inches was applied for impacts to structures and a threshold of one foot was used for flooding impacts in the 100-year flood zone.

As described in Section 3.6, historical subsidence in the Santa Clara Valley amounted to as much as 13 feet, with significant impacts on infrastructure and flooding potential,

[8] Westside Basin (WRIME, 2012), South East Bay Plain (EBMUD, 2013), Sonoma Valley (Sonoma County Water Agency, 2007), Livermore-Amador Valley (Jones & Stokes, 2005), Madera Groundwater Basin (Provost & Pritchard, 2014), and others.

particularly along the bay. Accordingly, the avoidance of subsidence has long been a major driver for groundwater management by Santa Clara Valley Water District. The District has investigated subsidence, established an extensive subsidence monitoring program and developed management practices to maintain groundwater levels above subsidence thresholds. These thresholds are defined groundwater levels at ten key wells located across the Santa Clara Subbasin; the nearest subsidence monitoring well (in Mountain View) has a groundwater elevation subsidence threshold of -26 feet msl. In addition, the District has defined a tolerable rate of only 0.01 feet per year of inelastic subsidence at its subsidence control points.

For the City of East Palo Alto, a potential exists for subsidence to affect structures and to increase flooding impacts if pumping results in groundwater level declines approximating pre-1970s levels. With regard to defining a BMO, the following are relevant:

- Planned future pumping is significantly less than pre-1970s amounts and groundwater levels declines are not anticipated to approach pre-1970s levels.
- Subsidence is a potential regional problem and warrants regional collaboration.
- Data on groundwater levels, pumping, and subsidence are incomplete, and the relationships between the vertical and areal distributions among pumping, groundwater levels, and subsidence are not known.
- Groundwater levels are not an absolute indicator of subsidence, but provide guidance for subsidence potential.
- Subsidence has occurred locally and the general potential for subsidence is real.
- Given the potential irreversible impacts, subsidence should be prevented rather than observed.

Recognizing the above, the subsidence BMO is defined initially as follows:

- Implementation of a monitoring program for groundwater pumping, groundwater levels, and the ground surface at selected sites to establish basic data.
- Coordination with other agencies for future regional groundwater and subsidence monitoring.
- Conduct of studies (insofar as funding is available) including numerical modeling to understand the subsidence potential.
- As an interim BMO, maintenance of groundwater elevations at post-1970 levels, with the recognition that this BMO will need update and refinement, and in the future may include site-specific subsidence thresholds and criteria (e.g., an amount or rate of subsidence).

4.3. PROTECT GROUNDWATER QUALITY

This BMO is responsive to two GWMP goals: to provide the City with a long-term, reliable and affordable high quality supply; and to maintain or improve groundwater quality and quantity for the benefit of all groundwater users. It directly addresses the issues of potential adverse impacts of pumping on groundwater quality, including saltwater intrusion and contamination.

Groundwater in the area is good for potable and irrigation uses, although characterized locally by TDS, chloride, and manganese concentrations that are above the secondary (aesthetic) MCLs. These parameters often increase with depth in the local subbasins. TDS and chloride also are elevated along the Bay and likely in Bay Mud deposits, which are also sources of manganese.

Contamination sites exist and are being remediated by responsible parties under oversight by State and Federal regulatory agencies. The principal (deep) aquifer zone utilized for water supply by municipal agencies is largely protected from surface and shallow aquifer contamination by the regional Bay Mud aquitard.

Salt water intrusion from San Francisco Bay historically was induced by intensive groundwater pumping and associated groundwater level declines that caused a reversal of the normal groundwater flow toward the Bay. With importation of water supply and reduction of groundwater pumping, groundwater levels increased and salt water intrusion was halted and even reversed to some degree. Nonetheless, salt water intrusion remains a potential threat particularly during drought. In general, groundwater quality monitoring sites and data are lacking except some municipal and water company wells and contaminant site monitoring wells near the Bay.

Given the importance of local groundwater for municipal and domestic supply, this BMO incorporates drinking water standards as key thresholds as measured in municipal and potable water supply wells (at this time, the O'Connor and PAPMWC wells). This BMO intends to maintain groundwater from municipal and potable water supply wells within primary (health-based) drinking water standards and to the degree possible achieve secondary (aesthetic) standards. Where secondary manganese standards cannot be achieved (such as at the Gloria Way Well), the City intends to provide treatment to reduce manganese to below secondary standards.

Recognizing the above, the water quality BMO is defined as follows:

- Identification or installation of monitoring wells along the bay to serve as sentry wells for salt water intrusion. Once installed, groundwater level and quality baseline conditions should be documented and specific thresholds and management criteria should be established.

- Maintenance of existing groundwater quality particularly with reference to drinking water standards in municipal and potable water supply wells.

- Maintenance of groundwater levels along the bayshore above mean sea level.

4.4. INTEGRATE MANAGEMENT OF GROUNDWATER AND SURFACE WATER

Recognizing that San Francisquito Creek is an important source of groundwater recharge, this BMO is responsive to the GWMP goals of providing the City with a long-term, reliable and affordable high quality supply, and maintaining or improving groundwater quality and quantity for the benefit of all groundwater users. Recognizing the regional importance of San Francisquito Creek and potential hydrologic connectivity of surface water and groundwater, this BMO also is responsive to the goals of engaging in regional groundwater management and promoting integrated water resource management for multiple beneficial uses.

Surface water and groundwater resources in the San Mateo Plain are connected, as surface water locally provides recharge to groundwater and as groundwater locally discharges to streams, wetlands and San Francisco Bay. However, data on the surface water-groundwater connections, including areal and temporal variations, are scarce. The largest and most significant stream is San Francisquito Creek, which is a regional resource for aquatic habitat, recreation, and recharge. The City overlaps a small portion of the San Francisquito Creek watershed and is situated at its lowermost end where it discharges into the bay. The City is an active member of the regional San Francisquito Creek Joint Powers Authority (SFCJPA), which plans, designs, and implements projects along the creek.

Given the general lack of information and limited but participatory role of the City, BMOs are directed to increasing understanding of groundwater-surface water interactions, increasing awareness of issues, and regional collaboration.

- Conduct of studies (insofar as funding is available) to better understand, delineate, protect and improve groundwater recharge along San Francisquito Creek and in its watershed, including consideration of managed aquifer recharge opportunities using storm water (and other sources).
- Participation in regional programs and conduct of City outreach and education to improve public and agency awareness of surface water-groundwater interactions and the importance of San Francisquito Creek as a resource for aquatic habitat, recreation, and recharge.
- Encouragement and participation in regional organizations, such as the San Francisquito Creek Joint Powers Authority, to preserve the habitat, recreational and recharge values of San Francisquito Creek. This includes maintenance and improvement of monitoring, studies of groundwater-surface water interactions along the creek, potential development of a linked surface water/groundwater model and promotion of multiple benefits (including recharge) in planning and implementing projects along the creek.

4.5. IMPROVE UNDERSTANDING OF THE GROUNDWATER SYSTEM

This BMO is fundamental to all of the groundwater management goals and supports the other BMOs. It includes:

- Implementation of a monitoring program to collect basic data and compile those data into useful data sets.
- Regular review and reporting on water resource conditions and management actions.
- Conducting studies to improve understanding of the groundwater/surface water system and support management.
- Development of management tools including a numerical groundwater flow and land subsidence model.

4.6. PROMOTE REGIONAL GROUNDWATER MANAGEMENT

This BMO is directly responsive to two GWMP goals: to promote integrated water resource management for multiple beneficial uses, and to engage in cooperative and sustainable groundwater management in local subbasins. Given that water is a regional resource and the City of East Palo Alto has jurisdiction over a limited area, this BMO also supports the goals of maintaining groundwater quality and quantity for the benefit of all groundwater users and providing the City with a long-term, reliable and affordable high quality supply. This BMO includes:

- Encouragement and participation in regional water resource management as appropriate with organizations including local water companies, non-governmental organizations, municipalities, San Mateo County, Santa Clara Valley Water District, BAWSCA and the IRWMP, Stanford University, and San Francisquito Creek Joint Powers Authority
- Outreach and education to improve public and agency awareness of the groundwater/surface water system and water supply/demand issues in general
- Continuation of relationships with state and federal regulatory agencies
- Close collaboration with City planners to review land use plans and coordination with City and County land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity.

5. GROUNDWATER MANAGEMENT ACTIONS

As described in Section 1.1.1, the 2014 Sustainable Groundwater Management Act (SGMA) provides a systematic procedure for a local agency to develop a groundwater management plan, including a number of requirements (e.g., involve stakeholders, provide monitoring, and mitigate overdraft) and a list of components. These are required for medium- and high-priority basins (San Mateo Plain is very low priority), where appropriate and in collaboration with the appropriate local agencies:

a. Control of saline water intrusion.
b. Wellhead protection areas and recharge areas.
c. Migration of contaminated groundwater.
d. A well abandonment and well destruction program.
e. Replenishment of groundwater extractions.
f. Activities implementing, opportunities for, and removing impediments to, conjunctive use or underground storage.
g. Well construction policies.
h. Measures addressing groundwater contamination cleanup, recharge, diversions to storage, conservation, water recycling, conveyance, and extraction projects.
i. Efficient water management practices for the delivery of water and water conservation methods to improve the efficiency of water use.
j. Efforts to develop relationships with state and federal regulatory agencies.
k. Processes to review land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity.
l. Impacts on groundwater dependent ecosystems.

These components were introduced in the GWMP workshops, where participants also specifically expressed the following concerns and interests:

- Concern over lack of process for groundwater use evaluation, and locations of City wells and proximity to City limits
- Concern over general availability of City water supplies and reliability of wells in event of water shortage such as earthquake
- Interest in regulating groundwater wells and pumping
- Interest in utilizing other water sources (e.g., recycled water) and conserving groundwater
- Interest in mapping significant recharge areas
- Interest in managed recharge of groundwater (e.g., with recycled water).

The management plan components and above concerns/interests are grouped in the following table, cross-referenced to the BMOs, and then summarized with planned actions. It is recognized that some actions can be included under multiple components; for the sake of brevity, actions are assigned where they seem most appropriate and repetition is minimized.

Table 2. Basin Management Plan Components

Basin Management Components	Basin Management Objectives					
	Maintain Groundwater Levels	Avoid Subsidence	Protect Groundwater Quality	Integrate GW-SW Management	Improve Understanding	Promote Regional Management
1. Public and Stakeholder Involvement						
Public outreach				✓	✓	✓
Stakeholder outreach				✓	✓	✓
2. Monitoring Program						
Levels and storage	✓	✓	✓	✓	✓	✓
Subsidence		✓			✓	✓
Quality			✓		✓	✓
Wells and production	✓	✓	✓	✓	✓	✓
Surface water and climate	✓		✓	✓	✓	✓
3. Groundwater Sustainability						
Conjunctive use	✓	✓	✓	✓	✓	✓
Recharge + replenishment	✓	✓	✓	✓	✓	✓
Conservation + efficiency	✓	✓	✓	✓	✓	✓
4. Groundwater Protection						
Saltwater control	✓		✓		✓	✓
Wellhead protection			✓		✓	✓
Remediation and control of contamination			✓		✓	
Well construction, abandonment, destruction			✓			✓
5. Coordinated Planning and Management						
Relationships with State + Federal agencies				✓	✓	✓
Coordination with planning agencies			✓	✓	✓	✓
Collaboration for regional planning	✓	✓	✓	✓	✓	✓

5.1. PUBLIC AND STAKEHOLDER INVOLVEMENT

Ongoing public and stakeholder involvement is fundamental to improving everyone's understanding of the groundwater system and to integrating groundwater-surface water management. Stakeholder involvement also is critical to the successful implementation of the GWMP and eventual development of a regional Groundwater Sustainability Plan.

5.1.1. Public Outreach

The City will continue its outreach to diverse members of the general public:

- Provide electronic copies of the GWMP upon request, publish the GWMP on the City's website, and provide a hard copy to the City library.
- Initiate annual reporting on the monitoring program and GWMP, including a written document and presentation to the City Council with updates on water resource conditions and water management activities.
- Continue to announce GWMP activities and provide documents on the City's website.
- Continue to meet with public organizations engaged in water issues.
- Continue to partner with BAWSCA and Tuolumne River Trust in education programs.

5.1.2. Stakeholder Outreach

The City will continue to engage with stakeholders to improve data, foster integrated surface water-groundwater management, and progress toward regional management:

- Continue to identify stakeholders and maintain lists of stakeholders and local water and land use planning agency representatives.
- Continue the Citizens Advisory Panel (CAP) for the ongoing GWMP process, including review of monitoring and annual GWMP reports.
- Support integration of surface water and groundwater management through discussions and planning with SFCJPA members.
- Foster data sharing among water purveyors by compiling and reviewing information and making it available.

5.2. MONITORING PROGRAM

Lack of data was identified as an important issue that is basic to improving understanding of the groundwater system and linked surface water resources, to avoiding adverse impacts, and to groundwater management. The City is committed to monitoring groundwater levels, groundwater quality, well pumping, subsidence, and specific water balance items as appropriate within its jurisdiction. It also supports coordinated monitoring and data sharing with other organizations.

Appendix C of this GWMP provides a detailed discussion of the monitoring program, which will address the following topics:

- Groundwater levels and storage
- Subsidence
- Quality
- Wells and production
- Surface water and climate.

The monitoring program includes a network of groundwater monitoring wells, a measurement and sampling program, established monitoring protocols and frequency, and a data management and evaluation program. Also included are surface water and land subsidence monitoring programs. Surface water monitoring includes tracking of meteorological data, streamflow in San Francisquito Creek, and tidal data (as needed). Subsidence monitoring includes benchmark surveying and GPS monitoring of stations within and adjacent to the City. Specific actions include:

- Organize a data management system (databases, spreadsheets) for compilation, review, analysis, and reporting of water resource data
- Initiate groundwater level (static and pumping)and quality monitoring of City wells
- Initiate water quality sampling and analysis for City wells
- Monitor and record flow rates and total volumes pumped for City wells
- Compile meteorological data measured by NOAA, and tidal data as needed
- Compile and summarize San Francisquito Creek flow rates measured by USGS
- Inventory private production wells in the City: assess status, map locations, compile well data into a well inventory, invite participation in monitoring program
- Install, maintain, and monitor land subsidence stations in the City
- Collect and review land subsidence and groundwater level and quality data from cooperating organizations
- Assess need for additional monitoring wells
- Initiate analysis and evaluation of monitoring results
- Prepare quarterly monitoring reports with summary in the annual GWMP Report.

5.3. GROUNDWATER SUSTAINABILITY

The City has been reliant on SFPUC water supply, without other sources or storage. Accordingly, the major impetus for the City’s groundwater development and management plan is to develop a supplementary and backup source to its SFPUC supply, namely groundwater supply, and to develop the means to utilize groundwater storage. This represents conjunctive use, which is the coordinated management of surface and groundwater supplies to increase the yield of both supplies and to enhance water reliability.

This management component is responsive to workshop participants' concern about the lack of data on well locations and uncertainty about the process for evaluating well sites and pumping, plus their interest in regulating groundwater wells and pumping. With regard to regulation of wells and pumping, such authority is available through the Sustainable Groundwater Management Act. However, the City is not pursuing status as a Groundwater Sustainability Agency and is not seeking that authority at this time. Nonetheless, the City has stated its goal to engage in cooperative and sustainable groundwater management in local subbasins which potentially could include such regulation.

Sustainable management will be implemented, meaning that groundwater will be developed and managed in a manner that can be maintained for an indefinite time without causing unacceptable consequences. This will involve the other basin management components (e.g., monitoring, groundwater protection, coordinated planning and regional management) plus replenishment, and water conservation, which are addressed in this section.

5.3.1. Conjunctive Use

The City is actively pursuing development of groundwater supply and storage through its reactivation of the Gloria Way Well and exploration and testing of the Pad D site, thus initiating conjunctive use. As a first step, the City will initiate the groundwater monitoring program; additional actions include:

- Complete the treatment and conveyance facilities for the Gloria Way Well and initiate pumping while monitoring proceeds.
- Continue planning for a full-scale Pad D supply well.
- Expand the monitoring network to include additional monitoring or sentry wells and additional land subsidence monitoring, possibly in conjunction with the USGS
- In collaboration with local agencies and organizations, document active production wells in the San Francisquito Cone Subbasin/San Mateo Plain Subbasin and evaluate groundwater pumping amounts.
- Seek funding for development of a robust, calibrated, and validated predictive groundwater flow model or linked surface water-groundwater flow model to evaluate potential impacts of pumping and management scenarios
- Seek funding for studies (e.g. water balance studies and assessment of other surface water sources such as recycled water that are reliable during drought) to support conjunctive use particularly through drought.

5.3.2. Recharge and Replenishment

Participants in GWMP workshops communicated interest in mapping significant recharge areas, utilizing other water sources (e.g., stormwater, recycled water, gray water), and actively recharging groundwater (managed aquifer recharge). This component has an important role in reducing potential adverse impacts of groundwater pumping (e.g., groundwater level declines, subsidence, salt water intrusion) particularly during drought.

Section 3.10 of this GWMP provides a discussion of recharge in the San Francisquito Cone area, while **Figure 13** provides a map of recharge areas. Important findings include:

- Human activities, particularly water importation and application, provide substantial basin replenishment as landscaping return flows and pipeline leakage
- Important recharge areas for the productive deep aquifer are landward of the Bay Mud
- Given its relatively low water use and its position overlying the Bay Mud, the City of East Palo Alto is not an area of significant replenishment to the deep aquifer zone (acknowledging the potential for future deep injection wells).

Accordingly, the following actions focus on regional collaboration; namely to collaborate with local agencies and organizations to:

- Improve the understanding of basin replenishment—evaluate sources and areas of replenishment, and identify means of protection
- Identify and assess additional water sources (e.g., stormwater, recycled water, gray water) and opportunities (sites and methods) for managed aquifer recharge
- For projects involving San Francisquito Creek, encourage evaluation of the creek as an important source of groundwater recharge; promote and protect recharge to support multiple benefits.

5.3.3. Conservation and Efficiency

Participants in GWMP workshops communicated interest in conserving water resources, including groundwater. The City of East Palo Alto is characterized by low water use, and has developed an UWMP that addresses and promotes water conservation and efficient water management practices. This action focuses on regional efforts to use water efficiently while protecting groundwater recharge.

- Collaborate with local agencies and organizations to encourage replacement of imported water and groundwater with recycled water and gray water for landscaping and other non-potable uses as appropriate.

5.4. GROUNDWATER PROTECTION

Groundwater quality protection—particularly salt water control—is a key factor to ensuring sustainable groundwater.

5.4.1. Saltwater Control

Given that the facts that salt water intrusion has occurred historically and the eastern boundary of the City is along the wetlands and shore of San Francisco Bay, the City has a frontline role in avoiding saltwater intrusion. Recognizing that potential saltwater intrusion is a regional issue that involves collaboration among agencies, the City will

- Identify potential monitoring wells to serve as sentry wells for salt water intrusion and prepare agreements for regular monitoring of groundwater levels and quality and/or data sharing. Subsequently, regular monitoring will be implemented (i.e., groundwater level and quality baseline conditions will be documented, specific thresholds and management criteria will be established, and regular reporting will be provided as part of the GWMP).

- In collaboration with other agencies, seek funding for additional, dedicated sentry wells (including hydrogeologic studies, siting and design, and construction).

- In collaboration with other agencies, seek funding for the determination of the location and status of the abandoned Ravenswood Wells along the Bay, and as appropriate, for their proper sealing and destruction.

5.4.2. Wellhead Protection

Identification of wellhead protection areas is a component of the Drinking Water Source Assessment and Protection (DWSAP) Program administered by the California Department of Public Health. Drinking Water Source Assessments involve delineation of capture zones around extraction sources (wells); inventory of Potential Contaminating Activities (PCAs) within protection areas; and vulnerability analysis to identify the PCAs to which the source is most vulnerable. The City will:

- Prepare Drinking Water Source Assessments for all of its production wells as they are brought online.

5.4.3. Remediation and Control of Contamination

Contamination sites exist in East Palo Alto and are being remediated by responsible parties under oversight by State and Federal regulatory agencies. The City does not have authority or responsibility for oversight or remediation of contamination; nonetheless, it will:

- Coordinate with responsible parties, Federal and State regulatory agencies and San Mateo County's Groundwater Protection Program staff to share information about contaminated sites, the local groundwater system, and wells.

5.4.4. Well Construction, Abandonment, Destruction

The Environmental Health Division of the San Mateo County Health System administers the Groundwater Protection Program that issues permits for construction and destruction of all wells including monitoring wells, agricultural wells, and community water supply wells. The City will:

- Identify any private wells near its Gloria Way well and (recognizing that inactive wells are potential conduits for contamination of aquifer zones) inform the Groundwater Protection Program staff of found wells.

5.5. Coordinated Planning and Management

Recognizing that groundwater is a regional resource, linked to surface water, and shared among many diverse interests, GWMP stakeholders communicated a strong interest in regional management that includes coordinated planning and integrated surface water/groundwater management.

5.5.1. Relationships with Federal and State Agencies

The City has developed working relationships with Federal regulatory agencies including the United States Environmental Protection Agency (EPA), which has responsibility for Superfund contamination sites (such as the Romic site). The City is a recipient of semi-annual monitoring reports for the Romic site. In addition, the City was the successful applicant for a Federal STAG grant to fund the Gloria Way Well project; the City and EPA are working together on that project.

The City also has a working relationship with the United States Geological Survey (USGS), which has focused on technical issues and data sharing. The USGS provided a proposed scope of work for a regional subsidence monitoring program for the City and nearby agencies.

State agencies with direct involvement in groundwater management include:

- Department of Water Resources (DWR) – UWMPs, CASGEM, SGMA
- State Water Resources Control Board (SWRCB) – water conservation, monitoring, SGMA
- Regional Water Quality Control Board (RWQCB) – water quality, permitting
- Department of Public Health (DPH) – drinking water quality and vulnerability
- Division of Toxic Substances Control (DTSC) – contaminated sites

The City, working with each as appropriate, will continue to:

- Coordinate with federal and state agencies on issues related to groundwater and surface water management, monitoring, water conservation, water quality and contaminated sites as well as opportunities for grant funding.

5.5.2. Coordination with Planning Agencies

In the City of East Palo Alto, water services and the planning division are both part of the Community and Economic Development Department. Close coordination among water services and planning staff helps ensure that existing and planned water supplies are adequate to meet existing and future water demands. The following actions foster that coordination:

- Provide the recharge area map to appropriate City and County land use planners.

- Provide the draft GWMP to City planners for review and commentary, and to assist in amendment or update of the General Plan.
- Review and provide commentary as appropriate on draft General Plan sections.
- Take into account the most recent planning assumptions used in the General Plan.
- Monitor City environmental impact reports and comment on such reports to ensure that water resources are protected.
- Collaborate in preparing the Urban Water Management Plan, including the Water Shortage Contingency Plan.
- Provide water supply assessments as required under SB 610.
- Coordinate with City land use planners to encourage protection of groundwater by limiting activities that create an unreasonable risk to groundwater supply or quality.

5.5.3. Collaboration for Regional Planning

Seven local agencies— East Palo Alto, Santa Clara Valley Water District, County of San Mateo, Palo Alto, Menlo Park, Atherton and Portola Valley—have passed resolutions in support of cooperative and sustainable groundwater management in the San Francisquito Creek Area. On its part, the City has developed this GWMP as a potential stepping stone to a regional Groundwater Sustainability Plan. The City will:

- Encourage regional water resource management with organizations including local water companies, non-governmental organizations, municipalities, San Mateo County, water districts, BAWSCA, IRWMP members, and the San Francisquito Creek Joint Powers Authority.
- Initiate discussion with San Mateo County and other water agencies regarding future governance (namely formation of one or more Groundwater Sustainability Agencies) for the San Mateo Plain Subbasin.
- Provide outreach and education to support public and agency awareness of the groundwater/surface water system, water supply/demand issues, and steps toward regional groundwater management.

6. IMPLEMENTATION PLAN

Most groundwater management plans in California have been developed and implemented long after agencies started pumping groundwater, and in some basins, after problems arose. This GWMP is being developed and implemented before the City initiates pumping in a phased manner. This approach will build an understanding of how the groundwater system works, develop needed supply for the City, and initiate regional management for sustainability.

6.1. IMPLEMENTATION STRATEGY

The overall strategy is to initiate a monitoring program to provide baseline information on water resource conditions and to guide step-by-step groundwater development by the City. The City has appropriated $125,000 to initiate groundwater monitoring and will continue to seek funding to support groundwater monitoring and management, including funding for development of a numerical model. The City will continue its groundwater management and support subsequent regional management including establishment of one or more Groundwater Sustainability Agencies for the San Mateo Plain Subbasin. While seeking collaboration, the City is responsible for this GWMP.

6.2. IMPLEMENTATION SCHEDULE

The management actions identified above are listed in **Table 3** along with an implementation schedule that identifies the approximate timing for commencing the activity after adoption of the GWMP. Most of the management actions are currently unfunded, but the City has committed to and appropriated funds for initiating a monitoring program with regular reporting. In addition, the City has committed to seek funding for development of a numerical groundwater flow model.

Table 3. Implementation Schedule

Basin Management Actions	Implementation Schedule
1. Stakeholder Involvement	
Public outreach	
Provide copies of the GWMP and publish on the City's website	within 1 month of adoption
Initiate annual reporting on the GWMP	FY 2015-2016 and ongoing
Announce GWMP meetings and documents on the website	FY 2015-2016 and ongoing
Continue to meet with organizations engaged in water issues	Ongoing
Continue to partner in education programs	Ongoing
Stakeholder involvement	
Maintain lists of stakeholders and agency representatives	Ongoing
Continue the Citizens Advisory Panel	Ongoing
Support integrated management with SFCJPA	Ongoing
Foster data sharing among water purveyors	FY 2015-2016 and ongoing
2. Monitoring Program	
Organize a data management system	FY 2015-2016 and ongoing
Initiate groundwater level /quality monitoring of City wells	FY 2015-2016
Initiate water quality sampling and analysis for City wells	FY 2015-2016
Monitor and record City well pumping	FY 2015-2016
Compile meteorological data	FY 2015-2016 and ongoing
Compile and summarize San Francisquito Creek flow data	FY 2015-2016 and ongoing
Inventory private production wells in the City	FY 2015-2016
Install, maintain, monitor subsidence stations in the City	FY 2015-2016
Collect and review monitoring data from cooperators	FY 2015-2016 and ongoing
Assess need for additional monitoring wells	FY 2015-2016 and ongoing
Initiate analysis and evaluation of monitoring results	FY 2015-2016 and ongoing
Prepare quarterly/annual monitoring reports	FY 2015-2016 and ongoing

continued

Basin Management Actions	Implementation Schedule
3. Groundwater Sustainability	
Conjunctive use	
Complete facilities for Gloria Way Well and initiate pumping	Upon well completion, 2016
Continue planning for Pad D well	FY 2015-2016 and ongoing
Collaborate to document wells and evaluate pumping	FY 2015-2016 and ongoing
Seek funding for a groundwater flow model	FY 2015-2016 and ongoing
Seek funding for studies to support conjunctive use	FY 2015-2016 and ongoing
Recharge + replenishment	
Collaborate to evaluate sources and areas of replenishment, and protect	Ongoing
Collaborate to identify opportunities for managed aquifer recharge	Ongoing
Encourage evaluation of the creek as a source of recharge	Ongoing
Conservation + efficiency	
Collaborate to encourage use of recycled water and gray water	Ongoing
4. Groundwater Protection	
Saltwater control	
Identify potential sentry wells, prepare agreements for monitoring	FY 2015-2016
Collaborate to seek funding for additional, dedicated sentry wells	FY 2015-2016 and ongoing
Collaborate to find, seal, destroy Ravenswood Wells	FY 2015-2016 and ongoing
Wellhead protection	
Prepare Drinking Water Source Assessments	upon well completion
Remediation and control of contamination	
Coordinate to share information about contaminated sites	as needed, ongoing
Well construction, abandonment, destruction	
Identify private wells, inform County Groundwater Protection Program	Ongoing
5. Coordinated Planning and Management	
Relationships with State + Federal agencies	
Coordinate on water management issues and funding opportunities	Ongoing
Coordination with planning agencies	
Provide the recharge area map to City and County land use planners	within 1 month of adoption
Provide draft GWMP to City planners, assist with General Plan update	within 1 month of adoption
Review and provide commentary on draft General Plan	FY 2015-2016
Account for planning assumptions in the General Plan	FY 2015-2016 and ongoing
Comment on City EIRs to protect water resources	as needed, ongoing
Collaborate in preparing UWMP and Water Shortage Contingency Plan	FY 2015-2016, 2016-2017
Provide water supply assessments as required under SB 610.	as needed, ongoing
Coordinate with City planners to protect groundwater	as needed, ongoing
Collaboration for regional planning	
Encourage regional water resource management	Ongoing
Initiate discussion re: future governance for San Mateo Plain Subbasin	FY 2016-2017
Provide outreach/education for regional groundwater management	Ongoing

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