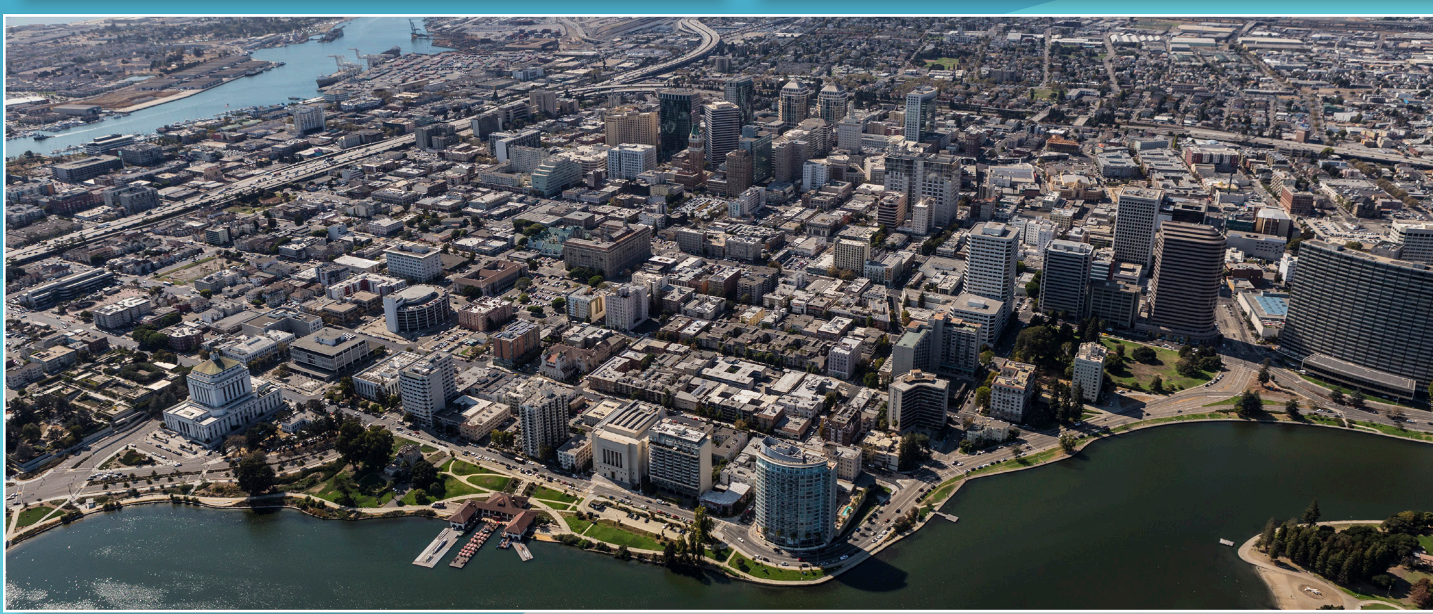
EAST BAY PLAIN SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN

JANUARY 2022



EBMUD

HAYWARD

JANUARY 2022

EAST BAY PLAIN SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN

PREPARED FOR

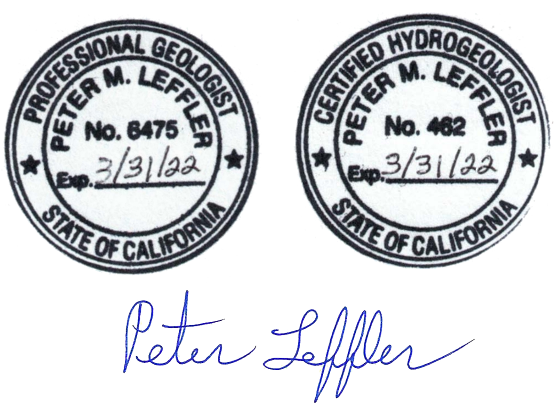
East Bay Municipal Utility District GSA and
City of Hayward GSA

EBMUD

HAYWARD

PREPARED BY

Luhdorff & Scalmanini Consulting Engineers
Geosyntec
Brown and Caldwell
Environmental Science Associates
Dr. Jean Moran
Farallon Geographics



LSCE TEAM

EAST BAY PLAIN SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN

ACKNOWLEDGMENTS

The East Bay Municipal Utilities District (EBMUD) and City of Hayward (Hayward) Groundwater Sustainability Agencies gratefully acknowledge the funding contribution from the California Department of Water Resources. Funding for this project has been provided in part from the Sustainable Groundwater Planning Grant Pursuant to the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1) and through an agreement with the State Department of Water Resources.

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GROUNDWATER SUSTAINABILITY PLAN
TECHNICAL ADVISORY COMMITTEE MEMBERS

The East Bay Plain Groundwater Sustainability Plan Technical Advisory Committee (TAC) was established in March 2019 to act as advisors for the East Bay Plain Subbasin Groundwater Sustainability Plan (GSP) and is made up of those persons representing various beneficial users and uses of groundwater in the Subbasin and other interested parties. The TAC provided general input, review of draft GSP content, reviewed and provided input on sustainable management criteria, and provided input on next steps for GSP implementation. The EBMUD and Hayward Groundwater Sustainability Agencies appreciate the contributions of the TAC member entities listed below:

- Alameda County Department of Public Works
- California State University - East Bay
- City of Alameda
- City of Berkeley
- City of Richmond
- City of San Pablo
- Contra Costa County
- Grolutions Horticultural Landscaping
- Lawrence Berkeley National Laboratory
- Sierra Club
- San Francisco Bay Regional Water Quality Control Board
- United States Geological Survey

GROUNDWATER SUSTAINABILITY AGENCIES' STAFF AND OTHER SUPPORT

Brad Ledesma (EBMUD)
Grace Su (EBMUD)

Cheryl Munoz (Hayward)
Chris Heppner (EKI/Hayward)

Luhdorff & Scalmanini Consulting Engineers (LSCE) led the consultant team that conducted modeling, planning, and other technical support for the EBMUD and Hayward Groundwater Sustainability Agencies in addition to composing the East Bay Plain Subbasin Groundwater Sustainability Plan.

PLANNING AND TECHNICAL SUPPORT

GEOSYNTEC
ESA
BROWN AND CALDWELL

DR. JEAN MORAN
FARALLON GEOGRAPHICS

On behalf of the EBMUD and Hayward Groundwater Sustainability Agencies, thank you to all of the community members who participated in public meetings, information sessions, and various outreach events. Your input was vital to shaping this GSP.

For further assistance interpreting the content of this document, please contact our Groundwater Sustainability Plan Manager.
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LIST OF ACRONYMS AND ABBREVIATIONS

μg/L	micrograms per liter
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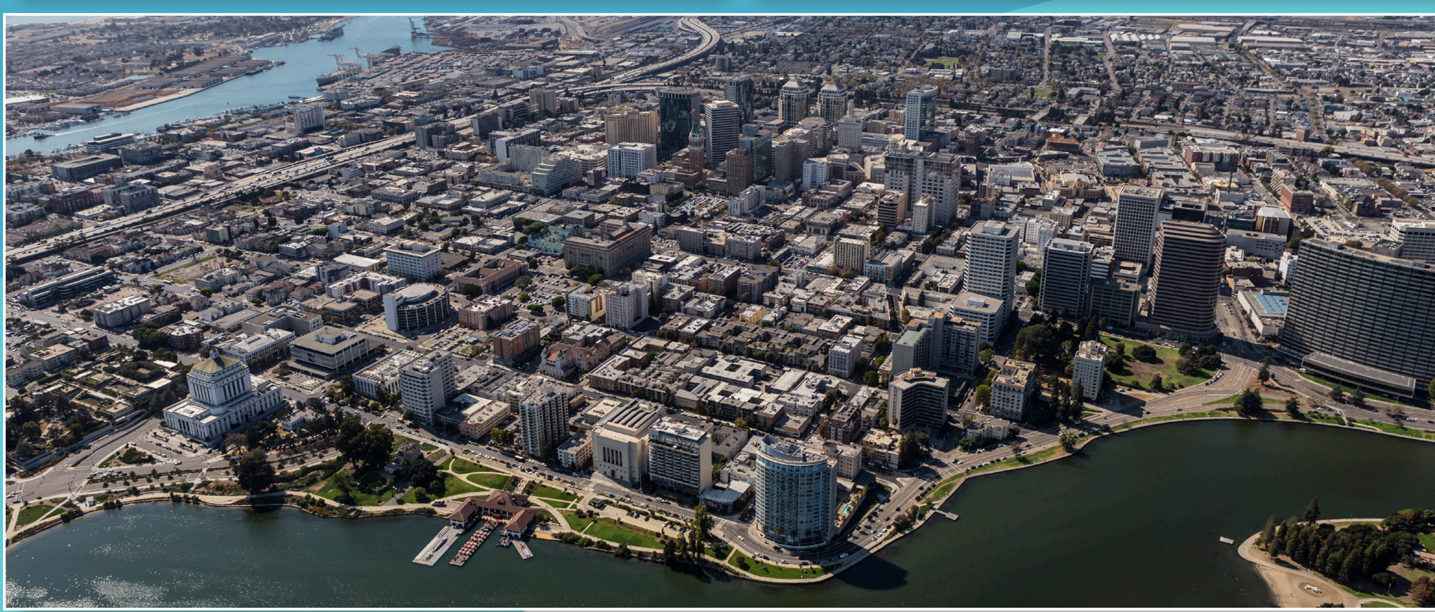
ACFCWD	Alameda County Flood Control and Water Conservation District
ACPWA	Alameda County Public Works Agency
ACWD	Alameda County Water District
AF	acre-feet
AFY	acre-feet per year
ASR	aquifer storage and recovery
B	benzene
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CASGEM	California State Groundwater Elevation Monitoring Program
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CWC	California Water Code
DAC	Disadvantaged Communities
DDW	California Division of Drinking Water
DMS	Data Management System
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection
EBMUD	East Bay Municipal Utility District
EBP	East Bay Plain
ft	foot, feet
FY	For Year
GAMA	Groundwater Ambient Monitoring and Assessment
GCM	Global Climate Models
GDE	groundwater dependent ecosystem
GMP	groundwater management plan
GP	general plan
gpd	gallons per day
gpd/ft	gallons per day per foot
GSA	groundwater sustainability agency
GSP	groundwater sustainability plan
GW	groundwater
Hayward	City of Hayward
HCM	hydrogeologic conceptual model
LBNL	Lawrence Berkeley National Laboratory
LSCE Team	GSP consultant team: LSCE, Geosyntec, ESA, BC, Dr. Moran, and Farallon Geographics
LSCE	Luhdorff & Scalmanini Consulting Engineers
LUST	Leaking Underground Storage Tank
MA	Management Actions
MCL	Maximum Contaminant Level
mg/L	Milligrams per Liter
MGD	Million Gallons per Day
MO	Measurable Objective(s)
MSL	Mean Sea Level
MT	Minimum Threshold(s)
MT	Minimum Threshold(s)
MTBE	Methyl Tert-Butyl Ether
NA	Not Applicable
O & M	Operating and Maintenance
PCE	perchloroethene
RMS	Representative Monitoring Sites

RWQCB	Regional Water Quality Control Board
SDACs	Severely Disadvantaged Communities
SFPUC	San Francisco Public Utilities Commission
SGMA	Sustainable Groundwater Management Act of 2014
SMCL	Secondary MCL
TAC	Technical Advisory Committee
TBD	To Be Determined
TCE	trichloroethene
TDS	total dissolved solids
TM	Technical Memorandum
TNC	The Nature Conservancy
TPH	total petroleum hydrocarbons
USGS	United States Geological Survey
WCR	Well Completion Report
WDR	Waste Discharge Requirements

EAST BAY PLAIN SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN

JANUARY 2022

EXECUTIVE SUMMARY



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EAST BAY PLAIN SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN

The Sustainable Groundwater Management Act allows local water agencies to form a groundwater sustainability agency that will develop, adopt, and implement a groundwater sustainability plan.

This is the coordinated plan for the East Bay Plain Subbasin, as prepared by East Bay Municipal Utility District and the City of Hayward, the exclusive groundwater sustainability agencies for the subbasin.

PREPARED FOR:
East Bay Municipal Utility District GSA and
City of Hayward GSA

PREPARED BY:
Luhdorff & Scalmanini Consulting Engineers
Geosyntec
Brown and Caldwell
Environmental Science Associates
Dr. Jean Moran
Farallon Geographics

LSCE TEAM

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EAST BAY PLAIN SUBBASIN GSP OVERVIEW

The East Bay Plain (EBP) Subbasin Groundwater Sustainability Plan (GSP) creates the framework for sustainable management of groundwater in the EBP Subbasin. East Bay Municipal Utility District (EBMUD) and the City of Hayward (Hayward) are the water providers that lie atop the subbasin and became the exclusive groundwater sustainability agencies (GSAs) for the portions of the EBP Subbasin located beneath their service areas, and have jointly prepared this GSP that meets the regulatory requirements listed in California Code of Regulations Title 23, Section 354 (Groundwater Sustainability Plans, Plan Contents). It is organized as follows:

CHAPTER 1

Introduction

Provides an overview of the EBP Subbasin GSAs and the development of the GSP for the EBP Subbasin, including how the GSAs are organized, their legal authority, and the estimated costs in implementing the plan.

CHAPTER 2

Plan Area and Basin Setting

Describes the plan area for the EBP Subbasin GSP and development of the basin setting, including the conceptual model of the subbasin's hydrogeology; current and historical conditions, such as groundwater elevations, seawater intrusion, and groundwater quality issues; water budgets (total annual volumes of groundwater and surface water entering and leaving the EBP Subbasin); and management areas, as applicable.

CHAPTER 3

Sustainable Management Criteria

Establishes the EBP Subbasin's sustainability goal, explaining the criteria used for defining sustainable groundwater management for the subbasin, describing measurable objectives, minimum thresholds, undesirable results for each indicator of groundwater sustainability, and proposed monitoring to track and verify progress toward the sustainability goal.

CHAPTER 4

Projects and Management Actions to Achieve Sustainability Goal

Describes projects and management actions for achieving and maintaining the EBP Subbasin's sustainability goal.

CHAPTER 5

Plan Implementation

Proposes the plan's implementation strategy, costs, and schedule.

Appendices

Includes additional information related to the GSP.

CHAPTER 1: INTRODUCTION

Groundwater Management in California

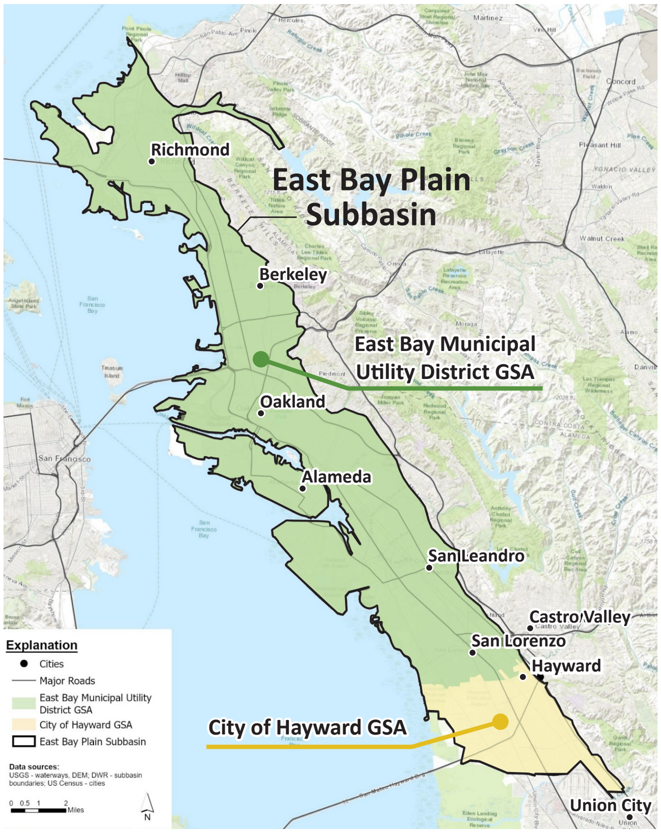
In September 2014, Governor Jerry Brown signed three bills into law that together became known as the Sustainable Groundwater Management Act (SGMA). The law created a statewide framework for sustainable management of groundwater on the local level throughout California.

The Sustainable Groundwater Management Act allows local water agencies to form a groundwater sustainability agency (GSA) that will develop, adopt, and implement a groundwater sustainability plan (GSP). East Bay Municipal Utility District (EBMUD) and the City of Hayward (Hayward) lie atop a groundwater subbasin known as the East Bay Plan (EBP) Subbasin. In 2016 and 2017, respectively, EBMUD and Hayward became the exclusive GSAs for the portions of the EBP Subbasin located beneath their service areas.

Sustainability Goal

The sustainability goal for the EBP Subbasin is to manage and protect the Subbasin in a manner that avoids the six undesirable results listed below, while continuing to collect and analyze data to support science-based decision making to evaluate new opportunities for sustainable groundwater beneficial uses:

- Chronic lowering of groundwater levels, indicating a significant and unreasonable depletion of supply.
- Significant and unreasonable reduction of groundwater storage.
- Significant and unreasonable seawater intrusion.
- Significant and unreasonable degraded water quality.
- Significant and unreasonable land subsidence.
- Depletions of interconnected surface water and groundwater that have significant and unreasonable reductions in beneficial uses of surface water, including beneficial use by ecosystems that depend on groundwater.



The purpose of this GSP is to characterize groundwater conditions in the EBP Subbasin, establish a sustainability goal and sustainable yield, and describe projects and management actions the GSAs will implement to maintain sustainable groundwater management through 2042 and beyond. The information in Chapter 1 complies with the following California Code of Regulation (CCR) requirements:

- **Sustainability Goal (CCR Title 23, Section 354.24)**
- **Groundwater Sustainability Plan Organization (CCR Title 23, Section 354)**

Map at Left
East Bay Municipal Utility District (EBMUD) and the City of Hayward (Hayward) lie atop a groundwater subbasin known as the East Bay Plan (EBP) Subbasin.

Agency Information

EBMUD and Hayward each formed a GSA as required by law, and the two GSAs combine to cover the entirety of the EBP Subbasin. The **Steering Committee** included senior GSA staff who oversaw and guided the **Technical Team** during development of the GSP. The Technical Team consisted of GSA staff members who developed and managed the GSP and associated projects, oversaw the consultants, and engaged with stakeholders.

They are also supported by **EBP Subbasin GSP Interested Parties**, which participated in public meetings and provided input on the GSP, the **EBP Subbasin GSP Technical Advisory Committee (TAC)**, which reviewed technical work products and provided comments and recommendations on the GSP, and the **EBP Subbasin GSP Interbasin Working Group**, which met quarterly during development of the GSP with participants from neighboring groundwater subbasins. The GSAs retained a team of private consultant firms (Consultants) to support preparation of the GSP. EBMUD and Hayward held six TAC meetings, ten interested party meetings, and nine interbasin working group meetings.

EAST BAY MUNICIPAL UTILITY DISTRICT GROUNDWATER SUSTAINABILITY AGENCY

The EBMUD GSA incorporates all or portions of the cities of San Pablo, Richmond, El Cerrito, Albany, Berkeley, Emeryville, Alameda, Oakland, Piedmont, San Leandro, and other unincorporated areas including the community of San Lorenzo.

Area covered: 61,000 acres
Annual groundwater pumping: Approx. 3,100 acre feet
Primary sources of water supply: Mokelumne River reservoirs, East Bay Hills reservoirs

CITY OF HAYWARD GROUNDWATER SUSTAINABILITY AGENCY

The Hayward GSA covers the portion of the City of Hayward located within the EBP Subbasin. Other portions of the City of Hayward are located in the East Bay Hills located east of EBP Subbasin and within the Niles Cone Subbasin to the south of EBP Subbasin.

Area covered: 10,300 acres
Annual groundwater pumping: Approx. 500 acre feet
Primary sources of water supply: San Francisco Public Utilities Commission's Regional Water System

EAST BAY PLAIN SUBBASIN GSP TECHNICAL ADVISORY COMMITTEE

The EBMUD and Hayward GSAs jointly formed the EBP Subbasin GSP Technical Advisory Committee, which helped guide the agencies through development of the GSP. Committee members included representatives from California State University - East Bay; the Cities of Richmond, Berkeley, San Pablo, and Alameda; Lawrence Berkeley National Laboratory; the Alameda County Department of Public Works; the San Francisco Bay Regional Water Quality Control Board; the Sierra Club; Contra Costa County; United States Geological Survey; and Grolutions Horticultural Landscaping.

INTERESTED PARTIES

The following state agencies and non-governmental organizations also contributed to the GSP: The Nature Conservancy, Clean Water Action, California Department of Fish and Wildlife.

EAST BAY PLAIN SUBBASIN GSP INTERBASIN WORKING GROUP

The GSAs for the EBP Subbasin participated in an Interbasin Working Group with representatives from neighboring groundwater subbasins. The working group met quarterly during development of this GSP. Members included one or more representatives each from EBMUD, Hayward, and Alameda County Water District.

Legal Authority of the Groundwater Sustainability Agencies

EBMUD and Hayward are the local agencies overlying the EBP Subbasin, as defined in the Sustainable Groundwater Management Act (SGMA), making them eligible to serve as separate GSAs within the EBP Subbasin (Water Code Section 10723[a]). Under the California Water Code, neither Alameda County nor Contra Costa County serves as a GSA, because all areas within the EBP Subbasin are covered by either EBMUD or Hayward.

Consequently, EBMUD and Hayward each held public hearings regarding the establishment of a GSA in accordance with Water Code Section 10723(b). Each agency's governing board then adopted a resolution to establish the GSA. On November 6, 2017, EBMUD and Hayward filed a notification letter with the California Department of Water Resources of their intent to jointly develop a single GSP for the EBP Subbasin. The California Department of Water Resources recognizes the intent to develop a single GSP as shown on their online SGMA Portal for the East Bay Plan profiles for the EBMUD GSA and the City of Hayward GSA.

As GSAs for the EBP Subbasin, EBMUD and Hayward have the legal authority to prepare a GSP and are pursuing the financial resources necessary to implement the plan.

Hayward Shoreline, City of Hayward Groundwater Sustainability Agency
Source: https://www.hayward-ca.gov/shoreline-master-plan

CHAPTER 2: PLAN AREA AND BASIN SETTING

Description of the Plan Area

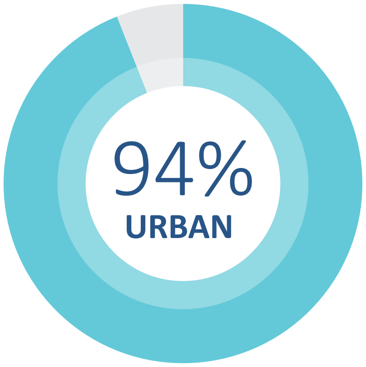
The Plan Area lies within the boundaries of Contra Costa and Alameda counties, including all or portions of the cities of Alameda, Albany, Berkeley, El Cerrito, Emeryville, Hayward, Oakland, Piedmont, Richmond, San Leandro, and San Pablo. Unincorporated areas (including San Lorenzo) within the subbasin are covered by the respective county general plans (GPs), and various city GPs cover the other portions of the Subbasin. The Subbasin does not contain state lands, but does include some federal lands including Lytton Tribal lands.

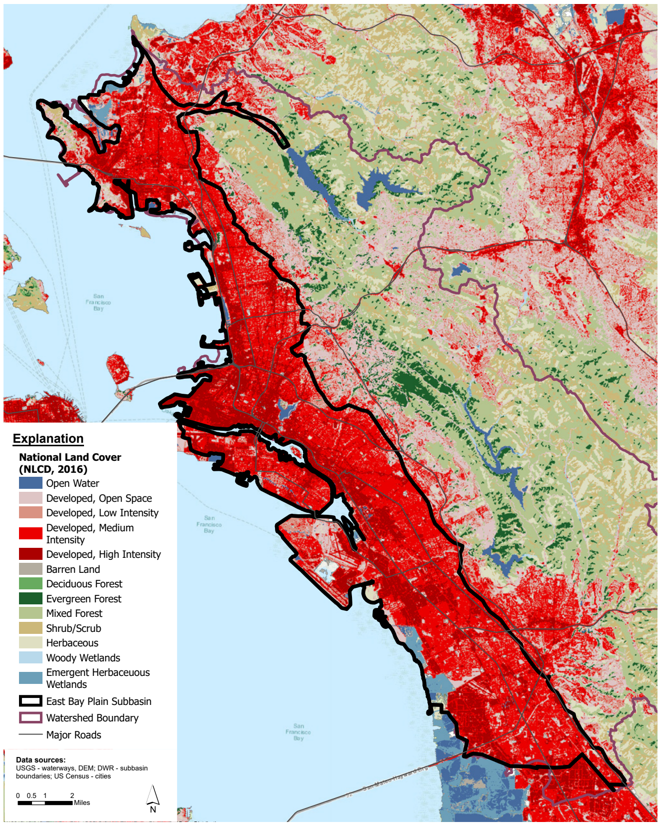
LAND USE

While the area is primarily urban (94%), it does have some areas with vegetation and open water.

Land Use Overview

USE TYPE	% OF EBP SUBBASIN AREA
Urban	94%
Open Water	1%
Barren Land	1%
Vegetation	4%





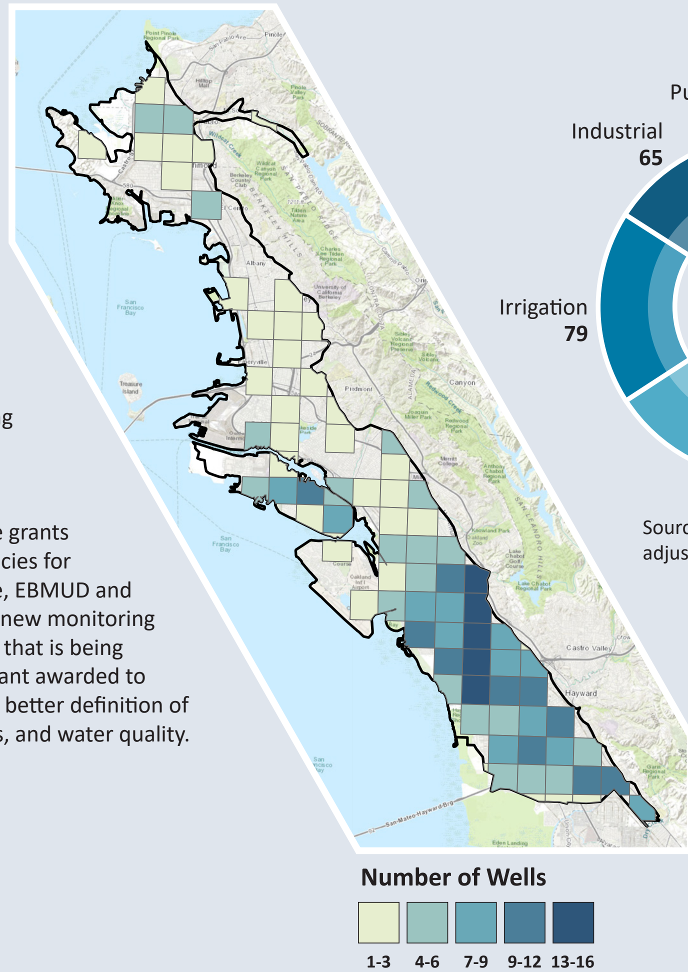
A comprehensive understanding of the plan area is important in developing the groundwater sustainability plan. Chapter 2 addresses the following California Code of Regulation (CCR) requirements:

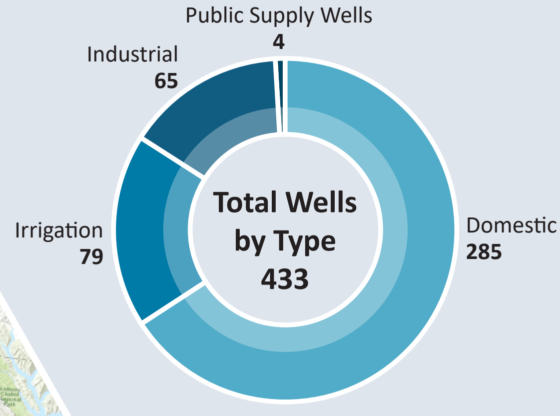
- Description of the Plan Area (CCR Title 23, Section 354.8)
- Summary of Jurisdictional Areas and Other Features (CCR Title 23, Section 354.8[b])
- Water Resources Monitoring and Management Programs (CCR Title 23, Sections 354.8 [b], 354.8 [d], and 354.8 [e]
- Land Use Elements or Topic Categories of Applicable General Plans (CCR Title 23, Section 354.8[f])
- Additional GSP Elements (CCR Title 23, Section 354.8[g])
- Notice and Communication (CCR Title 23, Section 354.10)
- Hydrogeologic Conceptual Model (CCR Title 23, Section 354.14)
- Current and Historical Groundwater Conditions (CCR Title 23, Section 354.16)
- Water Budget Information (CCR Title 23, Section 354.18)
- Management Areas (CCR Title 23, Section 354.20)

WELLS AND THEIR EFFECT ON GROUNDWATER

A system of domestic, irrigation, and industrial wells are located throughout the EBP Subbasin. As part of GSP implementation, well permitting agencies will be asked to consult with GSAs prior to issuing permits to ensure the groundwater basin's sustainability. The GSAs will also work with existing well owners to collect and analyze pumping data.

The GSAs apply for and may receive grants from various federal and state agencies for water-related projects. For example, EBMUD and Hayward are currently installing 12 new monitoring wells in the EBP Subbasin, an effort that is being funded through a Proposition 68 grant awarded to EBMUD. The new wells will provide better definition of the Subbasin's geology, water levels, and water quality.





Source: DWR Well Completion Report Database adjusted for known public supply wells

WATER RESOURCES PLANNING, MONITORING, AND MANAGEMENT PROGRAMS

To develop a comprehensive GSP and as stewards of water resources, the EBP Subbasin GSAs and corresponding local agencies have prepared and adopted regional, local, urban, groundwater management, and general plans. Each of these plans coordinate water resources for the region across a number of agencies and county lines.

Information in these plans regarding GSA surface water and groundwater supplies, distribution infrastructure, and monitoring programs has contributed to the development of this GSP.

LAND USE ELEMENTS OR TOPIC CATEGORIES OF APPLICABLE GENERAL PLANS

General plans have been prepared for Alameda County and Contra Costa County and several cities within the EBP Subbasin, which the GSP thematically characterizes by the following topics:

- Buildout
- Vacant land and infill/recharge potential
- Additional housing development and other future development
- Green infrastructure
- Creek protection

Generally, implementation of general plan policies aligns with GSP planning efforts and supports the sustainability of the EBP Subbasin. The GSP uses conservative assumptions related to groundwater recharge (Chapter 4: Projects and Management Actions to Achieve Sustainability Goal) to develop a future scenario.

Notice and Communication Regarding the GSP

The GSAs in the EBP Subbasin created a communication and engagement plan that includes a stakeholder engagement chart. Beneficial users are stakeholders in the EBP Subbasin who use or consume groundwater, including environmental uses, such as groundwater dependent ecosystems (GDEs). Other stakeholders include those with an interest in groundwater use and management.

The GSAs convened a EBP Subbasin GSP Technical Advisory Committee with technical experts and/or representatives associated with the various Subbasin stakeholders. An email distribution list of stakeholders and beneficial users was developed. Before public meetings for development of the GSP, the GSAs emailed a meeting agenda to the list of interested parties.

Public engagement opportunities during GSP development included:

- Ten general meetings for stakeholders and the public to learn about the SGMA process and Plan components, receive updates about planning activities, and provide input.
- SGMA webpages maintained by each GSA (EBMUD and Hayward), containing calendars of public meetings and other events; information about past meetings, including relevant presentation materials; links to external sites and resources; information about the GSAs and EBP Subbasin technical meetings; GSP documents; and subbasin maps.
- Email/telephone availability of the GSAs' SGMA staff.

PUBLIC ENGAGEMENT PROCESS

Stakeholder Engagement Plan created

Stakeholder Group convened, including EBP Subbasin GSP Technical Advisory Committee, Interbasin Working Group, and Interested Parties

The **Technical Advisory Committee** reviewed and commented on the consultants' deliverables and provided input for GSP development

The Draft GSP was made available for a **45-day public review** in September 2021, which was announced via email and social media. Hard copies were also made available at several public libraries.

Comments received during public review of the Draft GSP were reviewed and considered by the GSAs, the Technical Team, and consultants; the final GSP was submitted to DWR with responses to comments

Basin Setting

HYDROGEOLOGIC CONCEPTUAL MODEL

The geologic history of the EBP Subbasin over the past 800,000 years involves the rise and fall of sea level, which resulted in deposits of different types of sediments/soils from streams (e.g., clay, sand, gravel), wind (e.g., sand dunes), and the Bay (e.g., Bay Mud, silt). These sediments were laid down in different places at different times, thereby resulting in alternating sequences of clay, silt, sand, and gravel within each aquifer zone. Aquitard layers consist primarily of fine-grain materials (clay, silt). This depositional history resulted in more coarse-grained material (sand, gravel) in the Deep Aquifer Zone in the southern EBP Subbasin compared to shallower zones or more northerly locations. The transition zone is a hydrogeologic boundary between the EBP and Niles Cone Subbasins related to vertical offsets of coarse-grained layers that restrict groundwater flow between the two subbasins.

The EBP Subbasin extends across multiple jurisdictions and consists of three major aquifer zones across the area. Most high-yield production wells have been developed within the Deep Aquifer Zone and lower portion of the Intermediate Aquifer Zone in the southern EBP Subbasin. The Shallow Aquifer Zone and upper to middle portions of the Intermediate Aquifer Zone have geologic conditions that tend to result in lower yielding wells.

Based on recharge mechanisms, soil types, and surface geologic data, it has been found that groundwater recharge has the potential to occur throughout the EBP Subbasin.

CURRENT AND HISTORICAL GROUNDWATER CONDITIONS

Groundwater pumping is much lower today (3,600 AF) than in the 1960s (>20,000 AF), and groundwater levels are stable and the basin is sustainable. The EBP Subbasin GSAs are not aware of any residents who are solely or primarily dependent on groundwater for a drinking water supply.

Overall groundwater quality in the intermediate and deep aquifer is good, with contamination limited to the shallow aquifer.

Extensive water supply development and groundwater pumping from the Intermediate and Deep Aquifer Zones occurred in the southern EBP Subbasin during the 1950s and 1960s, resulting in Intermediate/Deep Zone groundwater levels that ranged from 10s of feet (ft) to well over 100 ft below sea level. However, no significant seawater intrusion problems were reported during this time.

Land subsidence is a decline in ground surface elevation, which can occur from natural or human-induced causes. Since 2008, two deep extensometers have continually measured the aquifer system compaction (elastic and inelastic subsidence) and expansion (uplift) in the southern portion of EBP subbasin area. The extensometer monitoring (done in coordination with USGS) is a key ongoing program that collects subsidence data on a continuous basis and no land subsidence has been reported to date.

Groundwater Quality

Overall groundwater quality in the EBP Subbasin has been evaluated in detail for several major constituents. Where appropriate, the minimum threshold is based on the maximum containment level (MCL), which is defined as "the highest level of a contaminant that is allowed in drinking water. Primary MCLs are set as close to the MCL goal as is economically and technologically feasible. Secondary MCLs are set to protect the odor, taste, and appearance of drinking water" (California Code of Regulations, 2019).

Total Dissolved Solids (TDS)

TDS has secondary MCLs of 500 mg/L (recommended) and 1,000 mg/L (maximum). Average concentrations are generally less than 1,000 mg/L except in localized areas near San Francisco Bay (primarily in the Shallow Aquifer Zone).

Chloride

Chloride has secondary MCLs of 250 mg/L (recommended) and 500 mg/L (maximum). The distribution of chloride concentrations, which can serve as a potential indicator for seawater intrusion, generally have concentrations less than 500 mg/L except near San Francisco Bay in the Shallow Aquifer Zone.

Nitrate

Available data for wells known to be screened in the Intermediate and Deep Aquifer Zones indicate that nitrate concentrations are below the primary MCL of 10 mg/L for nitrate as nitrogen. However, there are a limited number of Shallow Aquifer Zone wells distributed throughout the EBP Subbasin that have elevated nitrate concentrations exceeding the MCL.

Arsenic

Arsenic is a commonly occurring natural constituent in groundwater. Most wells with data have arsenic concentrations below the arsenic primary MCL of 10 ug/L; however, there are one or more wells in each depth zone with an average arsenic concentration above the MCL.

Manganese

Manganese is a commonly occurring natural constituent in groundwater, and the majority of wells tested in the EBP Subbasin have manganese concentrations exceeding the secondary MCL (no primary MCL has been established for manganese since it is not a health concern) in all three aquifer depth zones.

GROUNDWATER POLLUTANTS

Historical commercial and industrial activities in the EBP Subbasin have resulted in release of pollutants to the soil and groundwater system.

The pollutants selected for more detailed analysis were based on the need to establish current baseline conditions for the most common and potentially impactful contaminants. Environmental (i.e., contaminant) sites were reviewed using the State Water Resources Control Board's GeoTracker database; the review focused on perchloroethene (PCE), trichloroethene (TCE), total petroleum hydrocarbons, benzene, toluene, ethylbenzene, xylenes, methyl tert-butyl ether, and hexavalent chromium (generally considered a naturally occurring constituent, but included here to account for potential industrial sources).

A total of fourteen sites with existing PCE, TCE, and/or hexavalent chromium concentrations above the MCL were identified at locations throughout the EBP Subbasin from Richmond to Hayward.

The depth of contamination was limited to the upper 50 feet below ground surface (bgs) at all sites except one (located in Richmond), where monitoring well depths extended to 120 feet bgs. Other sites with minor contamination are present throughout the Subbasin; review of these sites generally indicated environmental site contamination is limited to the upper portion (i.e., upper 120 feet) of the Shallow Aquifer Zone.

A review of available information on PFAS contaminants in the EBP Subbasin as of August 2021 revealed three reported sites located adjacent to San Francisco Bay in the EBP Subbasin: West Contra Costa Landfill (Richmond area), Oakland Airport, and West Winton Landfill (Hayward area). The West Contra Costa Landfill is located adjacent to biosolids drying lagoons for a wastewater treatment plant, and had perfluorooctanoic acid (PFOA) detected in shallow brackish groundwater from six wells (up to 47 feet deep) and perfluorooctane sulfonate (PFOS) detected in four of six wells (up to 21 feet deep) at concentrations consistent with the range expected in municipal solid waste leachate. No additional sampling was recommended as of July 2020 (Geosyntec, 2020). The Oakland Airport site report indicated detection of PFAS compounds in soil and groundwater (in monitoring wells up to nine feet deep) in four different areas of the site. Additional investigation was ongoing at the time of the latest available report (CH2M Hill, December 2020). The West Winton Landfill site has been evaluated under a SWRCB order for PFAS sampling of landfill leachate and groundwater. Relatively low concentrations of PFAS compounds were detected in shallow brackish groundwater from monitoring wells up to 27 feet deep (Wood, April 2020).

The overall results of this review indicate that the Intermediate and Deep Aquifer Zones (depth intervals greater than 200 ft bgs) are generally not impacted by contaminants attributed to environmental sites, which are subject to clean up orders from the RWQCB and DTSC and are not the responsibility of the GSAs.

Water Budget

A water budget is a tabulation of all the components of inflow (recharge) and outflow (discharge) from the groundwater basin. Primary components of recharge in the EBP Subbasin that require quantification are rainfall infiltration, excess infiltration of applied irrigation water, streamflow infiltration, pipe leakage, bedrock inflow, and lateral subsurface inflows. Primary discharge components include groundwater pumping, lateral subsurface outflows, discharge to streams, and sewer pipe outflow.

CLIMATE CHANGE

The anticipated effects of future climate change were reviewed both in terms of expected sea level rise and relative to expected changes in hydrology (i.e., precipitation, evapotranspiration (ET), and streamflow) using DWR's SGMA Guidance for Climate Change and several local studies. Overall, these studies indicate a tendency towards greater precipitation and streamflow along with higher ET.

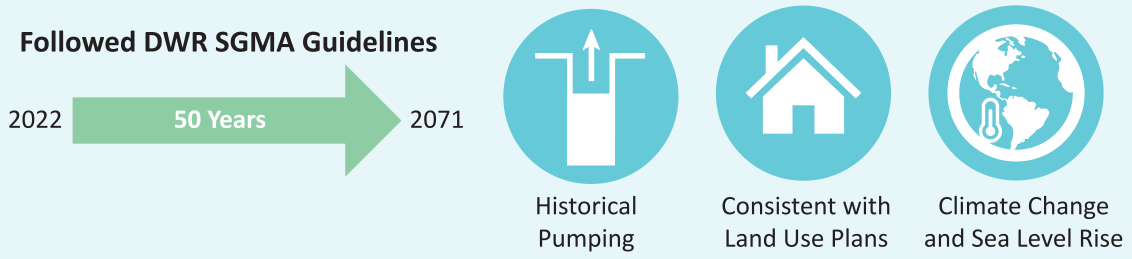
There is significant uncertainty with regard to total sea level rise expected by 2070, with estimates ranging from 1.5 to 3.5 feet by 2070. While DWR (2018) estimates sea level rise of 1.5 feet by 2070, this GSP uses a sea level rise estimate of 2.0 feet by 2070 to accommodate other studies indicating somewhat higher estimates of sea level rise.

The change factors defined in DWR's SGMA Guidance documents indicate expectations are for a higher percentage increase in precipitation than for ET, especially in the key months of December to March when most groundwater recharge occurs. In addition, streamflow is expected to be greater than historical amounts. However, due to significant uncertainty associated with these change factors and in order to be more conservative in the future hydrology used in this GSP, it was assumed that groundwater recharge and streamflow do not increase in the future and are the same as historical levels.

FUTURE SCENARIO

Looking ahead, it is reasonable to expect that existing groundwater facilities for public water supply (EBMUD's Bayside Phase 1 well for supplemental drought supply and the City of Hayward's emergency wells) will provide additional resilience to the overall water supply portfolio for the East Bay.

Pumping from the projects results in short-term drawdown that is not expected to produce undesirable results, and no significant change in stream connectivity or decrease in streamflow is expected. The recharge of the basin will slightly outpace discharge from the basin, resulting in a net increase in basin storage.



SUSTAINABLE YIELD

The estimate of sustainable yield is based on previous studies (Muir; 1996; Norfleet, 1998), the water balance analysis provided in the GSP HCM, and the groundwater model developed for this GSP. Muir conducted studies in the 1990s on the Alameda County portion of EBP Subbasin from Berkeley in the north to Hayward in the south.

Muir defined the "yield of the groundwater reservoir" in the East Bay Plain to be based on the amount of groundwater that could be pumped "...year after year without decreasing groundwater in storage to the point where the intrusion of seawater from San Francisco Bay would occur." The GSP water balance analysis provided non-modeling based estimates for various water balance components that were used as initial groundwater model inputs.

The EBP Subbasin groundwater model developed for this GSP used a steady-state groundwater model run to evaluate sustainable yield for the EBP Subbasin.

This analysis resulted in an initial estimated sustainable yield of approximately 12,500 AFY for the entire EBP Subbasin.

Based on best available data at this time, this estimated sustainable yield represents a maximum amount that assumes approximately evenly spaced pumping throughout the Subbasin. This initial estimate of sustainable yield will be refined in the future with collection of additional field data, refinement of the water balance, development of a better understanding of surface water depletion, updates to the groundwater model, and additional model simulations of transient model runs with specific proposed projects and management actions.

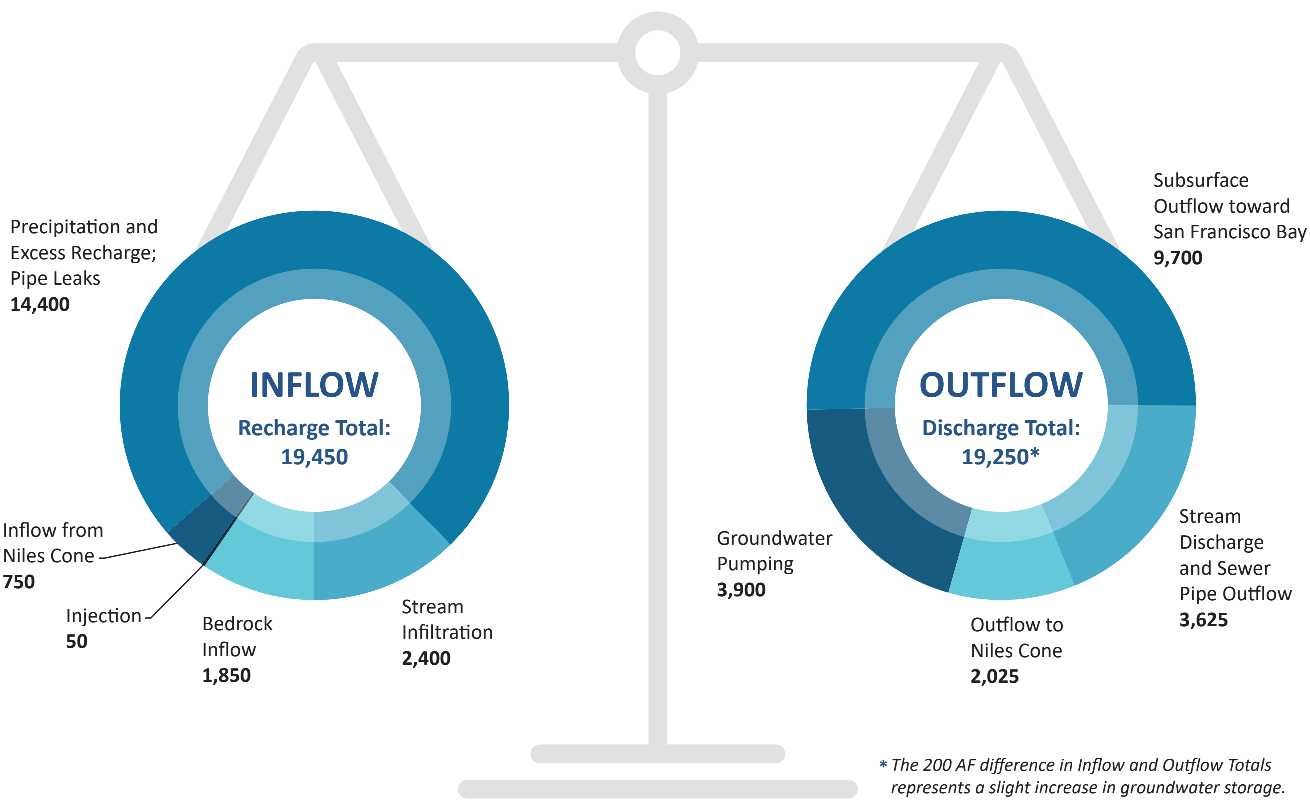
PROJECTED FUTURE WATER BUDGET

The future projected water budget includes anticipated impacts of climate change, land use changes, and changes related to implementation of GSA projects and management actions. Based on these forecasts, the recharge and discharge elements are balanced with an accounting for a small groundwater storage change component.

While total recharge to the EBP Subbasin is slightly reduced under the projected future water budget with sea level rise, comparison of total recharge to total discharge indicates an overall groundwater storage increase averaging 200 AFY.

Water Balance

RECHARGE (AFY)				DISCHARGE (AFY)			
Historical	**Current**	**Future Baseline**	**Future with Projects**	**Historical**	**Current**	**Future Baseline**	**Future with Projects**
19,700	19,475	19,300	19,450	17,550	19,000	19,025	19,250



** The 200 AF difference in Inflow and Outflow Totals represents a slight increase in groundwater storage.*

CHAPTER 3: SUSTAINABLE MANAGEMENT CRITERIA

Sustainable Management Criteria

This fundamental chapter of the Groundwater Sustainability Plan (GSP) defines sustainability in the Plan area, and addresses significant regulatory requirements. The undesirable results, minimum thresholds, and measurable objectives presented in this chapter define the future sustainable conditions in the Plan area and commit the associated GSAs (EBMUD and Hayward) to actions that will achieve these future conditions.

SUSTAINABILITY GOAL

The sustainability goal for the Plan area is to manage and protect the East Bay Plain Subbasin in a manner that avoids undesirable results while continuing to collect and analyze data to support science-based decision making to evaluate new opportunities for sustainable groundwater beneficial uses.

SGMA requires that the GSAs consider six sustainability indicators in the GSPs. Each have been assigned minimum thresholds and measurable objectives as set forth in this GSP to avoid undesirable results and ensure continued sustainable groundwater management of the EBP Subbasin over the planning and implementation horizon. Interim milestones were set equal to measurable objectives because the basin is sustainable under current conditions.

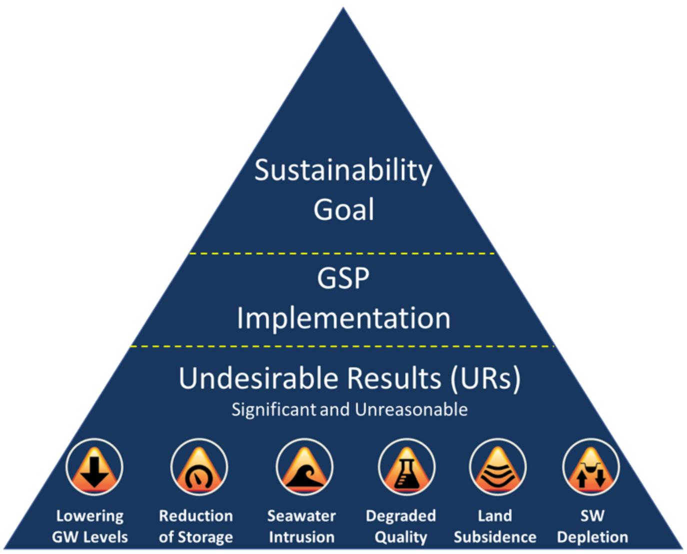
Interim sustainable management criteria (metrics defining when undesirable results occur and when the sustainability goal is maintained/achieved) for each indicator were developed with stakeholder input and using best available science and data with the caveat that major data gaps need to be addressed.

LOOKING AHEAD 20 YEARS

The sustainability goal and the absence of undesirable results are expected to be maintained through and beyond 2042 with implementation of the projects and management actions (MAs). The sustainability goals will be maintained through proactive monitoring and management by the GSAs.

Chapter 3 defines what sustainability looks like for the plan area considering a number of specific indicators, and addresses the following California Code of Regulation (CCR) requirements:

- ☑ **Sustainability Goal (CCR Title 23, Section 354.24)**
- ☑ **Undesirable Results (CCR Title 23, Section 354.26)**
- ☑ **Minimum Thresholds (CCR Title 23, Section 354.28)**
- ☑ **Measurable Objectives (CCR Title 23, Section 354.30)**
- ☑ **Description of Monitoring Networks (CCR Title 23, Section 354.34)**
- ☑ **Monitoring Protocols for Data Collection and Monitoring (CCR Title 23, Section 352.2)**
- ☑ **Representative Monitoring (CCR Title 23, Sections 354.36 and 354.38)**



A Network of Monitoring Wells

By establishing the GSP groundwater level monitoring network, the GSAs are able to collect data to assess sustainability indicators, the effectiveness of management actions and projects that maintain sustainability and evaluate each applicable sustainability indicator.

Monitoring protocols include specifics like frequency to allow for the monitoring of seasonal highs and lows. For wells that have sufficient historical data records, future groundwater data will be compared to historical data.

A network of groundwater quality representative monitoring sites includes 27 existing and new wells to be installed by 2022. These wells are also part of the water level monitoring indicator well network and will be sampled for groundwater quality by the Subbasin GSAs.

The RMS monitoring network is expected to evolve as new wells are drilled and water level data histories are developed, and will be periodically reviewed for potential improvements. Additional non-RMS monitoring wells are being considered for a broader monitoring network (Appendix 3.G).

Monitoring wells shown in the map at left are intended to fill the following data gaps:

- Limited historical groundwater level data
- Limited wells in the North
- Limited data on groundwater dependent ecosystems
- Lack of direct measurements of pumping
- Lack of chloride measurements and shallow wells near Bay margin
- Lack of historical concentration data to establish baseline concentrations
- Subsidence has only been directly measured in the EBP Subbasin using the extensometers near EBMUD's Bayside well
- Limited to no data on streamflow and stream-aquifer interconnection for major streams

SUSTAINABILITY INDICATOR:

Chronic Lowering of Groundwater Levels

EBP Subbasin is not experiencing a chronic lowering of groundwater levels and is currently in a sustainable condition.

UNDESIRABLE RESULTS

Declining groundwater levels resulting in water supply wells no longer providing enough groundwater for beneficial uses or users resulting in:

- Reduction in well capacity
- Impacts to groundwater dependent ecosystems (GDEs)

INTERIM CRITERIA

UNDESIRABLE RESULTS (UR)

- **25% of Spring Representative Monitoring Sites (RMS) well levels below minimum threshold**
  25% is at the lower end of a reasonable range from 20-50% and provides a balance to avoid URs
- **Two consecutive Spring measurements (March)**
  Spring water levels are less influenced by localized pumping

MINIMUM THRESHOLDS

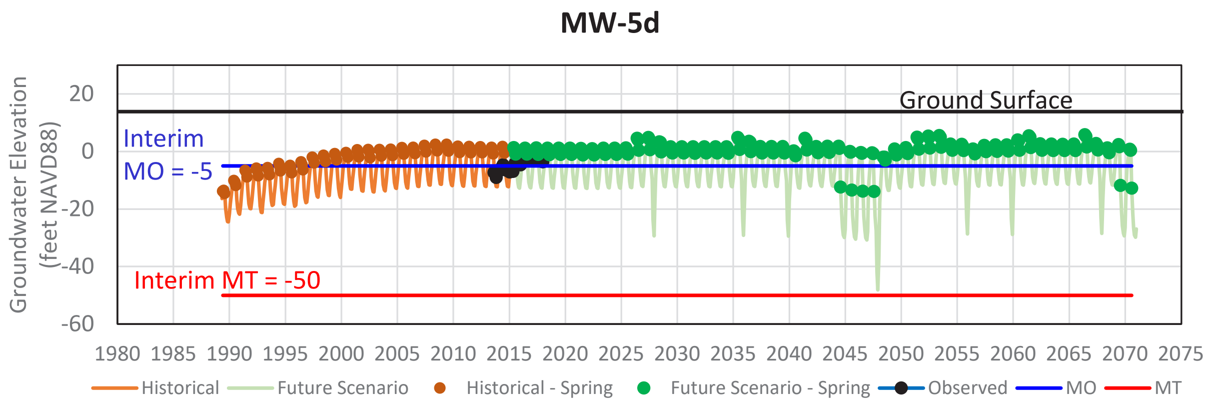
- **Shallow Aquifer: 50' below ground surface**
  Based on minimum well seal depth requirement for water supply and industrial wells
- **Intermediate/Deep Aquifer: 50' below mean sea level**
  Allows for sufficient available drawdown in deeper wells to maintain their capacity
- **Groundwater Dependent Ecosystems: 7.5' below baseline conditions in shallow wells**
  30' maximum rooting depth for most plants per The Nature Conservancy guidance; 25% of maximum rooting depth

MEASURABLE OBJECTIVES & INTERIM MILESTONES

- **Average of historical data, when recent data (<10 years) is available**
- **If no data or recent data is unavailable, groundwater model results are used**

SAMPLE MONITORING WELL DATA

See Appendix 3 for all locations



This hydrograph depicts observed and modeled deep aquifer zone groundwater elevations at MW-5 over time with associated groundwater level minimum thresholds and measurable objectives. Similar groundwater level hydrographs with sustainable management criteria for other RMS wells are presented in Appendix 3.A.

SUSTAINABILITY INDICATOR:

Reduction of Groundwater Storage

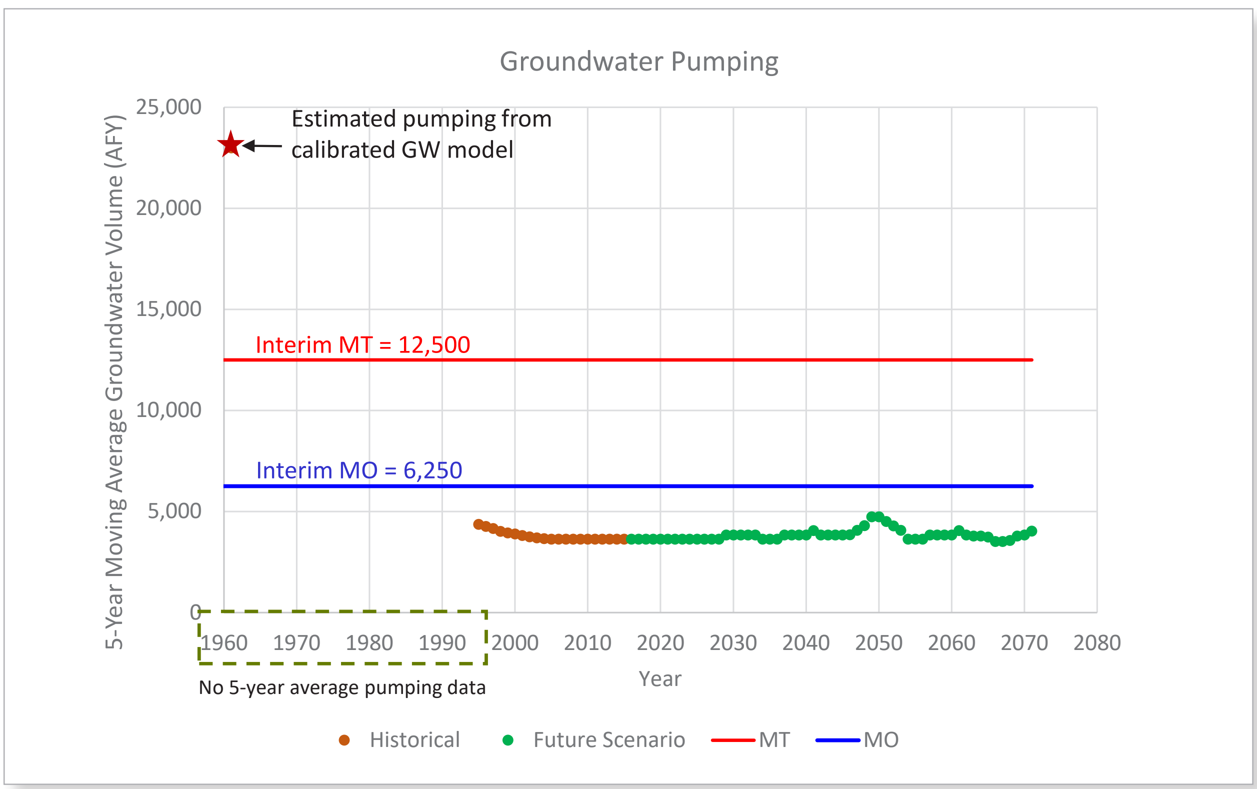
UNDESIRABLE RESULTS

Excessive regional groundwater pumping that results in significant and unreasonable long-term reduction in groundwater storage, resulting in:

- Reduction in well capacity

EBP Subbasin groundwater storage is stable because estimated groundwater pumping from the 1990s to present is well below the estimated sustainable yield of the Subbasin.

INTERIM CRITERIA		
UNDESIRABLE RESULTS (UR)	**MINIMUM THRESHOLDS**	**MEASURABLE OBJECTIVES & INTERIM MILESTONES**
• **Average annual subbasin pumping exceeds sustainable yield for five-year period** *Five years balances short-term extreme needs while not allowing for long-term overpumping*	• **12,500 AFY over five-year period** *Initial sustainable yield estimate; two million AF of excess storage estimated in EBP Subbasin*	• **Reasonable range would be 20 to 50% less than MT** *A 20-50% range is a reasonable balance between not letting a very localized problem define undesirable results and not allowing most of the basin to be impacted before declaring an undesirable result has occurred.* • **Use 50% to be conservative = 6,250 AFY** *The selection of 50% results in lowest MO of 6,250 AFY.*



This figure presents the historical and projected future five-year moving average of annual groundwater pumping with implementation of GSA projects.

SUSTAINABILITY INDICATOR:

Seawater Intrusion

EBP Subbasin has not experienced significant seawater intrusion even during historical periods of much greater groundwater pumping than is occurring today.

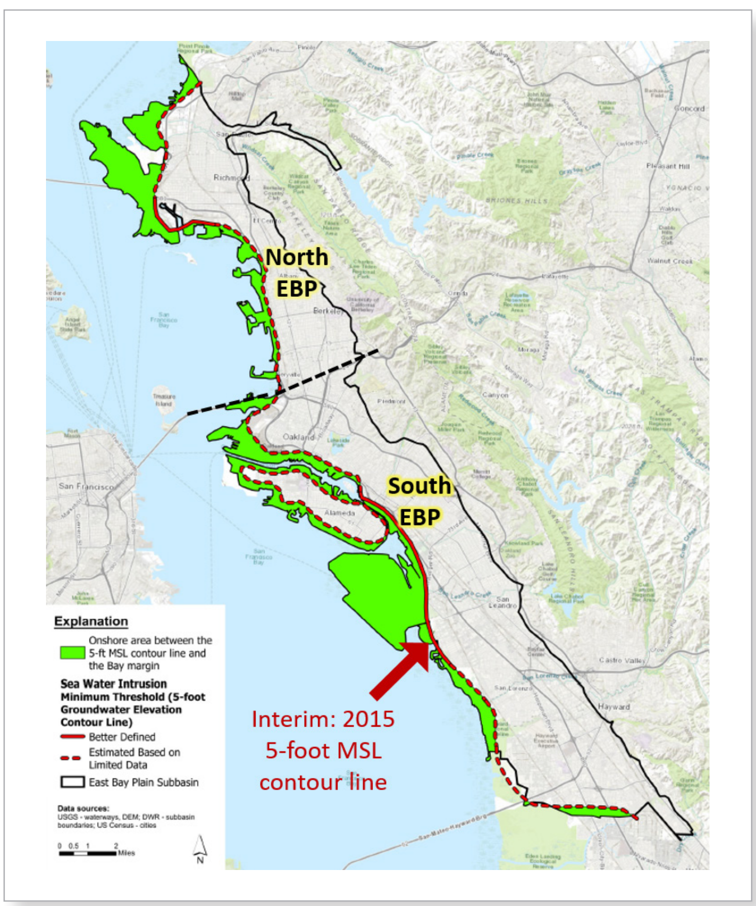
UNDESIRABLE RESULTS

Migration of saline Bay water into existing fresh water aquifers that are or could be developed for water supply, resulting in:

- The preclusion of beneficial use for drinking water

INTERIM CRITERIA

UNDESIRABLE RESULTS (UR)	MINIMUM THRESHOLDS	MEASURABLE OBJECTIVES & INTERIM MILESTONES
• **GW levels in Water Table Aquifer Zone (upper 50 feet) used as a proxy** *Water Table Aquifer is the only aquifer connected to the Bay with significant clay layers below* • **GW elevations exceed MSL near the Bay margin** *Seawater intrusion is not expected if shallow GW levels are maintained above MSL* • **Segmented into the north and south**	• **25% increase in onshore area between the 5 ft MSL contour line and Bay margin** *25% is at the lower end of a reasonable range from 20 to 50%* **AND** • **25% increase in chloride concentration in sentinel wells** *25% is at the lower end of a reasonable range from 20 to 50%*	• **Position of 5-foot MSL contour line based on 2015 Spring GW levels** *Current MSL is 1-foot; 5-foot MSL is lowest contour line that can be reasonably defined by available data and expected to adequately reflect inland movement of 1-foot MSL contour.*



The seawater intrusion sustainable management criteria are based in part on monitoring potential inland movement of the shallow aquifer five feet groundwater elevation contour (i.e., inland expansion of green area on this figure, which represents the area between San Francisco Bay margin and the five-foot groundwater elevation contour).

SUSTAINABILITY INDICATOR:

Land Subsidence

EBP Subbasin has no observed inelastic land subsidence even during historical periods of much greater groundwater pumping and much lower confined aquifer groundwater elevations than are occurring today.

UNDESIRABLE RESULTS

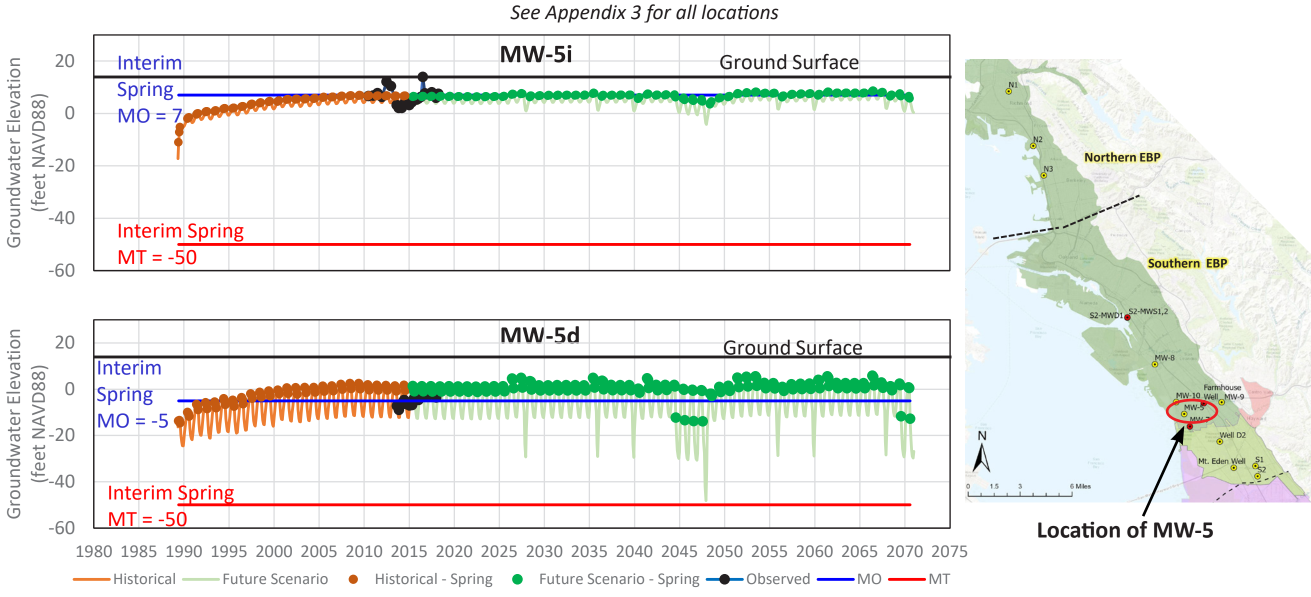
Inelastic subsidence due to excessive groundwater pumping that causes impacts at a regional scale, resulting in:

- Damage to critical public infrastructure such as levees, flood control channels, water supply aqueducts

INTERIM CRITERIA		
UNDESIRABLE RESULTS (UR)	**MINIMUM THRESHOLDS**	**MEASURABLE OBJECTIVES & INTERIM MILESTONES**
• **GW levels used as a proxy; based on historical spring lows** • **Better data for historical spring water levels compared to fall** • **25% of RMS wells fall below MT** *25% is at the lower end of a reasonable range from 20 to 50%* • **Intermediate / Deep Aquifer only; subsidence not expected in Shallow Aquifer**	• **South EBP -50 feet MSL (Spring)** *Observed / modeled historical lows in Intermediate and Deep Aquifer Zones* • **North EBP -20 feet MSL (Spring)** *Observed historical low for one well in Intermediate Zone* *Water levels and narrative from Richmond wellfield pumping*	• **Average spring groundwater levels in intermediate and deep aquifers when recent data (<10 years) is available** • **If data is unavailable, groundwater model results are used**

SAMPLE MONITORING WELL DATA

See Appendix 3 for all locations



These hydrographs depict observed and modeled intermediate and deep aquifer zone groundwater elevations at MW-5 over time with associated land subsidence minimum thresholds and measurable objectives, based on using groundwater levels as a proxy for land subsidence. Similar land subsidence hydrographs with sustainable management criteria for other RMS wells are presented in Appendix 3.D.

SUSTAINABILITY INDICATOR:

Degraded Water Quality

UNDESIRABLE RESULTS

Significant and unreasonable degradation of groundwater quality caused by GSA projects and management actions, resulting in:

- The preclusion of beneficial use for drinking water

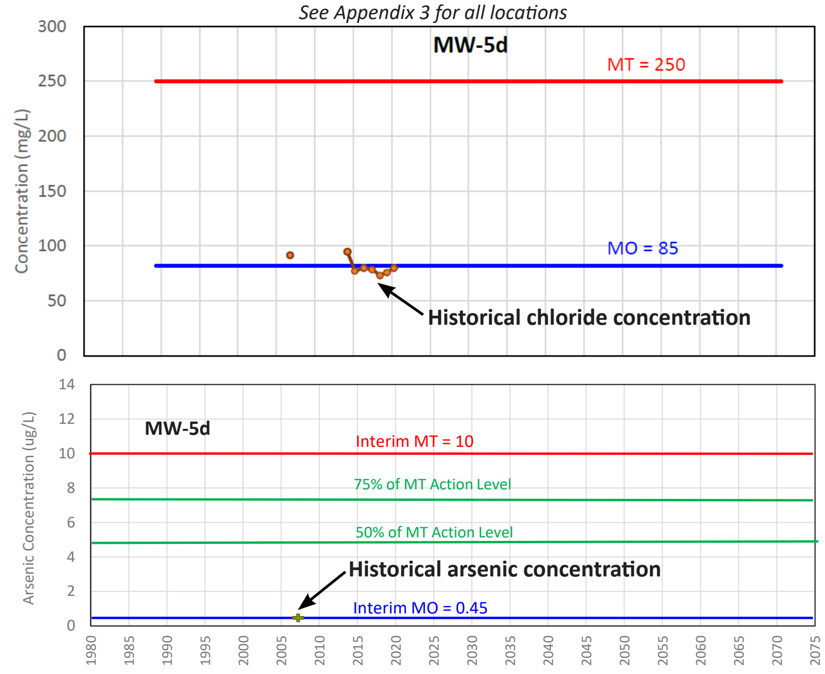
Overall groundwater quality in the EBP Subbasin is good; key constituents for monitoring degraded water quality are total dissolved solids, chloride, nitrate, and arsenic.

INTERIM CRITERIA

UNDESIRABLE RESULTS	MINIMUM THRESHOLDS	MEASURABLE OBJECTIVES & INTERIM MILESTONES
• **25% of RMS wells exceed MT** *25% is at the lower end of a reasonable range from 20 to 50%* • **If concentrations exceed 50% of MT for a constituent with Primary MCL (i.e., nitrate and arsenic) conduct additional investigation of cause(s); 50% Action Level corresponds to notifications required in Drinking Water Regulations** • **If concentrations exceed 75% of MT for a constituent with Primary MCL (i.e., nitrate and arsenic) GSA acts to avoid undesirable result (if caused by GSA activity) or reports to appropriate agencies (if not caused by GSA activity); 75% Action Level corresponds to SWRCB/RWQCB Basin Plan Amendments for Region 5**	• **MCLs:** • Nitrate – 10 mg/L (primary) • Arsenic – 10 ug/L (primary) • TDS – 500 mg/L (secondary) • Chloride – 250 mg/L (secondary) *GW quality is generally acceptable if below an established MCL* • **If baseline concentration already exceeds MCL (e.g., naturally occurring constituents or pre-existing conditions), set MT at baseline concentration plus 20%** *20% increase is based on evaluation of 3 potential sources of fluctuations:* *(1) analytical lab methods* *(2) sampling methods* *(3) variability in GW system*	• **Average baseline concentrations where data is available**

SAMPLE MONITORING WELL DATA

See Appendix 3 for all locations



These time-series plots of chloride (secondary MCL) and arsenic (primary MCL) show historical baseline concentrations with associated minimum thresholds and measurable objectives. In addition, key constituents with primary MCLs such as arsenic have been assigned Action Levels set at 50% and 75% of the MT. Time-series plots for other RMS wells are provided in Appendix 3.E.

SUSTAINABILITY INDICATOR:

Depletion of Interconnected Surface Water

While significant data gaps currently exist for characterization of groundwater – surface water interaction, best available data indicates current pumping has minimal impacts on interconnected surface water.

UNDESIRABLE RESULTS

Increase in streamflow depletion rate that results in significant and unreasonable effects to potential beneficial uses/users, resulting in:

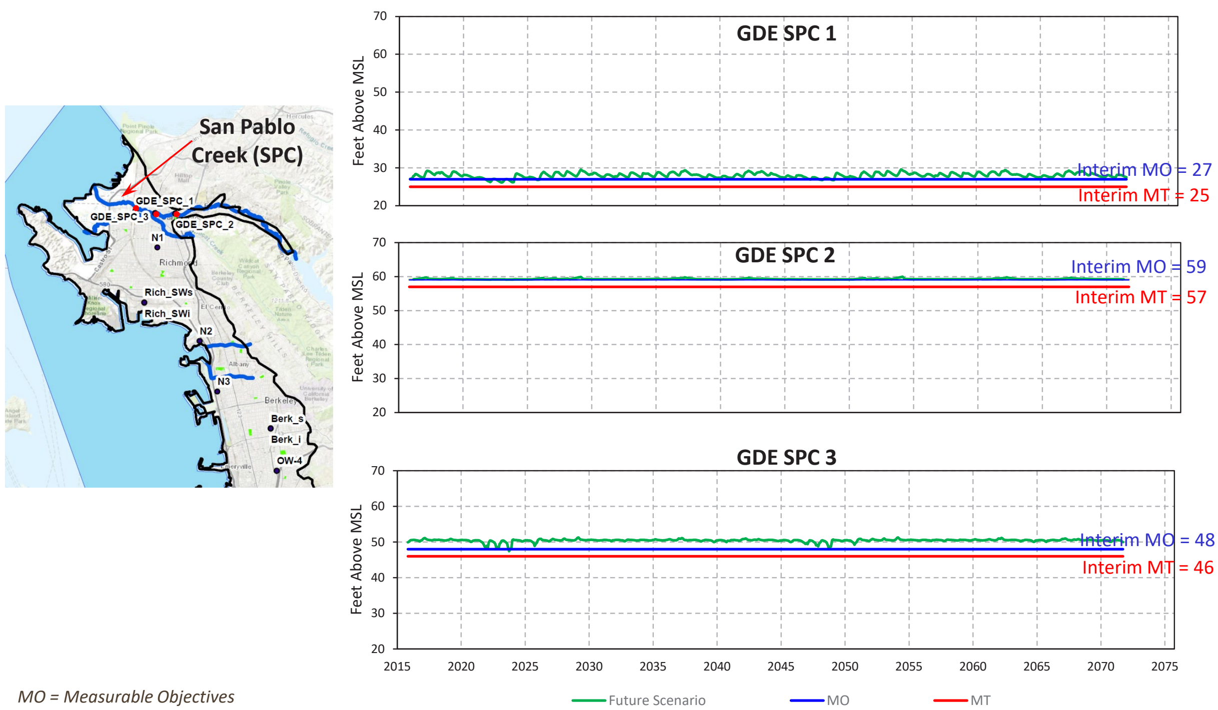
- Insufficient water for beneficial uses/users such as for aquatic species and GDEs

INTERIM CRITERIA

UNDESIRABLE RESULTS	MINIMUM THRESHOLDS	MEASURABLE OBJECTIVES & INTERIM MILESTONES
• **Shallow GW levels near major streams used as a proxy** • **50% of RMS wells fall below MT** • **50% is reasonable because of small number of shallow RMS wells near streams**	• **2 feet below MO** *Based on GW model runs* *Difference between baseline conditions and sustainability (pumping at 3,600 AFY versus 12,500AFY)* *Shallow GW levels decreased between 0 – 1.8 feet*	• **Low end of model-derived range of GW level fluctuations**

SAMPLE MONITORING WELL DATA

See Appendix 3 for all locations



MO = Measurable Objectives
MT = Minimum Threshold

While plans have been developed to collect data and fill data gaps over the next several years, best available data have been used to establish initial interim minimum thresholds and measurable objectives for depletion of interconnected surface water. These hydrographs show use of groundwater levels as a proxy based on groundwater model results at potential future shallow well locations to establish interim sustainable management criteria. Similar surface water depletion hydrographs with sustainable management criteria for other RMS wells are presented in Appendix 3.F.

CHAPTER 4: PROJECTS AND MANAGEMENT ACTIONS

Projects

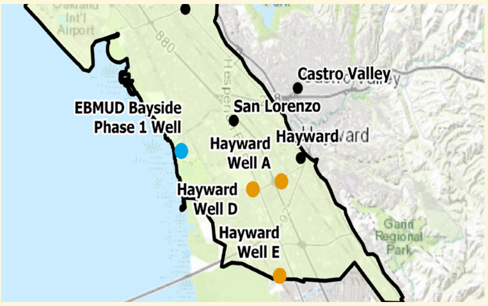
EBMUD and City of Hayward are committed to developing diverse water supply portfolios to help improve resiliency in the face of changing climate, water supply needs, and regulations. In addition to water conservation and recycled water, beneficial use of groundwater is an important potential source. The GSAs are also committed to maintaining sustainability within the EBP Subbasin, and the existing and potential future projects reflect the GSAs' desire to fill data gaps and let science-based decision making drive the feasibility of future groundwater pumping.

After sufficient data collection, future projects under consideration by EBMUD may include additional phases of Bayside, irrigation with groundwater, and the use of groundwater to supplement flows into San Leandro Creek that EBMUD voluntarily releases from Chabot Dam to approximate historic leakage flows. Potential future Hayward projects may include a well conversion study and a conjunctive use study.

The projects and management actions are described in accordance with:

- ☑ **Introduction to Projects and Management Actions (CCR Title 23, Sections 354.42 and 354.44)**

EBMUD's Bayside Phase 1 and Hayward's emergency wells were evaluated based on the six sustainability indicators, and found to meet sustainability goals and measurable objectives without any undesirable results for the EBP Subbasin.



EBMUD BAYSIDE PHASE 1 FACILITY

Completed in 2010, this facility enables EBMUD to inject potable drinking water into the Deep Aquifer of the EBP Subbasin during wet years and also to extract, treat, and use groundwater as a supplemental supply during times of drought. Phase 1 consists of an injection/extraction well, a water treatment plant and distribution pipelines connecting the treatment plant to the well, a subsidence monitoring system, and a network of groundwater monitoring wells.

Average annual operating cost: $30,000 to $200,000

HAYWARD EMERGENCY WELLS

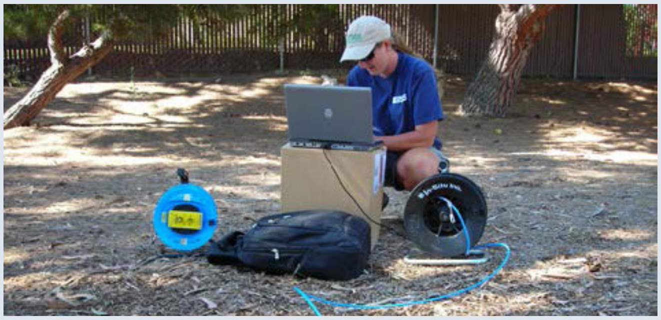
Emergency supply wells are planned for use as extraction-only wells to provide supplemental water supply to Hayward in the event of a short-term emergency, such as an earthquake that interrupts surface water supplies. Hayward has already constructed five extraction wells that are screened primarily in the Deep Aquifer, three of which are located within the EBP Subbasin.

Average annual operating cost: $60,000 to $500,000, in years operated for emergency water supply

Monitoring Actions

Implementing the following monitoring actions allows for effective groundwater basin management necessary to meet GSP/SGMA requirements while significantly improving the understanding of groundwater basin conditions, including stream-aquifer interaction.

GROUNDWATER LEVEL MONITORING



- Costs include both existing RMS wells and RMS wells planned for construction under a DWR Proposition 68 grant that are scheduled to be completed by mid-2022
- Most of these wells have (or will have) transducers installed for automated water level monitoring

GROUNDWATER QUALITY

- Same group of wells as for RMS groundwater level monitoring
- Sampled annually for arsenic, nitrate, chloride, and TDS with a more comprehensive list of analytes tested every five years
- Baseline sampling for key constituents is needed over the initial four years of GSP implementation to provide the basis for establishing MOs and MTs

SURFACE WATER MONITORING

- Install new stream gauges.
- Collect stream discharge data as close together in time as possible to improve understanding of gaining and losing reaches along a length of stream
- Isotope sampling
- Monitor events during different seasons and water year types
- An initial baseline habitat/GDE survey will be conducted, with regular biological surveys thereafter to monitor ecosystem health in potential GDE areas

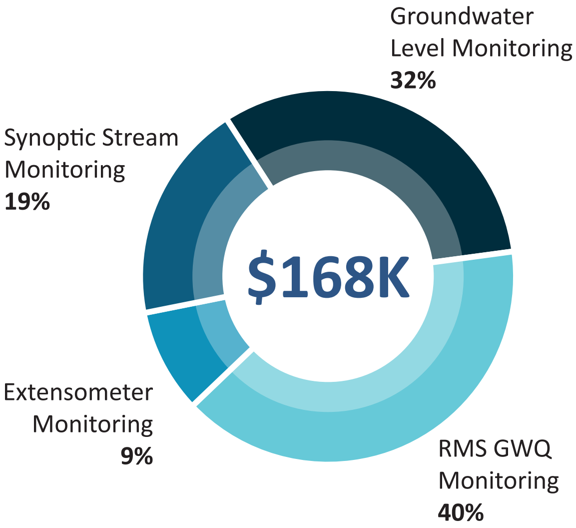
SUBSIDENCE

- The five-year GSP Update Report will include more detailed reporting on other data sets being collected such as subsidence (extensometer) data
- Subsidence monitoring will include collection of groundwater levels from RMS wells for comparison to extensometer data

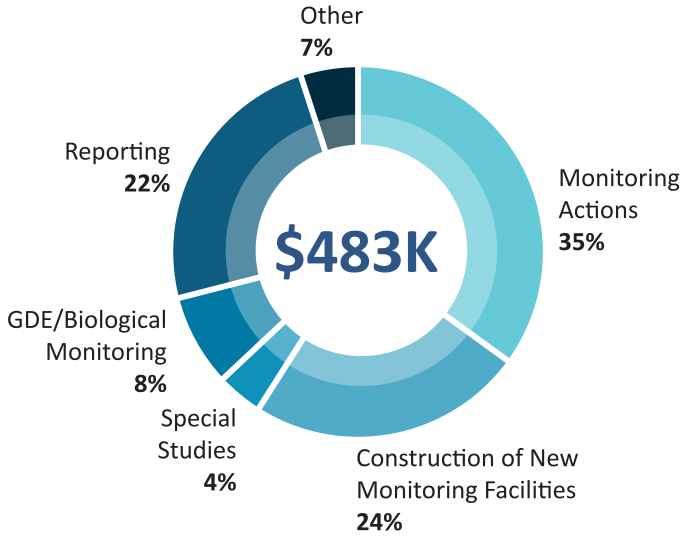
Future Informed by Science

Monitoring actions are going to fill data gaps to drive **science-based solutions** in the future.

Drilling operation for nested monitoring well



Estimated average annual operating costs for monitoring actions (not including potential management or administrative costs)



Annual costs of all management actions (not including potential management or administrative costs)

CHAPTER 5: PLAN IMPLEMENTATION

Estimated Costs

The EBMUD and Hayward GSAs will incur costs for managing the GSP implementation; planning and specialized studies; ongoing monitoring and installation of new facilities; and providing general administration (in addition to the capital and operating costs of projects included in Chapter 4). These project management costs can be categorized as:

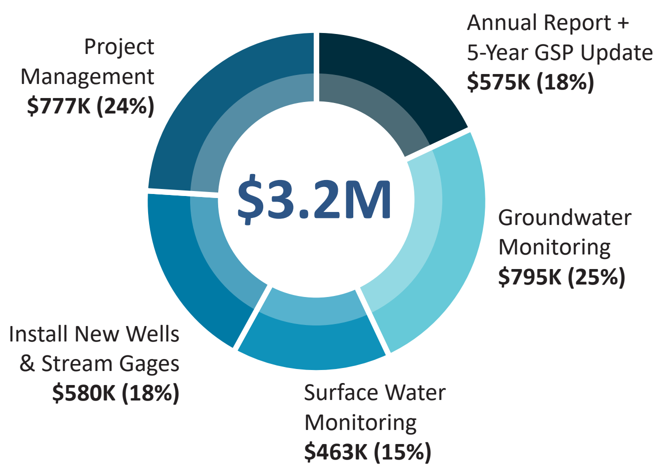
- **GSA Administration:** meetings, reporting, record keeping, bookkeeping, legal advice, continued outreach to stakeholders, and government relations
- **GSP Studies:** various planning, technical, and economic/fiscal studies
- **GSP Implementation and Updates:** include internal GSA coordination, meetings, and document preparation
- **Project Planning:** evaluate other project ideas proposed by stakeholders, assess cost-effectiveness of planned projects, and evaluate the joint implementation of multiple projects to ensure the GSP continues to meet the sustainability goal
- **Meetings and Stakeholder Outreach:** following submittal of the GSP, the GSAs will continue to conduct stakeholder outreach and hold meetings to discuss progress with GSP implementation
- **Monitoring:** tracking Subbasin conditions and sustainability indicators by collecting groundwater extraction and injection data, measuring groundwater elevations and water quality, and tracking total water use
- **Contingency:** actions needed to implement additional management measures if Subbasin conditions start trending towards minimum thresholds in any area

GSP FINANCING

The GSAs are pursuing a combined approach, targeting available grants, and considering a combination of fees and assessments to cover operating and program-specific costs. As required by statute, the GSAs would complete an engineer's report, rate study, and other necessary analyses to document and justify any rate, fee, or assessment.

As part of GSP Development, Chapter 5 addresses the following requirements:

- ☑ **Cost Estimate for Plan Implementation and Funding Sources (CCR Title 23, Section 354.6e)**
- ☑ **Annual Reports and Periodic Evaluation (CCR Title 23, Sections 356.2 and 356.4)**



Estimated five-year costs for proposed implementation activities (to be refined as plan implementation begins). Estimate doesn't include the project costs, but does include the monitoring and management costs from Chapter 4.

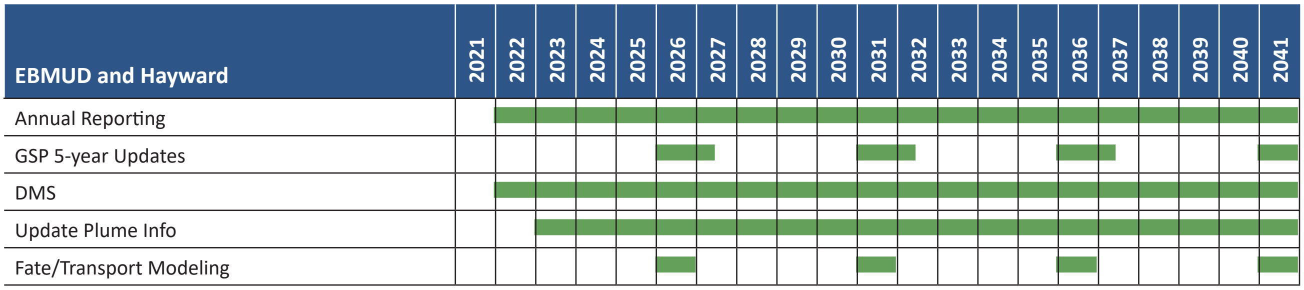
Meeting and engaging with stakeholders will be a high priority throughout GSP implementation.

Schedule for Implementation

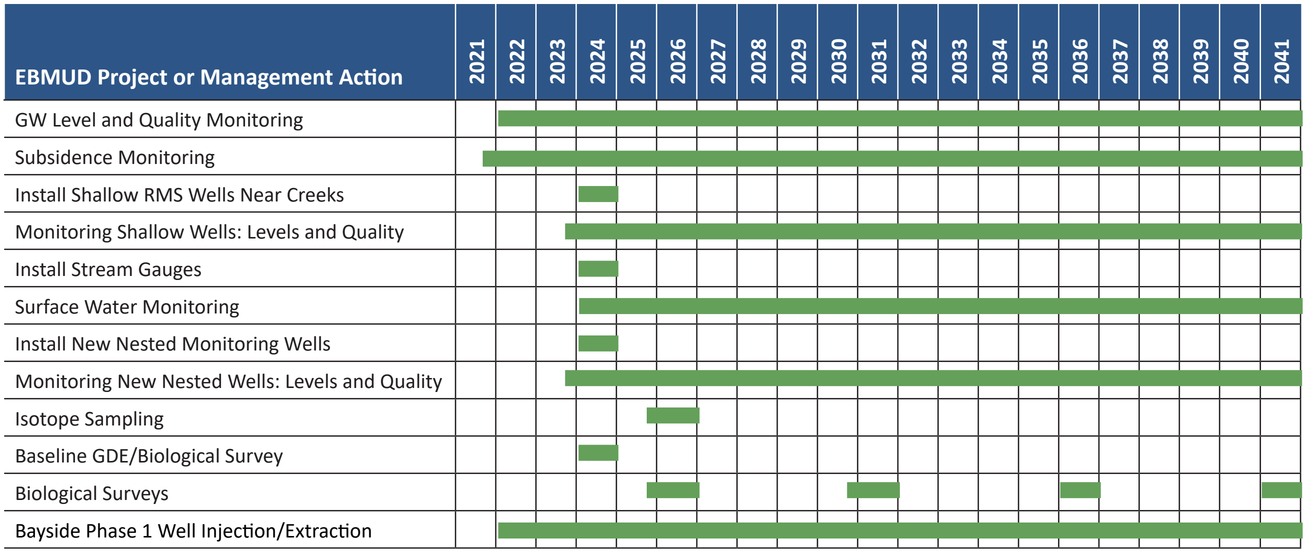
While the primary sustainability projects began prior to SGMA becoming law and are already contributing to the Subbasin sustainability goal, the GSAs will begin implementing other GSP activities in 2022, with full implementation of projects and management actions to maintain sustainability by 2042. Full schedules are shown below for all planned activities.

OPTI DATA MANAGEMENT SYSTEM (DMS)
GSP monitoring data will be collected via a web-based DMS to enable utilization of the same data and tools for visualization and analysis to support sustainable groundwater management and transparent reporting of data and results in the subbasin.

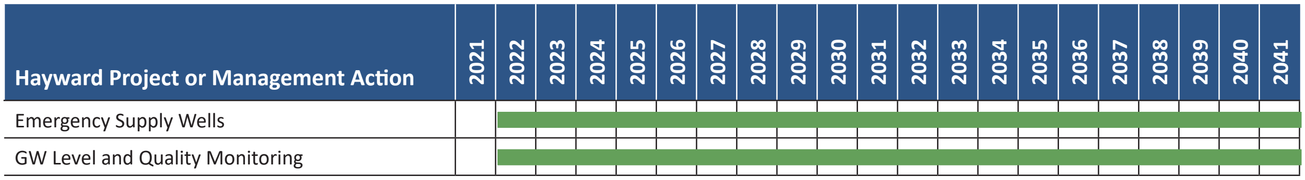
Combined GSA Management Actions



EBMUD GSA Implementation Schedule



Hayward GSA Implementation Schedule



JANUARY 2022

EAST BAY PLAIN SUBBASIN GROUNDWATER SUSTAINABILITY PLAN CHAPTER 1 - INTRODUCTION

PREPARED FOR

East Bay Municipal Utility District GSA and
City of Hayward GSA

PREPARED BY

Luhdorff & Scalmanini Consulting Engineers
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Farallon Geographics

LSCE TEAM

INTRODUCTION

In September 2014, Governor Brown signed three bills (AB 1739 [Dickinson], SB 1168 [Pavley], and SB 1319 [Pavley]) into law collectively known as the Sustainable Groundwater Management Act (SGMA) that created a statewide framework for sustainable, local groundwater management in California. As part of SGMA, local agencies are required to form groundwater sustainability agencies (GSAs) with the authority to develop, adopt, and implement a groundwater sustainability plan (GSP).

East Bay Municipal Utility District (EBMUD) became an exclusive GSA for the portion of the East Bay Plain (EBP) Subbasin (California Department of Water Resources (DWR) groundwater basin number 2-009.04) underlying EBMUD's service area in 2016 (**Appendix 1.A**) and the City of Hayward (Hayward) became an exclusive GSA for the portion of the EBP Subbasin underling Hayward's jurisdictional area in 2017 (**Appendix 1.B**). EBMUD and Hayward prepared this GSP under a cooperating agreement dated June 25, 2018 and amended on October 27, 2020 (**Appendix 1.C**).

1.1 Purpose of the Groundwater Sustainability Plan

The purpose of this GSP is to comply with DWR's requirement that the EBP Subbasin's GSAs (EBMUD and Hayward) prepare, adopt, and implement a GSP "consistent with the objective that a basin be sustainably managed within 20 years of Plan implementation without adversely affecting the ability of an adjacent basin to implement its Plan or achieve and maintain its sustainability goal over the planning and implementation horizon" (California Code of Regulations [CCR] Title 23, Section 350.4[f]).

This GSP also represents the coordinated plan for two GSAs (EBMUD and Hayward) that together represent the entirety of the EBP Subbasin. EBMUD and Hayward will satisfy SGMA requirements for the EBP Subbasin with this single GSP that covers the entire Subbasin.

1.2 Sustainability Goal

The sustainability goal for the EBP Subbasin is to manage and protect the Subbasin in a manner that avoids the six undesirable results listed below, while continuing to collect and analyze data to support science-based decision making to evaluate new opportunities for sustainable groundwater beneficial uses:

- Chronic lowering of groundwater levels, indicating a significant and unreasonable depletion of supply.
- Significant and unreasonable reduction of groundwater storage.
- Significant and unreasonable seawater intrusion.
- Significant and unreasonable degraded water quality.
- Significant and unreasonable land subsidence.
- Depletions of interconnected surface water and groundwater that have significant and unreasonable reductions in beneficial uses of surface water, including beneficial use by ecosystems that depend on groundwater.

As mandated under 23 CCR Section 354.24, the GSP must include information used to establish this goal and identify the measures and actions that will be implemented to achieve this goal. Detailed descriptions of information used, measures identified, and actions selected are in Chapter 2, 3, and 4. **Table 1-1** lists the regulations with the corresponding sections of this GSP to facilitate review.

Table 1-1. Sustainability Goal Development and Associated Groundwater Sustainability Plan Sections

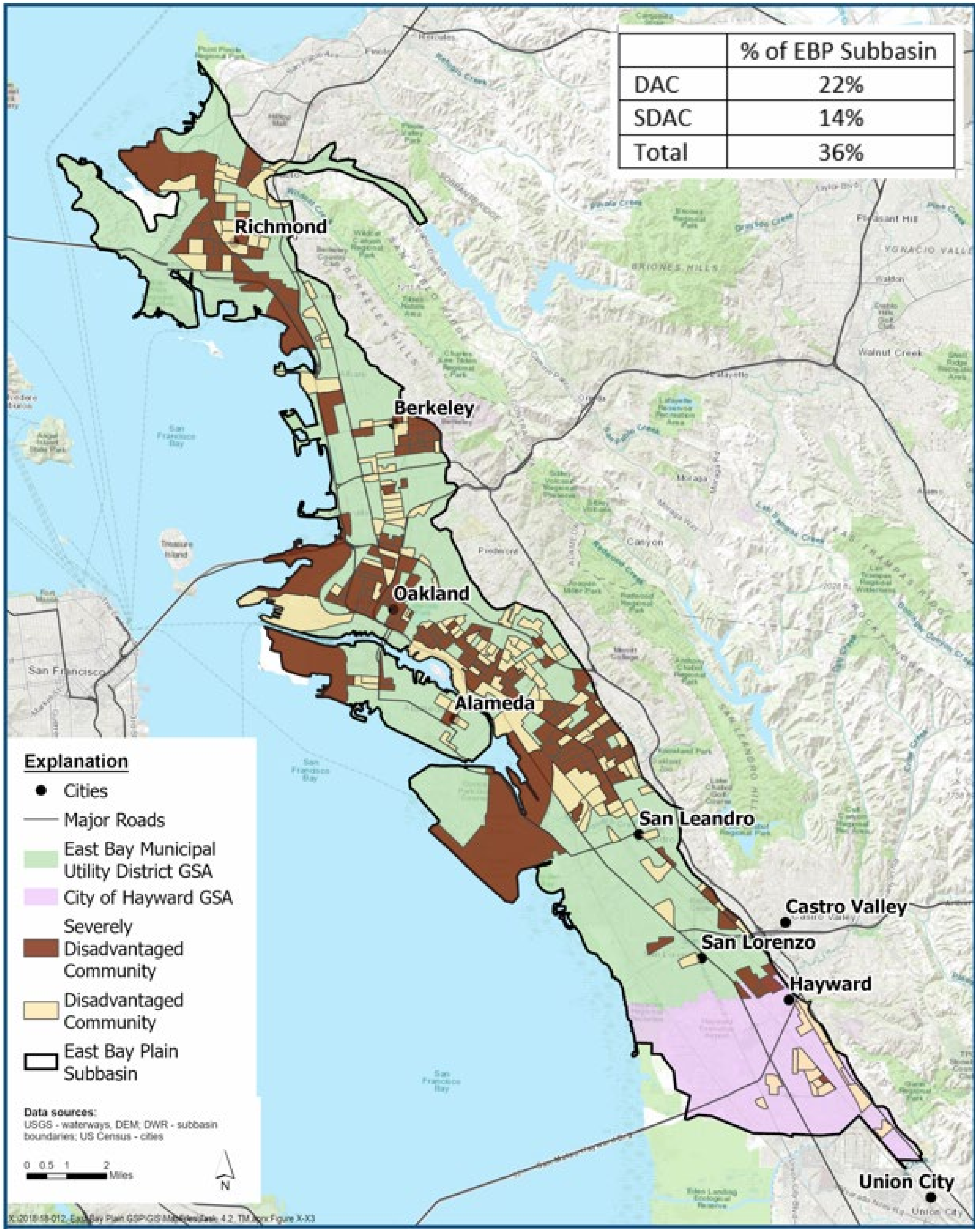
Sustainability Goal Development	23 CCR Section	Requirement	GSP Section(s)
Context, basis for goal	354.12	Basin Setting	2.2
	354.14	Hydrogeologic Conceptual Model	2.2.1
	354.16	Groundwater Conditions	2.2.2
	354.18	Water Budget	2.2.3
	354.20	Management Areas	2.2.4
Establishment of goal	354.24	Sustainability Goal	3.1
	354.26	Undesirable Results	3.2
	354.28	Minimum Thresholds	3.3
	354.30	Measurable Objectives	3.4
Measures and actions to achieve goal	354.32	Introduction to Monitoring Networks	3.5
	354.34	Monitoring Network	3.5.1, 3.5.2
	354.36	Representative Monitoring	3.5.3
	354.38	Review and Evaluation of Monitoring Network	3.5.4
	354.44	Projects and Management Actions	4

1.3 Agency Information

(California Code of Regulations [CCR] Title 23, Section 354.6)

As per SGMA, EBMUD and Hayward have formed GSAs covering the full extent of the EBP Subbasin**.** **Figure 1-1** delineates the areas managed exclusively by each GSA, along with the location of disadvantaged and severely disadvantaged communities (DACs and SDACs) identified with DWR's DAC Mapping Tool and United States census data.

Information on each GSA's organization and management structure, jurisdictional area, land use, and water supplies is provided below and summarized in **Table 1-2**. Information provided by each GSA to DWR pursuant to Water Code Section 10723.8 is included in **Appendix 1**. **Table 1-3** provides contact information for each GSA.



	% of EBP Subbasin
DAC	22%
SDAC	14%
Total	36%

Figure 1-1. Map of East Bay Plain Subbasin GSAs and Disadvantaged Communities

Table 1-2. Summary of East Bay Plain Subbasin Groundwater Sustainability Agencies

GSA Name	Agency Abbreviation	GSA Area (acres)	Primary Sources of Water Supply
East Bay Municipal Utility District GSA	EBMUD GSA	61,000	Mokelumne River Reservoirs, East Bay Hills Reservoirs
City of Hayward GSA	Hayward GSA	10,300	SFPUC Hetch Hetchy Reservoir

Table 1-3. Contact Information for East Bay Plain Subbasin Groundwater Sustainability Agencies

Groundwater Sustainability Agency	Contact Person	Contact Title	Mailing Address	Phone Number	Email Address
East Bay Municipal Utility District	Brad Ledesma	Senior Engineer, East Bay Municipal Utility District	375 Eleventh Street, Oakland, CA 94607	(510) 287-0668	bradley.ledesma@ebmud.com
City of Hayward	Cheryl Muñoz	Water Resources Manager, City of Hayward Public Works & Utilities Department	777 B Street, Hayward, CA 94541	(510) 583-4700	cheryl.munoz@ hayward-ca.gov

1.3.1 Organization and Management Structure of the Groundwater Sustainability Agencies

This section discusses each GSA's formation date, management structure, typical land use, and water supply availability. This GSP has been developed through joint coordination between the two GSAs, as described below.

1.3.1.1 East Bay Municipal Utility District Groundwater Sustainability Agency

The EBMUD GSA, formed on November 28, 2016, manages approximately 61,000 acres of the EBP Subbasin, which represents only a portion of EBMUD's service area. The EBMUD GSA represents the largest jurisdictional area in the Subbasin (**Figure 1-1**). The EBMUD GSA incorporates several cities that fall within the EBMUD service area, including San Pablo, Richmond, El Cerrito, Albany, Berkeley, Emeryville, Oakland, San Leandro, and San Lorenzo. As of 2015, most of the area within this GSA is designated as urban land use (94%). The remaining area is primarily native vegetation (4%), with some water surface and barren land (1% each).

As of 2020, municipal water use in the EBMUD GSA area was estimated to be approximately 92,400 acre-feet per year (AFY) using information available from EBMUD's 2050 Demand Study (Hazen, 2020). The primary source of water for the EBMUD GSA is surface water from Pardee Reservoir (**Figure 1-2**) and the secondary source is local runoff from the East Bay area watersheds within EBMUD's service area. Private groundwater wells are used for a portion of irrigation of large parcels, domestic irrigation, and industrial water uses to meet the remaining water demands in the EBMUD GSA.

The board of directors for the EBMUD GSA is the EBMUD Board of Directors (Board). Meetings of the EBMUD GSA Board of Directors are held concurrently with regular EBMUD Board meetings, which are typically scheduled on the second and fourth Tuesdays of each month at 1:15 p.m. These meetings are open to the public and are held at the EBMUD offices (375 Eleventh Street, Oakland, CA 94607), or via Zoom during the COVID-19 pandemic. Meeting agendas and materials are available for public viewing on the EBMUD website (www.ebmud.com).

Figure 1-2. Pardee Reservoir

1.3.1.2 City of Hayward Groundwater Sustainability Agency

The Hayward GSA, formed on June 6, 2017, manages approximately 10,300 acres of the EBP Subbasin (**Figures 1-1 and 1-3**). As of 2015, most of this area consists of urban land (97%). The remaining area is primarily native vegetation (2%), with some water surface (1%).

In 2017, municipal water use in the Hayward GSA area was estimated to be approximately 7,800 AFY based on the portion of the City of Hayward that occurs within the Hayward GSA. The Hayward GSA receives surface water supplies from outside the EBP Subbasin to support municipal water uses. The source of surface water imported by Hayward is the San Francisco Public Utilities Commission's Regional Water System. Hayward also maintains five emergency water supply wells (three within EBP Subbasin and two within Niles Cone Subbasin) for emergency use purposes (currently permitted to pump up to 15 days per year with not more than five consecutive days of pumping). Private groundwater wells are used for a portion of irrigation water uses to meet the remaining water demands in the Hayward GSA area.

The board of directors for the Hayward GSA is the Hayward City Council. Meetings of the Hayward GSA Board of Directors are held concurrently with regular Hayward City Council meetings, which are typically scheduled on the first, third, and fourth Tuesdays of each month at 7:00 p.m. These meetings are open to the public and are held at Hayward City Hall (777 B Street, Hayward, CA 94541), or via Zoom during the COVID-19 pandemic. Meeting agendas and materials are available for public viewing on the City of Hayward website (www.hayward-ca.gov).

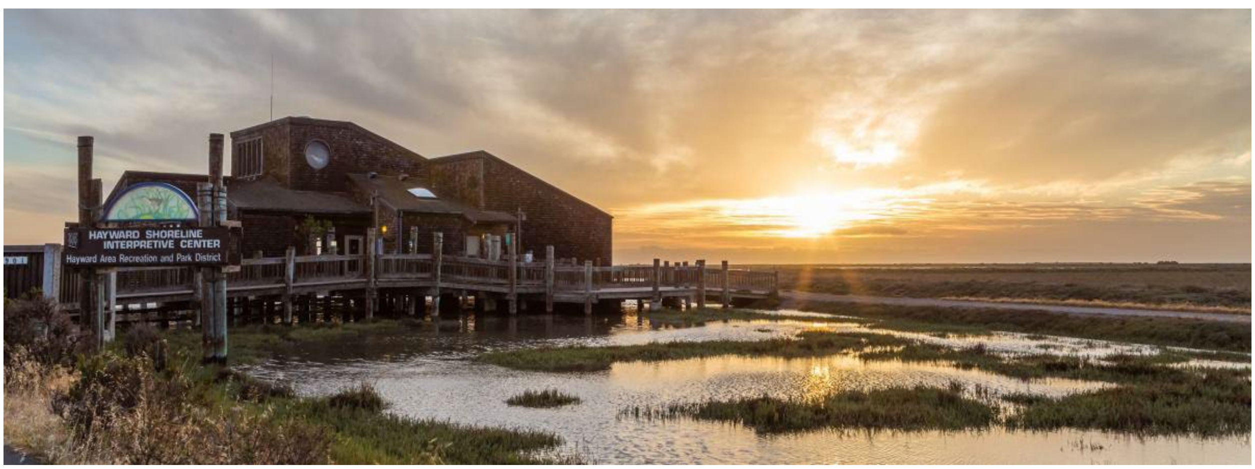


Figure 1-3. Hayward Shoreline—City of Hayward Groundwater Sustainability Agency
(Source: https://www.hayward-ca.gov/shoreline-master-plan)

1.3.1.3 East Bay Plain Subbasin GSP Technical Advisory Committee (TAC)

The GSAs for the EBP Subbasin have jointly formed the EBP Subbasin GSP Technical Advisory Committee (TAC) in accordance with the Stakeholder Communication and Engagement Plan. The opportunity to join the TAC was advertised at a communication and engagement meeting held on February 27, 2018; each member was required to complete an application. The TAC was finalized in October 2019 and includes one or more representatives from each of the following entities: California State University - East Bay, the Cities of

Richmond, Berkeley, San Pablo, and Alameda; Lawrence Berkeley National Laboratory; the Alameda County Department of Public Works; the San Francisco Bay Regional Water Quality Control Board; Contra Costa County; Sierra Club; United States Geological Survey; and Grolutions Horticultural Landscaping.

The TAC operates under a charter and serves as an advisory body for guiding the EBP Subbasin GSAs through development of the GSP. In this role, the TAC analyzed GSP components, including modeling studies, and made recommendations to the Technical Team comprised of GSA staff members. The TAC provided data and information for the GSP; reviewed and provided comments on draft deliverables during GSP development; and provided input on sustainable management criteria, the monitoring network, projects and management actions, and implementation of the GSP. The Technical Team addressed these comments and considered TAC recommendations in its decision-making process involving the GSA Steering Committee (comprised of senior GSA staff members). TAC meetings were held periodically during the GSP planning stages and following the development of draft deliverables.

1.3.1.4 East Bay Plain Subbasin GSP Interbasin Working Group (IWG)

The GSAs for the EBP Subbasin participate in an Interbasin Working Group with representatives from neighboring subbasins. The Interbasin Working Group, which was formed in April 2019, served as a forum for discussing issues outlined in the GSP regulations related to potential impacts on neighboring subbasins from the development of GSPs (and alternatives to GSPs). The aim of the Interbasin Working Group was to allow for:

- Exchange and discuss information and data for each subbasin;
- Provide updates for each subbasin regarding SGMA compliance;
- Develop an understanding of potential concerns among IWG members related to development of GSPs/alternatives in neighboring subbasins; and
- Discuss technical aspects of hydrogeology at the subbasin boundaries.

The Interbasin Working Group's members include one or more representatives from the following entities: EBMUD, Hayward, and Alameda County Water District. Meetings were held quarterly during development of this GSP for the EBP Subbasin.

1.3.1.5 Disadvantaged Communities

Disadvantaged communities comprise a large percentage of the total land area within the EBP Subbasin. Disadvantaged communities (DAC) occur over a land area equal to 14% and severely disadvantaged communities (SDAC) cover a land area total of 22.3%, together comprising 36.2% of the overall land area within the EBP Subbasin. The distribution of DAC and SDAC areas within the EBP Subbasin shows these areas are relatively well distributed between Richmond in the north and the northern portion of San Leandro in the south, with more limited DAC and SDAC areas south of central San Leandro (**Figure 1-1**). The DAC and SDAC areas are located within EBMUD and Hayward service areas with access to imported surface water supply. EBMUD also offers a Customer Assistance Program to help pay a portion of the water bill for qualified low-income residential customers and eligible homeless shelters. The EBP Subbasin GSAs are not aware of any DAC or SDAC who are solely or primarily dependent on groundwater from the EBP Subbasin for a drinking water supply.

1.3.2 Legal Authority of the Groundwater Sustainability Agencies

The GSAs involved in development of this GSP have the legal authority to prepare a GSP and are pursuing the financial resources necessary to implement the Plan. EBMUD and Hayward are local agencies overlying the EBP Subbasin as defined in SGMA and are therefore eligible to serve as separate GSAs within the EBP Subbasin (Water Code Section 10723[a]). Pursuant to Water Code Section 10724(a), neither Alameda County nor Contra Costa County serves as a GSA, because all areas within the EBP Subbasin are covered by either EBMUD or Hayward.

EBMUD and Hayward each held public hearings regarding the establishment of a GSA in accordance with Water Code Section 10723(b). Public notice for these hearings was provided in accordance with Government Code Section 6066. After holding these hearings, the governing body of each agency adopted a resolution to establish the associated GSA. On November 6, 2017, EBMUD and Hayward filed a notification letter with DWR of their intent to jointly develop a single GSP for the EBP Subbasin.

1.3.3 Estimated Cost of Groundwater Sustainability Plan Implementation

The estimated annual costs of GSP implementation for project management and management actions for the two GSAs included under this GSP are approximately $3.2 million dollars over the initial five years of the GSP Implementation Period (**Table 1-4**). The breakdown between GSAs is approximately $2,650,000 for EBMUD and $550,000 for Hayward and include both annual operating costs and capital costs. Operating costs of approximately $2.6 million dollars over five years include the costs of GSA project management, groundwater monitoring, surface water monitoring, and reporting. The total capital costs of new facilities (e.g., monitoring wells, stream gauges) to help fill data gaps related to various management actions are estimated to be approximately $600,000.

Table 1-4. Summary of East Bay Plain Subbasin GSP Implementation Costs for 2022 Through 2026

Groundwater Sustainability Agency	Management Actions (Chapter 4)	GSA Project Management (Chapter 5)	Combined GSA Project Management and Actions	Projects (Chapter 4)	Comments
East Bay Municipal Utility District	$2,036,750	$606,000	$2,642,750	$30,000 to $200,000/year	EBMUD Management Actions costs include $1.46 million in operating costs and $0.58 million in capital costs. Hayward has no capital costs.
City of Hayward	$375,250	$171,000	$546,250	$60,000 to $500,000/year	
Total	$2,429,000	$777,000	$3,206,000	$90,000 to $700,000/year	

Notes: Costs listed are totals for five years, except as noted.

While there are no new capital costs for planned GSA projects, project costs for operation and maintenance are expected to range between $30,000 to $200,000 per year for EBMUD and $60,000 to

$500,000 per year for Hayward. These annual project costs are a function of whether or not the project wells are operating in a given year. Individually, the GSAs manage their own financing, staffing, contracting, and daily operations related to GSP implementation, and the approach to meeting the GSP implementation costs will vary between GSAs. Additional detail on costs are provided in Chapters 4 and 5 of this GSP.

1.4 Organization of This Document

The two EBP Subbasin GSAs developed this GSP by retaining a team of consultants led by Luhdorff & Scalmanini Consulting Engineers (LSCE). The consulting team consists of Luhdorff & Scalmanini Consulting Engineers; Geosyntec; Brown and Caldwell; Environmental Science Associates; Dr. Jean Moran; and Farallon Geographics.

This GSP is organized in accordance with CCR Title 23 Section 354 as follows:

- **Chapter 1:** Introduces the EBP Subbasin GSAs and the development of this GSP.
- **Chapter 2:** Provides a detailed summary of the Plan area and the basin setting, including the hydrogeologic conceptual model, current and historical groundwater conditions, water budgets, and management areas (as applicable).
- **Chapter 3:** Establishes the EBP Subbasin's sustainability goal, to be achieved through coordination among all GSAs in the Subbasin. This section also establishes measurable objectives, minimum thresholds, and undesirable results for each sustainability indicator, then describes the proposed monitoring network to track and verify progress toward the EBP Subbasin's sustainability goal.
- **Chapter 4:** Describes planned projects and management actions for achieving the EBP Subbasin's sustainability goal.
- **Chapter 5:** Describes the Plan's implementation strategy, costs, and schedule.

To facilitate DWR review and assure compliance with all applicable GSP regulations, **Table 1-5** cross-references the GSP regulations to applicable GSP sections. In addition, the terminology in this GSP is aligned with SGMA definitions provided in Water Code Section 10721 and in CCR Title 23 Section 351. These definitions are provided as **Appendix 1.E**. of this GSP.

Table 1-5. Groundwater Sustainability Plan Requirements in the California Code of Regulations and Associated Plan Sections

Regulations (CCR Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5—Groundwater Sustainability Plans, Plan Contents)			Requirement	Groundwater Sustainability Plan Section(s)
Subarticle	Section	Paragraph(s)		
1. Administrative Information	4. General Information	(a)	Executive summary	Executive Summary
		(b)	List of references and technical studies	1.5, 2.3, 3.6, 4.3, 5.8, Appendices 2 and 6
	6. Agency Information	–	Agency information pursuant to California Water Code Section 10723.8, along with:	Appendix 1
		(a)	Agency name and mailing address	1.3
		(b)	Agency organization and management structure, persons with management authority for plan implementation	1.3.1
		(c)	Plan manager name and contact information	1.3
		(d)	Legal authority of agency	1.3.2
		(e)	Estimate of plan implementation costs and description of how agency plans to meet costs	1.3.3, 5.2, 5.3
	8. Description of Plan Area	(a)	Maps of plan area	2.1.1
		(b)	Written description of plan area	2.1.1
		(c)–(d)	Identification of existing water resource monitoring and management programs, and description of any such planned programs	2.1.2
		(e)	Description of conjunctive use programs	2.1.2
		(f)	Description of the land use elements or topic categories	2.1.3
		(g)	Description of additional plan elements (Water Code Section 10727.4)	2.1.4
	10. Notice and Communication	(a)	Description of the beneficial uses and users of groundwater in the subbasin	2.1.5
		(b)	List of public meetings	2.1.5
		(c)	Comments and responses regarding the plan	2.1.5
		(d)	Description of communication procedures	2.1.5

Table 1-5. Groundwater Sustainability Plan Requirements in the California Code of Regulations and Associated Plan Sections

Regulations (CCR Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5—Groundwater Sustainability Plans, Plan Contents)			Requirement	Groundwater Sustainability Plan Section(s)
Subarticle	Section	Paragraph(s)		
2. Basin Setting	12. Introduction to Basin Setting	–	Information about the basin setting (physical setting, characteristics, current conditions, data gaps, uncertainty)	2.2
	14. Hydrogeologic Conceptual Model	(a)	Description of the subbasin's hydrogeologic conceptual model	2.2.1
		(b)	Summary of regional geologic and structural setting, subbasin boundaries, geologic features, and principal aquifers and aquitards	2.2.1
		(c)	Cross sections depicting major stratigraphic and structural features	2.2.1
		(d)	Maps of the subbasin's physical characteristics	2.2.1
	16. Groundwater Conditions	(a)–(g)	Description of current and historical groundwater conditions: 1. Groundwater elevation 2. Change in storage 3. Seawater intrusion 4. Groundwater quality issues 5. Land subsidence 6. Interconnected surface water systems 7. Groundwater dependent ecosystems	2.2.2
	17. Water Budget	(a)	Water budget, providing total annual volume of groundwater and surface water entering and leaving the subbasin, including historical, current, and projected water budget conditions, and change in storage	2.2.3
		(b)–(f)	Development of a numerical groundwater and surface water model to quantify current, historical, and projected: 1. Total surface water entering and leaving, by water source type 2. Inflow to the groundwater system, by water source type 3. Outflows from the groundwater system, by water use sector	2.2.3

Table 1-5. Groundwater Sustainability Plan Requirements in the California Code of Regulations and Associated Plan Sections

Regulations (CCR Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5—Groundwater Sustainability Plans, Plan Contents)			Requirement	Groundwater Sustainability Plan Section(s)
Subarticle	Section	Paragraph(s)		
			4. Change in groundwater storage 5. Overdraft over base period 6. Annual supply, demand, and change in storage, by water year type 7. Estimated sustainable yield	
	20. Management Areas	(a)	Description of management areas	2.2.4
		(b)	Description of purpose, minimum thresholds, measurable objectives, monitoring, and analysis	2.2.4
		(c)	Maps and supplemental information	2.2.4
3. Sustainable Management Criteria	22. Introduction to Sustainable Management Criteria	–	Criteria by which an agency defines conditions that constitute sustainable groundwater management for the subbasin	3
	24. Sustainability Goal	–	Description of the subbasin's sustainability goal, including basin setting information used to establish the goal, sustainability indicators, a discussion of measures to ensure that the subbasin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved and maintained	3.1
	26. Undesirable Results	(a)	Processes and criteria used to define undesirable results applicable to the subbasin	3.2
		(b)-(c)	Description of undesirable results, including causes of groundwater conditions and potential effects on beneficial uses and groundwater users	3.2
	28. Minimum Thresholds	(a)	Establishment of minimum thresholds to quantify groundwater conditions for each applicable sustainability indicator	3.3
		(b)–(d)	Description of information and criteria to select, establish, justify, and quantitatively measure minimum thresholds	3.3

Table 1-5. Groundwater Sustainability Plan Requirements in the California Code of Regulations and Associated Plan Sections

Regulations (CCR Title 23, Division 2, Chapter 1.5, Subchapter 2, Article 5—Groundwater Sustainability Plans, Plan Contents)			Requirement	Groundwater Sustainability Plan Section(s)
Subarticle	Section	Paragraph(s)		
	30. Measurable Objectives	(a)–(g)	Establishment of measurable objectives, including interim milestones in increments of 5 years, to achieve and maintain the subbasin's sustainability goal	3.4
4. Monitoring Networks	32. Introduction to Monitoring Networks	–	Description of monitoring network, monitoring objectives, monitoring protocols, and data reporting	3.5
	34. Monitoring Network	(a), (e)–(g)	Development of monitoring network to yield representative information about groundwater conditions	3.5.1
		(b)–(d)	Monitoring network objectives	3.5.1
		(h)	Maps and tables of monitoring sites	3.5.1
		(i)	Monitoring protocols	3.5.2
	36. Representative Monitoring	(a)–(c)	Designation of representative monitoring sites	3.5.3
	38. Assessment and Improvement of Monitoring Network	(a)–(d)	Evaluation of monitoring network, including uncertainty, data gaps, and efforts to fill data gaps	3.5.4
		(e)	Adjustment of monitoring frequency and density to assess management action effectiveness	3.5.4
	40. Reporting Monitoring Data to the Department	(f)	Copy of monitoring data from data management system	
5. Projects and Management Actions	44. Projects and Management Actions	(a)–(c)	Description of projects and management actions to achieve and maintain the subbasin's sustainability goal	4

1.5 References

California Department of Water Resources (DWR). 2003. *California's Groundwater.* Bulletin 118. Update 2003.

DWR. 2016. *California's Groundwater, Interim*. Bulletin 118. Update 2016.

Hazen. 2020. *East Bay Municipal Utility District, 2050 Demand Study*. Prepared for EBMUD.

JANUARY 2022

EAST BAY PLAIN SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN
CHAPTER 2—PLAN AREA AND BASIN SETTING

PREPARED FOR

EAST BAY MUNICIPAL UTILITY DISTRICT GSA AND
CITY OF HAYWARD GSA

PREPARED BY

LUHDORFF & SCALMANINI CONSULTING ENGINEERS
GEOSYNTEC CONSULTANTS
BROWN AND CALDWELL
ENVIRONMENTAL SCIENCE ASSOCIATES
DR. JEAN MORAN
FARALLON GEOGRAPHICS

2. PLAN AREA AND BASIN SETTING

2.1. Description of the Plan Area

(California Code of Regulations [CCR] Title 23, Section 354.8)

The Plan Area for the East Bay Plain (EBP) Groundwater Sustainability Plan (GSP) is defined as the EBP Subbasin (2-009.04[1]), which is part of the Santa Clara Valley Groundwater Basin as described in California Department of Water Resources (DWR) Bulletin 118 (DWR, 2016), with boundary updates approved in 2016. The lateral extent of the EBP Subbasin is defined by the subbasin boundaries provided in Bulletin 118 (DWR, 2016). The EBP Subbasin is bounded in the north and west by San Francisco Bay, in the east by the East Bay Hills, and in the south by the Niles Cone Subbasin (**Figure 1-1**). As documented in **Appendices 2.A.a and 2.A.b**, the hydrogeologic conceptual model (HCM) describes detailed hydrogeologic and hydrologic features of the Subbasin. The plan area spans across Contra Costa and Alameda counties including City of Alameda, City of Albany, City of Berkeley, City of El Cerrito, City of Emeryville, City of Hayward, City of Oakland (and a small portion of the City of Piedmont), City of Richmond, City of San Leandro, City of San Pablo, and San Lorenzo (an unincorporated community in Alameda County). The vertical boundaries of the Subbasin are the land surface (upper boundary) and the definable bottom of the basin (lower boundary). The Subbasin's definable bottom was established as part of the development of the hydrogeologic conceptual model (HCM) using depth to bedrock and delineations of major aquifers/aquitards, see GSP Section 2.2.1.2 for more detail. **Appendices 2.A.a** and **2.A.b** contain the technical memorandums (TMs) that document the development of the HCM.

2.1.1. Summary of Jurisdictional Areas and Other Features

(23 CCR Section 354.8[b])

As identified in Section 1.3, two exclusive groundwater sustainability agencies (GSAs) cover the EBP Subbasin: the East Bay Municipal Utility District (EBMUD) GSA and the City of Hayward (Hayward) GSA. These two GSAs are cooperating to develop a single GSP for the EBP Subbasin. **Table 1-2** and **Figure 1-1** delineate the areas managed exclusively by each GSA. No area in the Subbasin is covered by an Alternative (to a GSP), and the Subbasin is not adjudicated.

GSP regulations require that federal (including tribal) and state lands within the EBP Subbasin be identified (**Figure 2-1**). The federal government recognizes the Lytton Band of Pomo Native Americans, which owns a casino in San Pablo located immediately west of San Pablo Avenue at its intersection with San Pablo Dam Road (U.S. Department of the Interior, Bureau of Indian Affairs, Office of Trust Services, 2016). The Lytton Casino property southern border aligns with Wildcat Creek (Google Maps, 2021). The land use diagram in the City of Alameda General Plan shows three areas of Federal Facility Overlay, which is described as lands currently owned by the Federal Government for military use. Each area has an underlying land use designation that would apply if the land were conveyed out of federal ownership in the future. The three areas are a portion of the former Alameda Naval Air Station in northwest Alameda (planned for wildlife habitat), Coast Guard Island in Oakland Estuary (planned for mixed use), and a small parcel on the southeast coast of Alameda Island adjacent to Oakland Estuary (planned for mixed use).

[1] Subbasin 2-009.04 is the formal California groundwater subbasin number assigned by DWR for the EBP Subbasin.

Other federal (Department of Defense) lands shown on **Figure 2-1** include in the Port of Oakland and Richmond areas.

The EBP Subbasin lies within the jurisdictional boundaries of Alameda and Contra Costa Counties. Unincorporated areas are covered by the respective county general plans (GPs), and major portions of the Subbasin within the boundaries of the two GSAs are covered by various city GPs.

Figure 2-2 depicts land use in the EBP Subbasin, which is classified primarily as urban (94%), with the remaining area classified as native vegetation, barren land, and water surface. Urban land uses include commercial, industrial, and residential. The vast majority of the Subbasin's land area is classified as medium- to high-intensity urban development.

Figure 2-3 and **Figure 2-4,** respectively, show the densities of domestic and irrigation wells per section[2] within the EBP Subbasin determined from a well completion report (WCR) database provided by DWR. The densities on **Figures 2-3** and **2-4** may not reflect the total number of existing or active wells in the Subbasin because not all wells may have been reported to DWR and may also reflect wells in DWR's database that are no longer active. In addition, it appears that residential irrigation wells have been categorized as either domestic or irrigation as described in the WCRs. Therefore, the DWR database was screened to distinguish between domestic irrigation wells (subsequently classified as domestic wells in **Figure 2-3**) and irrigation wells for larger parcels (included in **Figure 2-4**) based on well diameter.

The highest concentrations of both domestic and irrigation wells are located in the southern EBP Subbasin between San Leandro and Hayward. Higher concentrations of domestic wells are identified in San Leandro, San Lorenzo and Hayward area. Some domestic wells are also present on Alameda Island and in Oakland and Richmond, with a notable concentration of domestic wells in portions of Alameda Island (**Figure 2-3**). Larger diameter (greater than 6 inches) irrigation wells are most prevalent from San Leandro to Hayward, with additional irrigation wells reported on Alameda Island, in north Oakland/Berkeley, and in Richmond/San Pablo (**Figure 2-4**).

The map of industrial well locations shows a widespread distribution from southern Richmond to Hayward (**Figure 2-5**), although concentrations of industrial wells are greater between Oakland and Hayward than farther north. The sections indicating well locations shown on the public water supply map (**Figure 2-6**) correspond to the EBMUD and Hayward well locations.

2.1.2. Water Resources Monitoring and Management Programs
(23 CCR Sections 354.8[c], 354.8[d], and 354.8[e])

Water planning documents, along with existing surface water and groundwater monitoring and management programs within the EBP Subbasin are identified below.

[2] The term "section" here refers to the Public Land Survey System's use of townships, ranges, and sections to designate locations in California, and is commonly used to specify specific well locations.

2.1.2.1. Water Planning Documents

As stewards of water resources within their jurisdictions, the EBP Subbasin GSAs and corresponding local agencies have prepared and adopted the water planning documents presented in **Table 2-1**. Information in these plans regarding GSA surface water and groundwater supplies, distribution infrastructure, and monitoring programs has contributed to the development of this GSP. Summaries of key water planning documents are provided below.

Table 2-1. Water Planning Documents

Category	Document
Regional Water Plans	• Bay Area Integrated Regional Water Management Plan (approved in 2006, updated in 2019) • Bay Area Regional Reliability Drought Contingency Plan (2018)
Local Management Plans	• EBMUD Water Supply Management Program 2040 Plan (2012)
Urban Water Management Plans	• EBMUD Urban Water Management Plan 2020 (2021) • City of Hayward 2020 Urban Water Management Plan (2021)
Groundwater Management Plans	• South East Bay Plain Basin Groundwater Management Plan (2013)
General Plans	• Alameda County (1956–2015; 2010) • Contra Costa County (2005) • City of San Pablo (2011) • City of Richmond (2010) • City of El Cerrito (1999) • City of Albany (2016) • City of Berkeley (2001) • City of Emeryville (2009) • City of Oakland (1996–1998) • City of Alameda (2021) • City of San Leandro (2016) • City of Hayward (2014)
Other Plans	• EBMUD Strategic Plan (July 2020) • EBMUD 2050 Demand Study (2020) • East Bay Watershed Master Plan (2018) • City of Berkeley 2011 Watershed Management Plan (2011)

Bay Area Integrated Regional Water Management Plan

This plan is a collaborative effort to improve regional coordination for water resources management among various agencies in the nine San Francisco Bay Area counties that have formed the Regional Water Management Group, as well as other interested parties. These agencies include two currently organized as GSAs in the EBP Subbasin (EBMUD and Hayward). The plan establishes regional water management goals and serves as a basis for pursuing funding to accomplish these goals.

South East Bay Plain Basin Groundwater Management Plan (2013)

This plan provides a framework for regional groundwater management that covers the southern portion of the EBP Subbasin from approximately 29th Avenue in the Fruitvale neighborhood of southern Oakland to the EBP Subbasin's pre-2016 southern boundary with the Niles Cone Subbasin in Hayward. The objectives of the plan are to preserve basin storage by maintaining groundwater elevations to ensure sustainable groundwater use; to maintain or improve groundwater quality to maintain basin sustainability; and to manage potential inelastic subsidence due to groundwater pumping. These objectives align with four of the six sustainability indicators under the Sustainable Groundwater Management Act of 2014 (SGMA). The major groundwater management plan (GMP) components to achieve the objectives are stakeholder/public involvement, a monitoring program, data management and analysis, groundwater resource protection, and groundwater sustainability. The GMP includes the seven mandatory and 12 voluntary components of GMPs listed in California Water Code (CWC) Section 10750, which include monitoring and management of changes in surface water flows caused by pumping and control of saline water intrusion (the two remaining sustainability indicators under SGMA). Thus, before SGMA was enacted, the GMP provided for evaluation and consideration of the six sustainability indicators for a portion of the EBP Subbasin.

EBMUD 2020 Urban Water Management Plan

The California Water Code requires urban water suppliers within the state to prepare and adopt Urban Water Management Plans (UWMPs) for submission to the California Department of Water Resources (DWR). The UWMPs, which are required to be filed every five years, must satisfy the requirements of the Urban Water Management Planning Act (UWMP Act) of 1983, including amendments that have been made to the Act and other applicable regulations. The EBMUD Board of Directors adopted the UWMP 2020 and Water Shortage Contingency Plan (WSCP) - Attachment 1 to the UWMP on June 22, 2021, which was subsequently submitted to the California Department of Water Resources.

The primary purpose of the UWMP is to promote efficient use of available water supplies and it is a long-term resource planning document in which urban water suppliers evaluate their supplies and demands to ensure that adequate water supplies are available to meet existing and future water needs. The associated Water Shortage Contingency Plan (WSCP) provides a framework to help address water shortages that may occur, such as droughts, earthquakes that damage infrastructure, floods in the Delta that impact aqueducts, power outages, fires, and other emergencies.

EBMUD's primary source of water supply is from the Mokelumne River for which EBMUD has water right permits and licenses, subject to the availability of runoff and other conditions that could restrict the ability to receive its full entitlement (i.e., use by senior water right holders, curtailments by SWRCB, downstream obligations to protect public trust resources). EBMUD holds a water service contract with the United

States Bureau of Reclamation to receive water from the Central Valley Project (CVP) through the Freeport Regional Water Facility in dry years only.

Supply and demand assessment from EBMUD's WSCP shows that during prolonged severe droughts, the Mokelumne River supply cannot meet EBMUD's projected customer demands. The CVP supply helps offset some of the water need; however, it is not sufficient in the long-term. Consequently, EBMUD's long-term water supply goals include improving its water supply reliability and continuing to diversify its water supply portfolio. EBMUD will continue to review and evaluate using local groundwater from the EBP Subbasin is as part of diversifying its water supply portfolio.

Hayward 2020 Urban Water Management Plan

Hayward recently completed their Final 2020 UWMP. Hayward currently receives 100 percent of its potable water supply from purchases of imported surface water from San Francisco Public Utilities Commission (SFPUC). SFPUC water supply sources include: Tuolumne River/Hetch Hetchy watershed (via Hetch Hetchy Reservoir, Lake Lloyd, and Lake Eleanor), with Don Pedro Reservoir acting as a water bank integrated into system operations, and local runoff in Alameda County into San Antonio and Calaveras Reservoirs with San Antoinio Reservoir also receiving water from the Hetch Hetchy system.

Hayward had a total of 36,300 connections in Fiscal Year 2020 and supplied a water volume of 5,259 million gallons in 2002; comprised of 5,082 MG from SFPUC and 177 MG of recycled water. Hayward water demands have declined from a high of nearly 20 MGD in the early 2000s to less than 15 MGD since 2015. Total water use is approximately 55% single-family and multi-family residential, with the remainder comprised of commercial, industrial, irrigation, institutional, and other uses. The future water demand forecast through 2040 indicates increasing water demands to 6,862 MG in 2030 and 7,671 MG in 2040. The analysis of available water supplies compared to future water demands indicates there will be sufficient water for normal years through 2045, but shortages can be expected in single dry and multiple dry years in the future.

The Hayward WSCP is a strategic planning document to prepare for and respond to water shortages. The Hayward WSCP describes Hayward's actions to implement and enforce regulations/restrictions in a water shortage emergency, which are consistent with the plans/actions of its water wholesaler (SFPUC). Hayward dry year potable water supplies are from its SFPUC Regional Water System (RWS) allotment. Recycled water provides a small component of overall water supplies in terms of non-potable water. Hayward's emergency groundwater supply wells are currently intended for use only in emergencies involving interruption of imported surface water supply infrastructure. Hayward relies on SFPUC's portfolio of water supply programs that include development of additional water transfers, storage and exchange agreements to provide supply augmentation.

Hayward will conduct an annual water supply and demand assessment by July 1 of each year and submit an annual water shortage assessment stating anticipate shortage and required shortage response actions. Hayward has designated six standard water shortage levels (0 through 6) that reflect water shortages (relative to normal demand) of 0% for Shortage Level 0 to greater than 50% for Shortage Level 6 with shortage increments of 10% between Shortage Levels of 0 and 6. The WSCP outlines a number of demand reduction actions at various shortage levels; for example, a Shortage Level of 3 (21 to 30% water shortage) requires that irrigation be limited to two days per week when using potable water, among other actions.

2.1.2.2. Surface Water Monitoring and Management Programs

Available data and spatial information from the monitoring programs summarized in **Table 2-2** and described below were incorporated into this GSP to develop water budget and groundwater modeling, in compliance with 23 CCR Section 354.18.

Federal, State, and Regional Monitoring Programs

In support of GSP development, surface water data were collected from the following agencies and programs:

- California Data Exchange Center
- U.S. Geological Survey (USGS)
  - National Water Information System

Table 2-2 identifies key surface water monitoring stations and the agencies collecting the data for streamflow stations within the EBP Subbasin. Additional streamflow data for stations within the watershed east of the EBP Subbasin are not included in **Table 2-2**, but data for both USGS and California Data Exchange Center stations are provided in **Appendices 2.A.a and 2.A.b**. In the EBP Subbasin, limited streamflow data were available from USGS. These included monitoring data of two creeks in the Richmond area (Rheem and Wildcat Creeks), Peralta Creek in the Oakland area, San Lorenzo Creek, and Ward Creek in the Hayward area.

Local Monitoring Programs

Water data were also collected from the following local monitoring programs:

- Alameda County Public Works Agency (ACPWA) Flood Control Monitoring Program
- EBMUD reservoir releases from Briones/San Pablo Reservoirs to San Pablo Creek
- EBMUD reservoir releases from Upper San Leandro/Chabot Reservoirs to San Leandro Creek

The streamflow data obtained from ACPWA primarily recorded higher flows related to large rainfall events. **Figure 2-7** shows the surface water monitoring stations listed in **Table 2-2**. Streamflow data that were not incorporated into **Appendix 2.A.a** are included in **Appendix 2.A.c**.

Table 2-2. Surface Water Monitoring Stations within EBP Subbasin

Stream	Source	Site ID	Site Name	Available Data Period
Rheem Creek	USGS	11182030	Rheem Creek at San Pablo, CA	1960–1990
Wildcat Creek	USGS	11182030	Wildcat Creek at Richmond, CA	1964–1975
Wildcat Creek	USGS	11181390	Wildcat Creek at Vale Road at Richmond, CA	1975–1996
Peralta Creek	USGS	11181300	Peralta Creek at Oakland, CA	1972–1973
San Lorenzo Creek	USGS	11181040	San Lorenzo Creek at San Lorenzo, CA	1967–1978; 1987–2019
Ward Creek	USGS	373728122041401	Ward Creek at Folsom Avenue at Hayward, CA	1998–2002
San Pablo Creek	EBMUD	San Pablo Reservoir	Releases from San Pablo Reservoir	1992–Present
San Leandro Creek	EBMUD	Chabot Reservoir	Releases from Lake Chabot	1992–Present
Rockridge Branch—tributary to Glen Echo Creek	ACPWA	CCC01	Claremont Country Club Old Quarry Site	2013–2016
Temescal Creek	ACPWA	FA02	Lake Temescal Outlet	2013–2017
Temescal Creek	ACPWA	FA03	Lower Temescal Creek at Temescal Creek Park	2014–2017
Glen Echo Creek—tributary to Lake Merritt	ACPWA	FB01	Upstream of 27th Street near Valdez Street	2013–2015
Pleasant Valley Creek—tributary to Lake Merritt	ACPWA	FC01	Grand Avenue at Weldon Avenue	2013–2017
Sausal Creek	ACPWA	FE01/02	Logan at Culvert Outfall, Downstream of Logan Street	2013–2017
Chimes Creek—tributary to Lion Creek	ACPWA	FJ01	Altamont Avenue at Sunnymere Avenue	2013–2017
Lion Creek	ACPWA	FJ02	66th Avenue at Acts Christian Academy parking lot crossing of Line J, downstream of Eastlawn Street	2013–2017
Arroyo Viejo	ACPWA	FK01	Hegenberger Road at Rudsdale Street	2013–2017
Unknown	ACPWA	FM02	Line M at San Leandro Street	2013–2016
San Leandro Creek	ACPWA	FP01	San Leandro Creek Upstream of 98th Avenue	2013–2017
Estudillo Canal	ACPWA	M02A0001	Estudillo Canal at Manor Boulevard	2017–2019
San Lorenzo Creek	ACPWA	M02B0002	San Lorenzo Creek at Don Castro Reservoir (dam crest)	2017–2019
Chabot Creek	ACPWA	M02G0002	Chabot Creek at Norbridge Avenue	2017–2019
Ward Creek	ACPWA	M03B0001	Ward Creek at Folsom Avenue and Thackeray Avenue	2018–2019

Monitoring and Management Program Limitations on Operational Flexibility in the Basin

Continued operation of these water monitoring programs will support tracking the progress of GSP implementation by providing data on water availability and inflows and outflows from the Subbasin. However, currently operating surface water monitoring stations are generally limited to local programs, which focus on watershed streamflow monitoring and releases from reservoirs outside of the Subbasin and flood flow monitoring within the Subbasin. With the exception of one station on San Lorenzo Creek, there are no ongoing surface water monitoring stations within the EBP Subbasin that monitor both low flows (base flows) and flows from storm events. Thus, the understanding of stream infiltration and stream inflows from shallow groundwater is currently very limited. This is a key data gap that needs to be addressed during GSP implementation.

2.1.2.3. Groundwater Monitoring and Management Programs

Various federal, state, and local monitoring programs related to groundwater levels, groundwater quality, and land subsidence were historically and are currently conducted in the EBP Subbasin. The sections below describe each monitoring category in more detail.

Groundwater Level Monitoring

Monitoring of groundwater levels in the Subbasin has been conducted historically by EBMUD, Hayward, Alameda County, DWR, USGS, and the GeoTracker Groundwater Ambient Monitoring and Assessment Program (GAMA). The majority of the data collected before 2000 for the southern EBP Subbasin were derived from a monitoring program implemented by Alameda County Flood Control and Water Conservation District (ACFCWCD), which is a program that started during a time of considerably greater groundwater pumping in the Subbasin. The California State Groundwater Elevation Monitoring Program (CASGEM) was initiated in 2011 in the southern EBP Subbasin, and in 2015 in the northern EBP Subbasin with EBMUD as the local monitoring entity. Groundwater levels are collected and submitted each fall and spring as part of the CASGEM program. **Appendix 2.A.d** presents maps that show the CASGEM well locations and recent monitoring dates for historical groundwater level monitoring in the EBP Subbasin.

Groundwater Quality Monitoring

Monitoring of groundwater quality in the Subbasin has been conducted historically by EBMUD, Hayward, ACFCWCD, Port of Oakland (for a channel deepening study), regulated facility operators and other entities (for contaminant site monitoring for the San Francisco Bay Regional Water Quality Control Board (RWQCB), USGS, GAMA, and DWR. **Appendices 2.A.a and 2.A.b** present maps that show the well locations, monitoring programs, and monitoring dates for historical groundwater quality monitoring conducted in the EBP Subbasin.

Land Subsidence Monitoring

Land subsidence monitoring has been conducted primarily by USGS, as described in **Appendices 2.A.a** (Section 3.2.5) and **2.A.b** (Section 5.5). In cooperation with USGS, EBMUD installed two deep extensometers to continually measure aquifer system compaction (elastic and inelastic subsidence) and expansion (uplift) in the southern portion of the EBP Subbasin area in 2008. The USGS extensometer monitoring is a key ongoing program that collects subsidence data on a continuous basis. **Appendix 2.A.b** presents additional information on the extensometer monitoring site and recent data from historical land subsidence monitoring conducted in the EBP Subbasin and vicinity.

2.1.2.4. Conjunctive Use Programs

EBMUD has developed the Bayside Project as part of its supplemental water supply portfolio. The project currently includes one aquifer storage and recovery (ASR) well. The ASR well can inject potable water when surplus water is available from San Leandro Creek watershed. The ASR well can extract groundwater during droughts as necessary.

2.1.3. Land Use Elements or Topic Categories of Applicable General Plans
(23 CCR Section 354.8[f])

This section includes discussion of applicable GPs and well permitting agencies in the EBP Subbasin. GPs have been prepared for two counties and several cities, and there are three different well permitting agencies (Contra Costa County, Alameda County and City of Berkeley) covering portions of the EBP Subbasin.

2.1.3.1. General Plans in the East Bay Plain Subbasin

The EBP Subbasin lies within portions of Alameda and Contra Costa Counties. Thus, both the Alameda County and Contra Costa County GPs have jurisdiction over unincorporated areas of the Subbasin located within respective counties. Incorporated areas of the Subbasin are covered by GPs completed by several cities. More than 95% of the total water supply for the EBP Subbasin is provided by imported surface water sources that originate from reservoirs in the Sierra Nevada primarily and from local reservoirs in the East Bay Hills (about 10% of total surface water provided by EBMUD).

Appendix 2.A.e describes several GPs for counties and cities in the EBP Subbasin. The GPs are summarized below, with a focus on factors potentially related to groundwater recharge, groundwater use, creek restoration, surface water/groundwater interaction, and GSP implementation.

Review of county and GPs indicated several common characteristics and themes in these documents:

- Most areas are considered essentially built out, with effective buildout having occurred several years before publication of the GP document. In some cities, the population has been greater in the past than at the present (i.e., the time of GP adoption).
- For many jurisdictions, vacant land typically composes less than 5% of the total land area, with potentially developable vacant land on the order of 2% of total land area. In many cases, even infill potential on vacant parcels have been previously built upon or have compacted soils, limiting recharge potential for the Subbasin.
- Although the State of California requires cities and counties to plan for a certain amount of future population growth with increased housing units, most of these additional housing developments are planned to be multifamily and mixed-use redevelopment projects in certain focused areas (e.g., transportation corridors, downtown).

- Most future changes and development will occur as redevelopment of parcels with existing structures and paving, supplemented by a small amount of infill development.
- Green infrastructure is emphasized for future development and redevelopment projects to reduce urban runoff, improve runoff and creek water quality, and increase infiltration of runoff and groundwater recharge. This would be accomplished using pervious pavement and development of stormwater retention/percolation basins and related best management practices.
- Many GPs emphasize creek protection and restoration, including daylighting of creeks currently carried underground in culverts.
- The GPs note that water supply is derived from surface water sources provided by EBMUD and Hayward. Few GPs mention the use of groundwater as a supply, even where groundwater pumping for irrigation and industrial uses is known to occur.
- GPs that do mention groundwater related to water supply (e.g., City of San Leandro GP) describe historical uses of groundwater (e.g., residential irrigation). These plans then emphasize cooperating with EBMUD regarding the use of groundwater as a potential supplemental drought supply, and potentially using groundwater (from Hayward) as an emergency supply (e.g., in case an earthquake interrupts surface water supplies).

Currently, necessary data are not available to accurately quantify the net effects of small increases in development of currently vacant/undeveloped parcels, which would tend to increase impervious area and decrease groundwater recharge to some degree. However, given the effects of green infrastructure requirements for new developments, which would tend to maintain or increase groundwater recharge, a minimal net change is likely with future development/redevelopment. There could possibly even be a net increase in groundwater recharge. For example, future redevelopment of an existing parcel with impervious surfaces already in place (e.g., parking lot) with green infrastructure (e.g., pervious pavement, retention/infiltration basins) may improve rainfall infiltration (and reduce runoff).

Generally, implementation of GP policies aligns with GSP planning efforts and supports the sustainability of the EBP Subbasin. Additional discussion of potential increases in impervious surfaces is provided in Section 2.2.3.5.

2.1.3.2. Permitting Process for Wells in the East Bay Plain Subbasin

Permitting Process for Wells in Alameda County

ACPWA is responsible for all permitting and enforcement for the construction, reconstruction, and destruction of wells in the portion of the EBP Subbasin underlying Alameda County (except for the City of Berkeley). Wells overseen by ACPWA include monitoring, remediation, vapor monitoring, piezometer/seismic, cathode, water supply (domestic, municipal, industrial, and irrigation), and geothermal wells. ACPWA permitting also covers boreholes related to contamination, environmental, and geotechnical studies. The jurisdictions covered by ACPWA include the cities of Alameda, Albany, Castro Valley, Emeryville, Hayward, Oakland, Piedmont, San Leandro, and San Lorenzo (an unincorporated community in Alameda County). The City of Berkeley does its own well permitting, as described below.

The application process for water well permits can be completed by mail or handled online through the Alameda County Permits Online website: https://www.acpwa.org/drilling-and-wells-permit. Annular seal inspection appointments are scheduled by contacting ACPWA–Water Resources by phone. ACPWA restricts work on all water wells to be performed only by those possessing an active C-57 water well contractor's license. The website listed above includes additional information on Alameda County Water Well Ordinance No. O-2015-20, a DWR information sheet for water well owners, an Alameda County information sheet on testing of drinking water wells, and other permitting information.

Permitting Process for Wells in Contra Costa County

The Contra Costa Health Services Environmental Health Division (Contra Costa HS&EH Division) manages the permitting process for all well construction and destruction in the portion of the EBP Subbasin underlying Contra Costa County, , including the cities of El Cerrito, Richmond, and San Pablo. To protect groundwater, Contra Costa County reviews plans of well designs, issues permits for well construction and destruction and for soil borings, and conducts inspections during drilling to ensure that wells/borings are constructed properly and destroyed in a manner to prevent groundwater contamination. Wells under county oversight include water wells, dewatering wells, monitoring wells, cathodic protection wells, geothermal wells, piezometers, inclinometers, soil vapor probes, cone penetrometer tests, and soil borings (including geotechnical borings). The application process for well permits is detailed on the Contra Costa County website: https://www.cchealth.org/eh/land-use/#Wells. The Contra Costa Environmental Health Division restricts work on all water wells to be performed only by those possessing an active C-57 water well contractor's license. The website listed above includes additional information on the well permitting process; guidelines for well destruction and dewatering wells; requirements for annual seals and well destruction materials; county and state standards, ordinances, and regulations; and other information related to well permitting.

Permitting Process for Wells in the City of Berkeley

The City of Berkeley Toxics Management Division manages the permitting process for construction and destruction of monitoring wells in the portion of the EBP Subbasin underlying the City of Berkeley. A subsurface drilling permit application is available online[3]. The permit covers construction of groundwater monitoring and soil vapor wells, destruction of groundwater monitoring and soil vapor wells, well modification, and soil borings. The City of Berkeley inspects grout seals for wells, probes, and boreholes. The well permit includes conditions of approval, which include a note that the permit does not apply for domestic, municipal, agricultural, or irrigation water supply wells. It is not clear if a well permit for a water supply well is required in the City of Berkeley or if a water supply well is even allowed in the City of Berkeley (ACPWA has stated it does not cover the City of Berkeley, and the City of Berkeley has stated it does not permit water supply wells). Further discussions with City of Berkeley staff indicates they would likely work with ACPWA on permitting of well types not currently addressed by City permits.

[3]https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Toxics/SubsurfacePermitApp.pdf.

2.1.3.3. Effects of Land Use Plans Outside the Subbasin

Outside the EBP Subbasin, other land use plans have been developed as part of the GPs for the cities in the Castro Valley Basin to the east and the Niles Cone Subbasin to the south. These GPs are similar in scope, goals, and objectives to the county and city GPs described above. In addition, portions of the GPs described above (e.g., City of Oakland, City of San Pablo, City of Hayward) cover areas located within the watershed but outside the EBP Subbasin.

The Castro Valley Basin is a small, low-priority groundwater basin with minimal groundwater development that does not require development of a GSP but does contribute a small amount of lateral subsurface inflow to the EBP Subbasin. The Niles Cone Subbasin is covered by an alternative (to a GSP) that has been prepared by Alameda County Water District (ACWD) to sustainably manage it in compliance with SGMA. Thus, future land use changes within the Castro Valley Basin and Niles Cone Subbasin will also be managed to maintain sustainability in the immediately adjacent EBP Subbasin. Provided that these subbasins are managed to maintain sustainability, these land use plans are not expected to affect the ability of the EBP Subbasin's GSAs to conduct sustainable groundwater management.

2.1.4. Additional GSP Element

(23 CCR Section 354.8[g])

2.1.4.1. Control of Saline Water Intrusion

Before 1930, areas near San Francisco Bay where groundwater was developed from the Shallow Aquifer Zone reportedly experienced some seawater intrusion issues (e.g., San Pablo Wellfield in Richmond, Alameda Island). After 1930, seawater intrusion was not a major issue for groundwater supply development. Extensive water supply development and groundwater pumping from the Intermediate and Deep Aquifer Zones occurred in the southern EBP Subbasin during the 1950s and 1960s, resulting in Intermediate/Deep Zone groundwater levels that ranged from 10s of feet (ft) to well over 100 ft below mean sea level (msl). However, no significant seawater intrusion problems were reported during this time.

Additional information on the potential for seawater intrusion is provided in Section 2.2.2.4 and **Appendix 2.A.b**.

2.1.4.2. Wellhead Protection

Wellhead protection refers to both the immediate location of the well in terms of well and pump station design features (e.g., well pad, annual seal) and the broader area surrounding the well. In general, a wellhead protection area is the area surrounding a public water supply well through which contaminants are reasonably able to move toward the well (i.e., the recharge area that provides water to the well).

The ACPWA, Contra Costa HS&EH Division, and City of Berkeley well ordinances and well permitting processes do not specifically address wellhead protection but do include requirements related to placement of annular seals. The EBMUD GMP's section on wellhead protection notes that EBMUD and Hayward groundwater wells used for drought supply and/or emergency purposes are subject to California Division of Drinking Water (DDW) permitting requirements related to wellhead projection areas, which includes implementation of the Drinking Water Source Assessment and Protection (DWSAP) program.

EBMUD completed a DWSAP assessment in 2012. The EBMUD GMP lists recommended actions as: (1) obtain updated coverage of potentially contaminating activities and provide that information to stakeholders; and (2) share current wellhead protection measures and provide a summary of actions taken by others as a tool in managing their individual wellhead protection programs. Hayward's emergency supply wells are currently permitted as standby sources pursuant to California Code of Regulations (CCR) Title 22 Section 64414. As such they are limited to five consecutive days of use and 15 total days per year of use. Additional requirements for longer term use of these wells, including potential preparation of DWSAPs, will be addressed as needed in the future.

2.1.4.3. Migration of Contaminated Groundwater

In general, groundwater contamination in the EBP Subbasin is limited to the upper portion of the Shallow Aquifer Zone, while most pumping for groundwater supply occurs in wells screened in the underlying Intermediate and Deep Aquifer Zones. The Intermediate and Deep Aquifer Zones are protected from contamination and potential seawater intrusion due to the prevalence of fine-grained deposits between the upper 120 ft or so (where most contamination occurs) and the deeper coarse-grained deposits (which are tapped for groundwater supply).

However, contaminated groundwater can migrate through improperly constructed groundwater wells and improperly abandoned wells screened in multiple aquifer units, which can become conduits for vertical flow of poor-quality water between aquifers. Inadequate surface sanitary seals can allow contaminants to migrate downward from the ground surface into the well structure, and ultimately into the aquifers screened by the well. Abandoned and improperly destroyed wells are also potential conduits for migration of contaminants in the subsurface. Also, numerous types of facilities and land uses can be potential sources of chemical constituents that migrate down through the vadose zone and into aquifers, with subsequent migration to pumping wells.

Section 2.1.4.2, *Wellhead Protection*, notes requirements for well permitting related to annular seals that are meant to help mitigate the potential for vertical migration of contaminants. Section 2.1.4.4, below, describes requirements related to well destruction and abandonment. Additional information on contaminated sites is provided in Section 2.2.2.3 and in **Appendix 2.A.b**.

2.1.4.4. Well Abandonment and Well Destruction Program

Existing ACPWA, Contra Costa HS&EH Division, and City of Berkeley well ordinances/standards and state law require proper well destruction. Alameda and Contra Costa Counties and the City of Berkeley are responsible for administration and enforcement of the well ordinances and regulations and oversee proper well destruction in the EBP Subbasin. Wells are required to be destroyed in accordance with State standards as delineated in the Water Well Standards[4] (DWR, 1981).

[4] As of 2021, a comprehensive update to the DWR Water Well Standards is in progress.

2.1.4.5. Replenishment of Groundwater Extractions

The various forms of recharge that replenish extracted groundwater, including the types and amounts of historical and current recharge, are described in detail in Section 2.2.3, *Water Budget Information*. Future estimates of recharge are detailed in Section 2.2.3 and **Appendix 6.E** - *Groundwater Model Documentation*. Chapter 4 presents a detailed description of future replenishment for groundwater extractions that will occur with the implementation of projects and management actions for this GSP.

2.1.4.6. Conjunctive Use and Underground Storage

Historical and current conjunctive use operations in the EBP Subbasin have been conducted primarily by EBMUD. Conjunctive use activities by EBMUD and other entities are described in more detail in Section 2.1.2.4, *Conjunctive Use Programs*. Potential future conjunctive use and underground storage operations are described in detail in Chapter 4 and simulated by the groundwater model as described in the **Appendix 6.E**.

2.1.4.7. Well Construction Policies

Well construction policies are described in Section 2.1.3.2. As part of GSP implementation, ACPWA, Contra Costa HS&EH Division, and the City of Berkeley will continue to process and approve new well construction permits. The GSAs will request well permitting agencies to consult with GSAs prior to issuing permits to ensure the groundwater basin's sustainability.

2.1.4.8. Groundwater Contamination Cleanup, Recharge, Diversions to Storage, Conservation, Water Recycling, and Extraction Projects

Monitoring and remediation of areas of preexisting and historical groundwater contamination are being addressed primarily by various regulatory programs under the San Francisco Bay RWQCB and DTSC. Various types of projects (e.g., recharge, diversions, extraction, water recycling) are described in Section 2.2.1.6, *Surface Water Bodies and Source/Delivery Points for Local and Imported Water Supplies*, and Section 2.2.3, *Water Budget Information*, and in the Chapter 4 discussion of projects and management actions. Water conservation projects are described in Section 2.1.3, *Land Use Elements or Topic Categories in Applicable General Plans,* and in Section 2.1.4.9. There are several historical, current, and planned water recycling projects in the GSP area that are described in more detail in **Appendix 2.A.b**.

2.1.4.9. Efficient Water Management Practices

EBMUD prepared a Water Conservation Master Plan (EBMUD, 2011) that provided an overview of EBMUD water conservation efforts, anticipated water savings, and drought response plans to help ensure a reliable water supply by meeting water demand reduction targets consistent with other local and statewide policies. Modeling conducted in 2019 as part of EBMUD's 2050 Demand Study showed that EBMUD had achieved 46 MGD of water conservation savings from 1995 through 2018. . EBMUD has made substantial progress in implementing its 2011 Water Conservation Plan and is currently finalizing the 2021 update to that plan. EBMUD has set a new goal of increasing conservation savings to 70 MGD by 2050. Water conservation measures used by EBMUD include (additional program details are available in the EBMUD's 2020 Urban Water Management Plan):

- Water Management Services – providing information to customers regarding leak detection, consumption, and water savings cost-benefit calculators;
- Education and Outreach – marketing, community outreach, and sponsorships, professional training, community partner and stakeholder group participation;
- Conservation Incentives – promote customer use of new water saving technologies, including climate-appropriate landscaping, water efficient fixtures/appliances/irrigation systems;
- Regulations and Legislation – target new property development and some existing demand by establishing ‘green" product standards, building and plumbing codes, and landscape ordinances;
- Supply-Side Conservation – expand use of new technology, instrumentation, and data collection for distribution system optimization, leak detection, and water loss reduction;
- Research and Development – use of new technologies and support demand and supply-side conservation.

The City of Hayward is among the lowest per-capita water users statewide (13XX residential) and compared to other agencies that purchase water from San Francisco Public Utilities Commission, partially because Hayward has long been committed to implementing diverse and effective water conservation measures across customer sectors.

The City's 2020 Urban Water Management Plan includes a full discussion of Hayward's water conservation measures and programs and can be found at: https://www.hayward-ca.gov/documnets/urban-water-management-plan.

Water conservation measures used by Hayward include:

- Water Management Services – Provide information to customers regarding water consumption, use analysis, and potential leaks.
- Education and Outreach - Inform customers through social media and its website about drought and water reduction efforts, water conservation measures and programs.
- Conservation Incentives and Assistance – Improve water use efficiency through equipment retrofits, reuse technologies, and efficiency audits and action plans.
- Regulations and Legislation – Reduce water use for new and existing development through plumbing codes, landscape and efficient water use ordinances.
- Supply Side Conservation – Use of technology and data collection to address distribution system loses, leak detection and water loss reduction.

Research and Development - Research and evaluate new programs and technology to support water demand and consumption efforts.

Hayward has a webpage devoted to water conservation practices (https://www.hayward-ca.gov/your-environment/green-your-life/conserve-water). The website offers free water efficient devices, rebates for homeowners, no-cost consulting for energy and water savings for multifamily properties, green house calls for Hayward residents, landscape classes and other landscaping information/outreach, education on monitoring water usage, and other water saving tips and resources.

2.1.4.10. Relationships with Federal and State Agencies

The GSAs in the EBP Subbasin have relationships with a number of federal and state agencies related to surface water supply, water quality, and water management. EBMUD obtains most of its surface water supply from Pardee and Camanche Reservoirs via the Mokelumne Aqueduct system; EBMUD also collects local runoff from the East Bay Hills in its reservoirs located in the East Bay. The Pardee and Camanche Reservoir dams are owned and operated by EBMUD and under the jurisdiction of the Federal Energy Regulatory Commission because they produce hydropower. DWR Division of Safety of Dams also has jurisdiction of both the Sierra Nevada and East Bay Hills dams related to meeting the State's established safety criteria. These same federal and state agencies regulate Hetch Hetchy Dam and Reservoir, which provides Hayward's water supply via SFPUC. The EBMUD Bayside Phase 1 project operates under a waste discharge permit issued by the RWQCB.

The GSAs also apply for and occasionally receive grants from various federal and state agencies for water-related projects. For example, EBMUD and Hayward are currently installing 12 new monitoring wells in the EBP Subbasin that is being funded through a Proposition 68 grant awarded to EBMUD. The new wells will provide better definition of the Subbasin's geology, water levels, and water quality (along with aquifer testing and the collection and evaluation of isotope samples) and for ultimate incorporation into the GSP monitoring network.

2.1.4.11. Land Use Plans and Efforts to Address Potential Risks to Groundwater Quality and Quantity

Land use plans are described in Section 2.1.3, *Land Use Elements or Topic Categories in Applicable General Plans* and in **Appendix 2.A.e**. To the extent that a given land use plan mentions groundwater issues, **Appendix 2.A.e** includes discussion of how that land use plan addresses groundwater quality and quantity.

2.1.4.12. Impacts on Groundwater Dependent Ecosystems

Potential impacts on groundwater dependent ecosystems (GDEs) are described in detail in Section 2.2.2.7, *Groundwater Dependent Ecosystems* and in **Appendix 2.A.b**.

2.1.5. Notice and Communication

(23 CCR Section 354.10)

2.1.5.1. Overview

The intent of SGMA is to ensure successful, sustainable management of groundwater resources at the local level. Success will require cooperation by all beneficial users (defined below). Cooperation is far more likely if beneficial users have consistent messaging of valid information and are provided with opportunities to help shape the path forward. Hence, SGMA requires broad and diverse stakeholder involvement in GSA activities and the development and implementation of GSPs for groundwater basins around the state, including the EBP Subbasin.

To facilitate stakeholder involvement in the GSA process, the GSAs in the EBP Subbasin created a Communication and Engagement Plan (**Appendix 2.B.a**) for the following purposes:

- Explain the GSA's decision-making process.
- Identify opportunities for public engagement and discuss how public input and response will be used.
- Describe how the GSAs encourage the active involvement of diverse social, cultural, and economic elements of the population within the Subbasin.
- Outline other methods the GSAs will follow to inform the public about progress implementing the GSP, including the status of projects and management actions.

2.1.5.2. Description of Beneficial Uses and Users in the Basin

Under SGMA, all beneficial uses and users of groundwater must be considered during the development of a GSP. GSAs must encourage the active involvement of diverse social, cultural, and economic elements of the population. Thus, beneficial users are any stakeholders in the EBP Subbasin community who have an interest in groundwater use and management. Their interest may be related to GSA activities, development, and implementation of a GSP, and/or water access and management in general. Beneficial uses and users also include the environmental uses including GDEs. To assist in identifying the categories of beneficial uses and users in the EBP Subbasin, the Communications and Engagement Plan includes a stakeholder interested parties list that was updated during GSP development (**Appendix 2.B.b**).

According to the Basin Plan, groundwater in EBP Subbasin is considered suitable or potentially suitable for municipal and domestic water supply (MUN), agricultural supply (AGR), industrial service supply (IND, and industrial process supply (PRO) beneficial uses (California Regional Water Quality Control Board, San Francisco Bay Region, 2019). The major groundwater pumpers in the Subbasin utilize groundwater for either irrigation (both large parcels such as parks and residential parcels) or industrial uses. Groundwater for municipal supply is currently a standby water supply source and will be used by EBMUD and Hayward in the future. Beneficial users of groundwater for irrigation water supply on large parcels include parks, golf courses, schools/colleges (for landscaping and athletic fields), and cemeteries. Domestic well owners in EBP Subbasin utilize groundwater as a supplemental source of irrigation supply; the GSAs are not aware of any households that are dependent on groundwater as their source of drinking water supply. While disadvantaged communities (DAC) currently receive water supplies from EBMUD and Hayward, these communities, along with non-DAC communities, may be served with a small proportion of groundwater from the Subbasin in the future) with implementation of future GSA projects described in this GSP. Environmental beneficial users include riparian vegetation along creeks and in wetland areas, and wildlife (e.g., fish, birds) that may utilize surface water (supported by groundwater discharge) and vegetation along surface water bodies for habitat. As noted above, other beneficial users include stakeholders who have an interest in groundwater use and management. These other beneficial users may include, but are not limited to, local land use planning agencies, the federal government (including Indian Tribes), and environmental interests (besides GDEs described above).

2.1.5.3. Communications

Decision-Making Processes

As noted above, the EBP Subbasin is divided among two GSAs for GSP development. The two GSAs have jointly developed this single GSP. GSAs' governing bodies (i.e., EBMUD's Board of Directors and Hayward's City Council) are the final decision-makers for the EBP Subbasin.

To assist in developing the GSP, the GSAs convened a EBP Subbasin GSP Technical Advisory Committee (TAC) in 2019. The committee brought together local agencies and related parties vested with the authority and/or ability to support SGMA implementation in the EBP Subbasin. Representatives from California State University – East Bay, the Cities of Richmond, Berkeley, San Pablo, and Alameda, and from Lawrence Berkeley National Laboratory (LBNL), Alameda County Department of Public Works, the San Francisco Bay RWQCB, Contra Costa County, Sierra Club, United States Geological Survey (USGS), and Grolutions Horticultural Landscaping regularly attended TAC meetings. **Figure 2-8** illustrates the GSA decision-making process, which includes the GSA governing bodies, Steering Committee, Technical Team, Consultants, TAC, Interbasin Working Group, and stakeholders (including the public).

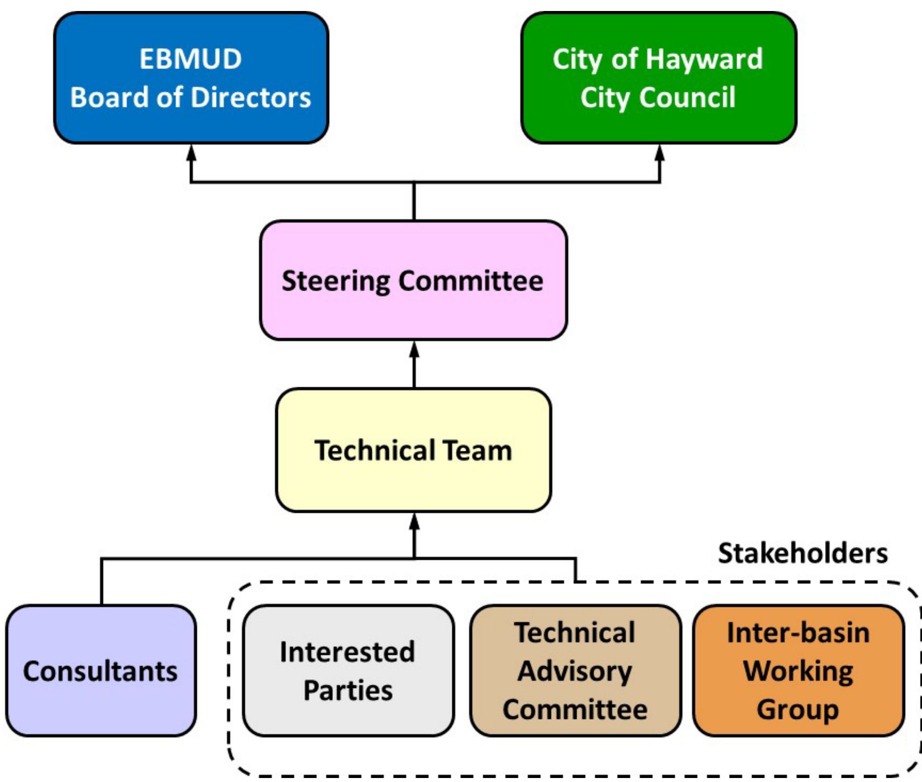


Figure 2-8. GSA Decision-Making Process

The Steering Committee included senior GSA staff members who oversaw and guided the Technical Team during development of the GSP. The Technical Team consisted of GSA staff members who developed and managed the GSP and associated projects, oversaw the consultants, and engaged with stakeholders. The Technical Team kept the Steering Committee updated during GSP development and provided recommendations at key decision points. The Consultants conducted technical studies and groundwater modeling and prepared draft GSP documents. **Table 2-3** lists the members of the Steering Committee and Technical Team and the Consultants for the GSP.

Generally, the representatives composing the TAC are technical experts and/or representatives associated with the various Subbasin stakeholders. The TAC reviewed and commented on the Consultant's deliverables and provided input for GSP development. The GSAs and Consultants considered the comments and input and incorporated them into the GSP as appropriate.

Table 2-3. Members of Key GSA Decision-Making Groups

Group	EBMUD Members	Hayward Members
Steering Committee	Mike Tognolini Linda Hu	Alex Ameri Cheryl Muñoz
Technical Team	Brad Ledesma Grace Su	Cheryl Muñoz
Consultants	Luhdorff and Scalmanini Consulting Engineers, Geosyntec, Brown and Caldwell, Environmental Science Associates, Dr. Jean Moran, Farallon Geographics	

Public Engagement Opportunities

Several meetings offered opportunities for public engagement while the GSP was being developed:

- **GSA Board meetings**: Both GSAs in the EBP Subbasin held regular public meetings, generally on a monthly schedule and generally in conjunction with standing Board and City Council meetings.
- **General stakeholder meetings**: Meetings were held throughout GSP development to enable Subbasin stakeholders and the public to learn about the SGMA process and Plan components, receive updates about planning activities, and provide input on GSP development. These meetings often included presentations by the Consultants about technical aspects of GSP preparation and topics such as the Subbasin setting, water budgets, and undesirable results.
- **SGMA webpage**: Each GSA developed and maintained interactive webpages providing SGMA compliance and GSP development information and updates. Interested parties can subscribe to a mailing list to be notified of updates and meeting information.
- **Email/Telephone**: GSAs' SGMA staff are available to reach via email and telephone on demand.

In addition to the regular GSA Board meetings, the GSP was discussed at the public meetings listed in **Appendix 2.B.c**. **Figure 2-9a** illustrates a typical GSP public live event held before the onset of the COVID-19 pandemic; subsequent GSP meetings and events were held virtually using Microsoft Teams or Zoom (**Figure 2-9b**).

Figure 2-9a. GSA Public Live Event Held on February 27, 2018

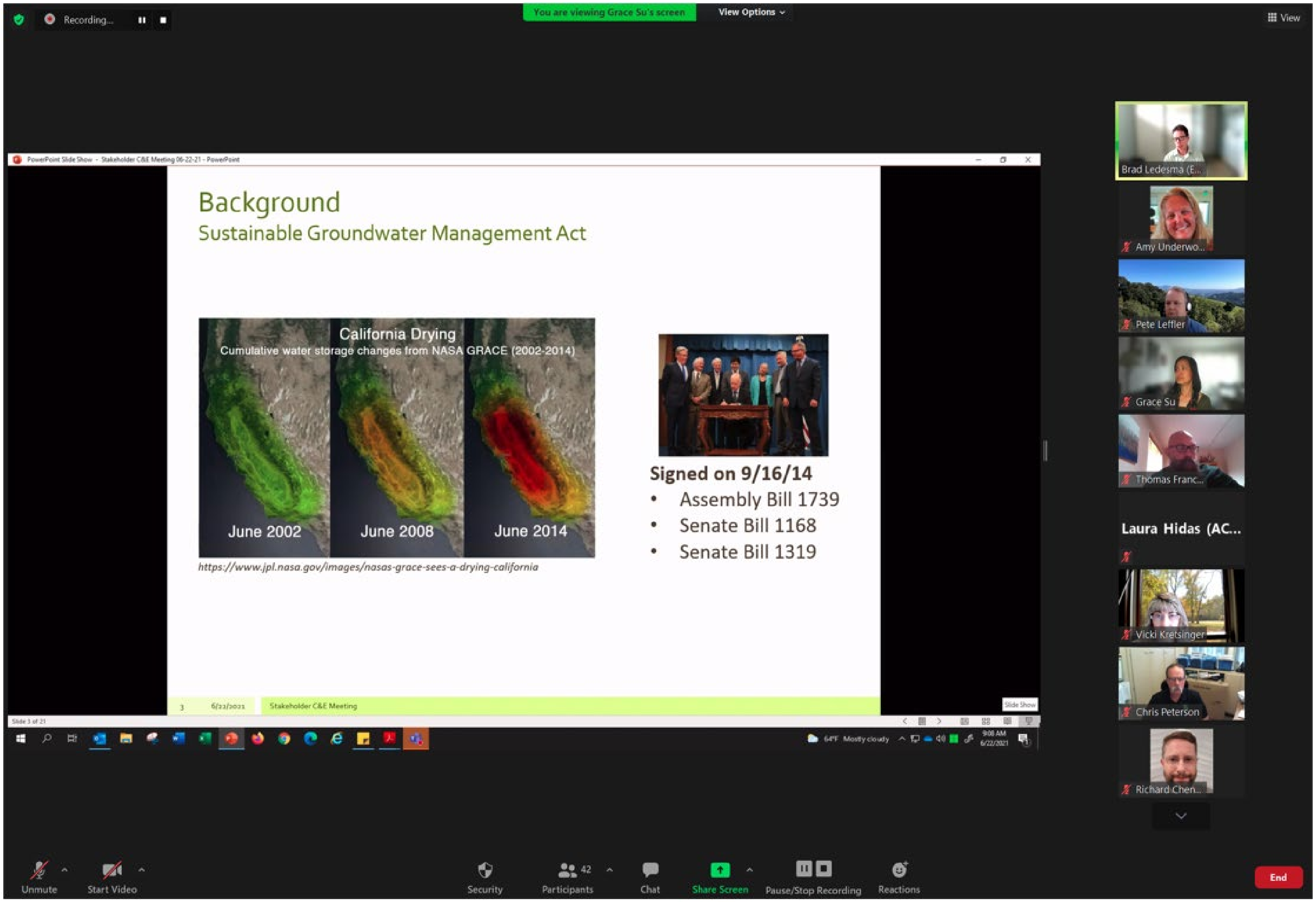


Figure 2-9b. General Stakeholder Meeting Virtual Event Held on June 22, 2021

2.1.5.4. Informing the Public about GSP Development Progress

List of Interested Parties

In accordance with CWC Section 10723.4, the GSAs established and maintained a list of persons interested in receiving notices regarding GSP preparation, meeting announcements, and availability of the draft GSP, maps, and other relevant documents. An email distribution list of Subbasin-wide stakeholders and beneficial users was developed for outreach throughout the GSP planning process. The GSAs maintained and updated the list, which is included in **Appendix 2.B.b**. Any person may send a written request to be placed on the list of interested persons.

Distribution of Materials

Typically, before a public meeting associated with the development of the GSP for the EBP Subbasin, the GSAs created and distributed an agenda containing key information about the topics to be covered. The agenda was emailed to the list of interested parties. Presentation materials were posted to EBMUD and Hayward GSP websites after the meetings. Technical memoranda were also posted to the GSA websites after being reviewed by the TAC and finalized by the Consultants. The Draft GSP was made available for a 45-day public review in September 2021. Comments received during public review of the Draft GSP were reviewed and appropriately addressed by the GSAs, the Technical Team, and Consultants. Appropriate modifications were made for the final GSP that was submitted to DWR that included responses to comments.

Noticing of Public Hearing

The GSAs for the EBP Subbasin noticed the public hearings in local newspapers.

Centralized EBP Subbasin Website

Throughout the planning process (and beyond), the GSAs have maintained Subbasin GSA/GSP websites with information about EBP Subbasin-wide planning efforts related to SGMA: https://www.ebmud.com/water/about-your-water/water-supply/groundwater-sustainability-agencies; and https://www.hayward-ca.gov/content/sustainable-groundwater-management.

The EBP Subbasin websites contain the following information:

- Calendar of public meetings and other events
- Information about past public meetings, including relevant meeting materials
- Links to external sites (e.g., DWR's SGMA portal) and other resources such as white papers
- Information about the GSAs and EBP Subbasin technical meetings
- GSP documents
- Subbasin maps

As the GSP is implemented, the GSAs will continue to maintain GSP websites to keep the public informed about progress made in implementing the GSP, including the status of projects and management actions. Materials to be posted on the website will include GSP Annual Reports and other information documenting progress made in implementing the GSP and maintaining basin sustainability through and beyond 2042. In addition, the links to GSAs' data management system will be listed on the webpage for public and interested parties to view SGMA compliance information and query the GSP database.

Engagement Matrix

The Engagement Matrix in **Appendix 2.B.c** provides details about the meetings outlined above. The matrix lists the date, topic, and location of each public GSP-related meeting and identifies how each meeting was publicized, to whom it was targeted, what opportunities for feedback were provided, and who participated.

Stakeholder Input and Responses

The engagement opportunities described above provided various avenues for stakeholders to provide input on GSP development. The matrix in **Appendix 2.B.d** summarizes the public comments received and outlines how this input influenced decision-making during GSP development. A list of frequently asked questions (FAQ) has been compiled from stakeholder input and is included on the EBMUD webpage for the EBP Subbasin GSP.

2.2. Basin Setting

2.2.1. Hydrogeologic Conceptual Model
(23 CCR Section 354.14)

A detailed HCM was developed for the EBP Subbasin (DWR Subbasin No. 2-009.04) and the Technical Memorandum documenting HCM was published in September 2021 (**Appendix 2.A.b**). Various aspects of the detailed HCM are summarized and documented in this GSP. For more detailed information, refer to the TMs in **Appendix 2.A**.

2.2.1.1. Regional Geologic and Structural Setting

The topography of the EBP Subbasin is generally relatively flat and sloping gently upward to the east, although elevations begin to rise more rapidly near the East Bay Hills; bedrock knobs occur in the northern portion of the Subbasin. For the purposes of the HCM described in **Appendices 2.A.a and 2.A.b**, the northern EBP Subbasin is generally defined as lying north of Interstate 580/State Route 24 in Oakland and the southern EBP Subbasin is to the south of these highways (**Figure 2-10**).

A general surface geologic map for the study area (**Figures 2-11a and 2-11b**) delineates surficial sediments in the EBP Subbasin as Quaternary alluvium and marine deposits. The regional structural trend (encompassing the greater San Francisco Bay Area) is northwest-southeast, with the Hayward Fault forming the eastern boundary and the San Andreas Fault along the San Francisco Peninsula forming the western boundary (**Figure 2-12**). San Francisco Bay is situated along the Franciscan synform, which exerted a strong influence over early patterns of sediment deposition. Basement rocks in the study area include graywacke, shale, sandstone, greenstone, mélange, and ultramafic rocks. A regional structural analysis indicated local uplift west of the Hayward Fault in the Oakland-Berkeley area (Norfleet Consultants, 1998).

The unconsolidated fill within the San Francisco Basin is 800 ft to about 1,000 ft thick in much of the area, but it is asymmetrical, with the deepest portion occurring along the San Francisco Bay shoreline between

San Leandro and Hayward. From this deepest portion, the basement surface rises gradually to the west and steeply to the east. The lower 300–500 ft of sediments consists of continental alluvial fan/plain deposits of the Merced and Santa Clara Formations and equivalent time units, whereas the overlying sediments are a series of alternating estuarine and alluvial deposits. The unconsolidated fill in the Richmond portion of the San Pablo Basin consists primarily of continental units, but it also has marine and freshwater clay layers in the upper portion of the stratigraphic section.

The EBP Subbasin has a major regional fault (Hayward Fault) along its eastern margin, and it lies within a geologic depression that resulted in deposition of unconsolidated sediments and formation of San Francisco Bay along the western margin of the Subbasin. The depositional history of the EBP Subbasin over the past 800,000 years involves the development of major depositional centers and alluvial cones that shifted over geologic time. This depositional history differentiates the likely different sources for Deep Aquifer Zone sediments in the EBP Subbasin (**Figure 2-13**). It also helps substantiate structural differences (confined vs. unconfined) and stratigraphic relationships in the transition zone between the EBP and Niles Cone Subbasins (**Appendix 2.A.b**). The transition zone is a hydrogeologic boundary between the two subbasins related to stratigraphic offsets of coarse-grained Deep Aquifer units that causes an impedance to groundwater flow in the Deep Aquifer between the two subbasins.

2.2.1.2. Lateral and Vertical Subbasin Boundaries

DWR defines the Subbasin's lateral boundaries as follows (DWR, 2003):

> *…a northwest trending alluvial plain bounded on the north by San Pablo Bay, on the east by the contact with Franciscan Basement rock, on the south by the Niles Cone Groundwater Basin. The East Bay Plain Basin extends beneath San Francisco Bay to the west.*

Figure 2-14 presents a map of the topography of the EBP Subbasin and surrounding watershed, with an outline of the Subbasin's boundaries. A surface geology map of the EBP Subbasin was also reviewed in comparison to EBP Subbasin boundaries defined by DWR, as displayed in **Figure 2-11**.

The western hydrogeologic boundaries of the EBP Subbasin aquifers beneath San Francisco Bay are not well defined. It is likely that the Deep Aquifer Zone extends a significant distance to the west beneath San Francisco Bay in the southern portion of the EBP Subbasin, while shallower aquifers likely do not extend as far to the west beneath the bay. To the east, the Hayward Fault generally separates older consolidated/fractured bedrock from more recent unconsolidated alluvium and forms the distinct eastern boundary of the Subbasin. The Subbasin's southern hydrogeologic boundary occurs within a "transition zone" defined originally by LSCE (2003) and refined more recently as part of GSP efforts (**Appendix 2.A.b**). However, a recent (2016) modification of the Subbasin boundary on jurisdictional grounds moved the basin boundary farther north along the western portion of the southern boundary (**Figure 2-15**).

DWR states, "The East Bay Plain subbasin aquifer system consists of unconsolidated sediments of Quaternary age…The cumulative thickness of the unconsolidated sediments is about 1,000 ft…" (DWR, 2003). The vertical extent of the Subbasin was further evaluated in terms of the depth to bedrock and relative to delineation of major aquifers/aquitards. **Figure 2-16** shows contours for the top of bedrock elevation beneath the Subbasin. The map of bedrock elevation contours generally shows that the deepest portion of the Subbasin is located along the San Francisco Bay shoreline between Bay Farm Island and Hayward, with depths reaching to slightly greater than 1,000 ft below ground surface (bgs). The area of greatest depths to bedrock are south of Oakland and extend beneath San Francisco Bay to the west. Between Bay Farm Island and Hayward, depths to bedrock gradually decrease toward the east to about 600 ft bgs, and then decrease rapidly from that point to the Hayward Fault, which forms the eastern boundary of the Subbasin. North of Oakland, EBP Subbasin areas are generally less than 400 ft deep and, in much of the northern Subbasin, are less than 200 ft to bedrock. The Subbasin is shallowest in Albany and El Cerrito (close to zero feet thickness in some areas), and then deepens somewhat in the Richmond area, where depths of about 600 ft to bedrock are present in some areas.

In the portion of the EBP Subbasin south of Alameda Island, the Deep Aquifer (i.e., primary coarse-grained sediments within the Deep Aquifer Zone) is considered to be the deepest aquifer in the Subbasin. Depths to the base of the Deep Aquifer range up to 650 ft bgs. At several locations where deeper boreholes were drilled, sediments below the Deep Aquifer were generally described (and/or indicated on geophysical logs) as fine-grained, although some logs indicate some thin discontinuous beds of coarse-grained units.

2.2.1.3. Major Aquifers/Aquitards

The major aquifers and aquitards of the EBP Subbasin have been subdivided into a Shallow Aquifer Zone (0–200 ft bgs), Intermediate Aquifer Zone (200–400 ft bgs), and Deep Aquifer Zone (greater than 400 ft bgs). In general, all three zones are present in the southern EBP Subbasin; however, only the Shallow Zone or the Shallow and Intermediate Zones are present over most of the northern EBP Subbasin.

Each designated zone has combinations of fine- and coarse-grained units. The coarse-grained units are generally discontinuous and make up a much smaller portion of total sediment thickness. The major exception to these conditions occurs in the upper portion of the Deep Aquifer Zone in the southern EBP Subbasin. In this location, coarse-grained units (i.e., the Deep Aquifer) tend to be relatively thick and continuous, as shown in geologic cross section A-A’ (**Figure 2-17**).

Geologic cross sections illustrate the occurrence of much shallower depth to bedrock and less frequent occurrence of coarse-grained units in the northern EBP Subbasin: geologic cross section B-B’ (**Figure 2-18**), for the Richmond area; and the northern portion of geologic cross section C-C’ (**Figures 2-19a, 2-19b, and 2-19c**), which covers the area between Berkeley and San Leandro (in the northern and southern portions of the EBP Subbasin, respectively). These cross sections also illustrate the occurrence of only the Shallow or Shallow/Intermediate Zones in the northern EBP Subbasin, as compared to the presence of all three depth zones over most of the southern EBP Subbasin. This designation of Shallow, Intermediate, and Deep Aquifer Zones is applied throughout the Subbasin to classify groundwater level and quality data. Additional information on major aquifers and aquitards is provided in **Appendix 2.A.b**.

2.2.1.4. Aquifer Parameters

Appendix 2.A.b provides a detailed summary of aquifer parameter data derived from existing reports. Data for the Shallow and Intermediate Aquifer Zones in the northern portion of the Subbasin are limited to specific capacity data (only available for five wells). Transmissivities range widely, from about 10 to 40,000 gallons per day (gpd) per foot (gpd/ft), with a geometric mean of about 1,200 gpd/ft.

Aquifer parameter data for the Shallow and Intermediate Aquifer Zones in the southern portion of the Subbasin are also generally limited to specific capacity data (about 30 wells). Transmissivities are typically in the range of 5,000–10,000 gpd/ft for the Shallow Aquifer Zone and 10,000–20,000 gpd/ft for the Intermediate Aquifer Zone.

Local and regional aquifer testing combined with extensive and detailed work on geologic cross sections validate that the EBP Deep Aquifer is continuous from south of Davis Street in San Leandro to Hayward and from near the Hayward Fault to beneath San Francisco Bay. In this area, transmissivity values are high, ranging from 50,000 gpd/ft to more than 100,000 gpd/ft over much of the Deep Aquifer extent (although lower transmissivity values, 10,000 gpd/ft, occur along the eastern edges of the Deep Aquifer near the Hayward Fault).

Figure 2-20 provides transmissivity values for the continuous portion of the Deep Aquifer in the EBP Subbasin. The map generally shows relatively high transmissivity values on the order of 100,000 gpd/ft through the depositional center of the Deep Aquifer along the western EBP Subbasin from south of San Leandro to Hayward. The transmissivity of the Deep Aquifer declines to the east toward the Hayward Fault as the aquifer thins and pinches out.

The primary source of information about specific yield values, which are generally applicable to shallow unconfined aquifers, is the study conducted by DWR (1994) to evaluate groundwater storage in the portion of EBP Subbasin from Berkeley on the north to Hayward on the south (using DWR's pre-2016 southern basin boundary). DWR evaluated 357 well logs based on 50-ft depth intervals by assigning specific yield values to lithologic descriptions on well logs (e.g., clay = 3%, silt = 5%, medium to coarse sand = 20%, gravel = 25%). The results indicated a range of specific yield from 4% to 9% for most 50-ft depth intervals, with an overall average of 6%. These relatively low specific yield values are consistent with the predominantly fine-grained sediments observed in the EBP Subbasin.

Storage coefficient values, which are generally applicable to confined aquifers, are available from aquifer tests involving observation wells. Aquifer test data are only available for the Deep Aquifer in the southern EBP Subbasin, where storage coefficient values locally ranged from 0.00002 (EBMUD Farmhouse Well) to 0.002 (EBMUD Bayside Well). A long-term regional test covering the area from San Lorenzo to Hayward yielded an overall average storage coefficient value for the Deep Aquifer of 0.00015 (**Appendix 2.A.b**).

2.2.1.5. Recharge and Discharge Areas

Groundwater recharge has the potential to occur throughout the EBP Subbasin. Areas of groundwater recharge were evaluated based on recharge mechanisms, soil types, and surface geologic data. The primary sources of vertical recharge include precipitation and excess irrigation recharge, streamflow infiltration, and leaking pipes. The area with potential for recharge from rainfall/irrigation water and leaking pipes essentially covers the entire Subbasin, whereas streamflow infiltration potential is limited to areas where stream channels are present. However, some areas may provide greater potential for existing recharge and future managed recharge that may occur during GSP implementation.

Mapping of soils by hydrologic groups A, B, C, and D provides a good indication of recharge potential. Hydrologic group A soils have high infiltration rates, group B soils have moderate infiltration rates, group C soils have slow infiltration rates, and group D soils have very slow infiltration rates. If a soil is placed in group D because of a high water table, it may have a dual designation such as B/D (with the first letter representing the soil's infiltration rate if the soil is drained).

The hydrologic group soils mapping in **Figure 2-21** shows two relatively large areas of group B soils, which appear to be associated with San Leandro and San Lorenzo Creek alluvial fans. These group B soils are generally in the middle to eastern portion of the Subbasin in these areas. Large areas of group A soils are present on Alameda Island and in the western Oakland and northwestern San Leandro areas, corresponding primarily with the locations of Merritt Sand deposits indicated on geologic maps. Hydrologic group C soils cover most of the remaining central and eastern areas of the southern Subbasin, and hydrologic group D soils cover most of the remaining western portions of the southern Subbasin. The northern EBP Subbasin consists primarily of hydrologic group C and D soils, with a greater proportion of hydrologic group C soils occurring in the Richmond area.

Overall, significant recharge can generally be expected to occur in areas with hydrologic group A, B, and C soils, with the highest infiltration rate in group A and the lowest rate in group C (all other factors being equal). Specifically, the best recharge areas are in the central to eastern portions of the southern EBP Subbasin between Oakland and Hayward, and in areas with group A and B soils and a sufficiently deep water table. The Richmond area, in the northernmost portion of the EBP Subbasin, is the next best recharge area, while the western portion of the entire Subbasin and the area between Oakland and Richmond have the lowest potential for recharge.

2.2.1.6. Surface Water Bodies and Source/Delivery Points for Local and Imported Water Supplies

The primary surface water bodies within the boundaries of the EBP Subbasin are various creeks and Lake Merritt. The creeks with the largest contributing watersheds in the East Bay Hills are San Pablo Creek and Wildcat Creek in the northern portion of the EBP Subbasin, and San Leandro Creek and San Lorenzo Creek in the southern portion of the Subbasin (**Figure 2-22**). Several creeks with smaller watersheds are also present. Lake Merritt was created in 1869 by building a dam across tidal marshes of the former San Antonio Slough. Lake Merritt currently serves many recreational functions, is a wintering location on the Pacific Flyway, and is a receiving water body for a highly developed 4,600-acre urban watershed. The major reservoirs within the watersheds east of the EBP Subbasin include San Pablo Reservoir, along San Pablo Creek, and Upper San Leandro Reservoir and Lake Chabot, along San Leandro Creek. **Figure 2-22** shows these surface water features.

EBMUD and Hayward provide nearly the entire water supply for the EBP Subbasin, which is primarily surface water. EBMUD diverts surface water from its Mokelumne River watershed reservoirs in addition to managing water supply from local reservoirs in the East Bay Hills. EBMUD also has a contract with the U.S. Bureau of Reclamation to divert from the Central Valley Project, which it diverts from the Sacramento River in dry years through Freeport Intake Facility that is available to meet water demands during droughts and has developed the Bayside Groundwater Project to also meet water demands during droughts. Hayward obtains surface water from the SFPUC Tuolumne River system and has developed a system of emergency groundwater supply wells for potential use in the event the surface water supply is disrupted.

EBMUD and Hayward have extensive wastewater collection and treatment systems that cover the majority of the EBP Subbasin. Additional wastewater collection and treatment facilities are operated by the City of Richmond, Stege Sanitary District, City of San Leandro, and Oro Loma Sanitary District. Most treated wastewater is discharged to the San Francisco Bay. The remaining treated wastewater is part of the EBMUD and Hayward recycled water systems (some of the other smaller wastewater treatment facilities also provide some recycled water). Uses of recycled water include large-scale irrigation projects (e.g., parks, golf courses) and industrial facilities (e.g., energy facility and refinery cooling). Local and imported water supplies are described in detail in **Appendix 2.A.b**.

2.2.2. Current and Historical Groundwater Conditions

(23 CCR Section 354.16)

Groundwater conditions include groundwater levels, groundwater storage, groundwater quality, seawater intrusion, land subsidence, surface water/groundwater interaction, and GDEs. The following sections describe each element of groundwater conditions in detail.

2.2.2.1. Groundwater Levels

Groundwater elevations can vary with depth, so the aquifer system is divided into four depth intervals for characterization of groundwater levels and flow:

- **Upper Shallow Aquifer:** 0–50 ft bgs (Water Table Aquifer Zone, or upper portion of Shallow Aquifer Zone where stream/aquifer interaction occurs),
- **Lower Shallow Aquifer:** 50–200 ft bgs (middle to lower portion of Shallow Aquifer Zone)
- **Intermediate Aquifer:** 200–400 ft bgs (Intermediate Aquifer Zone)
- **Deep Aquifer:** Greater than 400 ft bgs (Deep Aquifer Zone)

Most groundwater supply wells are screened at depth intervals somewhere between the lower portion of the Shallow Aquifer Zone and the middle of the Deep Aquifer Zone. Aquifer productivity generally increases with depth.

The spatial (geographic) and temporal (over time) distributions of historical groundwater level data are limited for all aquifer/depth zones. In general, the majority of wells with historical groundwater level data from the late 1950s to 1990s are groundwater supply wells in the southern EBP Subbasin. Most water level data collected since 2000 have come from monitoring wells throughout the entire Subbasin that are screened in the Shallow Aquifer Zone. However, during this time period, some data have also been collected for the Intermediate and Deep Aquifer Zones from EBMUD and Hayward monitoring and production wells in the southern EBP Subbasin. In general, overall groundwater flow is from the East Bay Hills toward San Francisco Bay, with local influences from pumping depressions.

<u>Shallow Aquifer Zone</u>

Available data for the Upper Shallow Aquifer (0-50 feet bgs) show the overall pattern of groundwater flow is from northeast to southwest following topography, although localized influences (e.g., utility trenches, streams, dewatering operations) tend to affect localized flow directions **(Figure 2-23)**. Groundwater elevation contour maps for other years, such as Spring/Fall 2002, 2008, and 2012, show similar elevations and groundwater flow patterns as maps for 2018 (**Appendix 2.A.b**).

Available data for the Lower Shallow Aquifer Zone (50–200 ft bgs) for various years in the area south of San Leandro Creek indicate that groundwater flows from the East Bay Hills toward San Francisco Bay and toward the southern boundary of the EBP Subbasin. Groundwater elevations typically range from about 40 ft above mean sea level (msl) near the East Bay Hills to about 0 ft above msl at the San Francisco Bay margin. Groundwater contour elevation maps for several years such as 1993, 2002, and 2018 (along with some years before 1990) are provided in **Appendix 2.A.b**.

Intermediate Aquifer Zone

Groundwater elevation contours for the Intermediate Aquifer Zone (200-400 ft bgs) for several representative years were prepared and are provided in **Appendix 2.A.b**. In general, before the 1990s, groundwater elevations were below sea level, with elevations highest near the East Bay Hills and lowest closest to the bay shoreline. The gradual recovery in Intermediate Aquifer Zone groundwater elevations continued into the early 1990s for most of the EBP Subbasin between Berkeley and Hayward; in spring 1993, the lowest groundwater elevations were in the range of -20 ft to -30 ft msl.

After the 1990s, Alameda County discontinued its groundwater monitoring program, and groundwater level data for the Intermediate Aquifer Zone became sparser than in previous years. To the extent that water level data are available after 2000, groundwater elevations in the Intermediate Aquifer Zone are indicated to generally be above sea level. Recent groundwater elevations (from Spring 2018) indicate a range from about 10 ft msl near the East Bay Hills to about 0 ft msl near the San Francisco Bay margin in the southern EBP Subbasin.

Deep Aquifer Zone

Groundwater level data are sparse for wells with depths greater than 400 ft; for many years, only one or two data points are available. Thus, maps prepared for **Appendix 2.A.b** have available data plotted to provide some indication of groundwater levels, but contours of groundwater elevations were not drawn. In general, the available data were limited to the southern portion of the Subbasin. A greater number of data points were available for the Deep Aquifer Zone starting in 2000, although available data remained limited to the southern one-third of the Subbasin.

Data for Spring 2002 indicated that Deep Aquifer Zone groundwater elevations ranged from about 30 ft above msl to about -10 ft below msl (**Figure 2-24**). The Spring 2002 map has limited data points, but the data generally show higher elevations near San Leandro Creek, with decreasing elevations (and groundwater flow) toward the south in the Hayward and Union City areas. The Fall 2002 map is generally similar to the Spring 2002 map, but more available data in the southern EBP Subbasin indicate a component of flow toward San Francisco Bay and toward the south within the EBP Subbasin. Groundwater elevations in the Deep Aquifer Zone for Spring 2018 show a relatively narrow range of groundwater elevations, from about -5 ft msl to 10 ft above msl for most wells. The hydraulic gradient has a relatively gentle slope from east to west (**Figure 2-25**). Deep Aquifer Zone groundwater elevations for the Fall 2018 generally ranged from -20 ft below msl to 0 ft above msl, with most data clustered between -4 below msl and 1 ft above msl.

Groundwater Hydrographs for Various Aquifer Zones

Groundwater hydrographs for selected individual wells in various depth zones are provided in **Appendix 2.A.b**. A map with an inset hydrograph of groundwater levels and a composite hydrograph illustrates how groundwater levels in the EBP Subbasin have fluctuated over time (**Figures 2-26 and 2-27**). Heavy groundwater pumping in the 1950s and early 1960s caused groundwater elevations in the Intermediate and Deep Aquifer Zones to fall well below sea level in the southern portion of the Subbasin. Beginning in the mid-1960s, groundwater pumping (by Hayward and for other industrial/irrigation uses) was reduced substantially, which resulted in a long-term recovery in groundwater levels in the Intermediate and Deep Aquifer Zones from the mid-1960s to the 1990s (**Figures 2-26 and 2-27**).

Also, although groundwater elevations in the Intermediate and Deep Aquifer Zones were substantially below sea level from the 1950s through 1970s, when considerably more groundwater pumping took place than occurs today, groundwater elevations in the Shallow Aquifer Zone were substantially higher and were generally maintained above sea level, a condition that has continued to the present day. Groundwater elevations in all aquifers have been relatively stable (at or above mean sea level) over the past 10–20 years. The composite hydrograph (**Figure 2-27**) provides a further indication of the hydraulic isolation of the Intermediate and Deep Aquifer Zones from the Shallow Aquifer Zone that is illustrated in the geologic cross sections described in Section 2.2.1.3.

Figures 2-28 and 2-29 show maps with inset groundwater level hydrographs and a composite hydrograph for water levels in the Shallow Aquifer Zone throughout the EBP Subbasin over the past 20 years. These hydrograph figures demonstrate that shallow groundwater levels in both the northern and southern portions of the EBP Subbasin have been maintained above sea level in the recent years for which data are available.

2.2.2.2. Groundwater Storage

DWR (1994) provided estimates of total groundwater storage capacity (from the ground surface to the base of alluvium), total groundwater in storage (from the water table to the base of alluvium), and total usable groundwater storage capacity (the volume of groundwater in storage above sea level). Total groundwater storage capacity was estimated to be 2,670,000 acre-feet (AF), which is based on an average equivalent specific yield of about 6%. Total groundwater volume in storage was estimated to be 2,560,000 AF, which is based on an average depth to water of 25 ft (range of 5–40 ft) and an average specific yield of 6%. Total usable storage capacity was estimated to be 80,000 AF, which represents the volume of groundwater in storage in the Shallow Aquifer Zone above msl.

As described in **Appendix 2.A.b**, the area covered by DWR's calculations differs significantly from the EBP Subbasin as defined in this GSP. The general approach used by DWR (1994) to calculate changes in groundwater storage was applied to the area within the current EBP Subbasin boundaries. The calculated total groundwater storage capacity for the entire EBP Subbasin is 2,280,000 AF, and total groundwater in storage beneath the water table was calculated to be 2,173,000 AF. Overall, the DWR study area for the groundwater storage calculations was approximately 5% larger than the current area of the EBP Subbasin.

The total usable storage capacity as calculated by DWR (80,000 AF) is likely underestimated, given that groundwater levels in the Intermediate and Deep Aquifer Zones have historically been drawn down more than 100 ft below sea level for an extended period of years without causing seawater intrusion (see discussion in Section 2.2.2.4). Additional evaluation of groundwater storage was conducted using the calibrated groundwater model documented in **Appendix 6.E.** Evaluation of groundwater storage using the groundwater model indicated a total of 1,926,000 AF in the entire EBP Subbasin, with 233,000 AF in the northern EBP Subbasin and 1,693,000 AF in the southern EBP Subbasin. Within the southern EBP Subbasin, there is a total of 511,000 AF in the Shallow Aquifer Zone, and a total of 1,182,000 AF in storage in the Intermediate and Deep Aquifer Zones.

2.2.2.3. Groundwater Quality

SGMA defines significant and unreasonable degradation of water quality, including the migration of contaminant plumes that impair water supplies, as one of six sustainability indicators. The GSP and GSAs are not responsible for remediation of existing and historical poor groundwater quality in the EBP Subbasin; regulated sites are addressed by other ongoing programs and are under the jurisdiction of regulatory agencies such as the San Francisco Bay RWQCB and DTSC. However, the GSP is intended to document baseline conditions and identify projects or management actions that avoid significant and unreasonable degradation of groundwater quality caused by groundwater extraction and/or other projects planned for ongoing groundwater sustainability (e.g., injection, environmental uses of groundwater).

Maps of available groundwater quality data for key groundwater quality constituents (TDS, chloride, nitrate, arsenic, and manganese) were prepared to characterize groundwater quality in the EBP Subbasin. **Table 2-4** lists each of the constituents and why the constituent was chosen to highlight groundwater quality.

Table 2-4. Key Groundwater Quality Constituents Selected for Characterizing the EBP Subbasin

Constituent	Reason Selected
Total Dissolved Solids (TDS)	Provides an indication of the overall quality of the groundwater and suitability for municipal, domestic, industrial, irrigation, and other water supply purposes.
Chloride	Provides a useful indicator for seawater intrusion.
Nitrate	Provides a useful indicator of the potential impact of wastewater treatment and disposal system (e.g., septic tanks, percolation ponds), fertilizer application, and livestock operations.
Arsenic	A naturally occurring constituent that was included to provide an indication of suitability for municipal, domestic, industrial, irrigation, and other water supply purposes
Manganese	A naturally occurring constituent that was included to provide an indication of suitability for municipal, domestic, industrial, irrigation, and other water supply purposes

Wells with groundwater quality data were classified into four different depth categories in the same manner as for groundwater level data: less than 50 ft bgs (Water Table Aquifer Zone or Upper Shallow Zone), 50–200 ft bgs (Lower Shallow Aquifer Zone), 200–400 ft bgs (Intermediate Aquifer Zone), and deeper than 400 ft (Deep Aquifer Zone). Separate maps were prepared for each of the four different aquifer depth zones, and a single map was prepared showing all wells deeper than 50 ft bgs. The map for wells deeper than 50 ft bgs includes wells with unknown construction and composite wells.

The five primary inorganic constituents described above were evaluated in detail, with maps showing the distribution of each constituent in the EBP Subbasin by aquifer. Maps were prepared to show average and maximum concentrations for each of the five constituents for the Shallow, Intermediate, and Deep Aquifer Zones (**Appendix 2.A.b**).

The key constituents listed in **Table 2-4** are described below followed by a discussion of existing and historical contaminants.

TDS, Chloride, and Nitrate

The maps of average TDS and chloride concentrations for all wells deeper than 50 ft (including wells with unknown depths) are similar. The maps indicate that areas of elevated concentrations[5] occur just south of the transition zone, in the northwest portion of Niles Cone Subbasin north of San Mateo Bridge adjacent to the EBP Subbasin, along the shoreline in western EBP Subbasin between Alameda Island and Bay Farm Island, in the middle to western portion of central Oakland, and in the Richmond area (**Figures 2-30 and 2-31**). The majority of wells with elevated TDS and chloride concentrations reflect conditions in the Shallow Aquifer Zone, although there also appear to be elevated TDS concentrations in deeper zones near Bay Farm Island.

Nitrate (as N) concentrations are generally greatest in the Shallow Aquifer Zone and lowest in the Deep Aquifer Zone. The map of average nitrate as nitrogen concentrations for all wells deeper than 50 ft (including wells with unknown depths) indicates that several wells exceed the primary MCL[6] (10 mg/L nitrate as N) throughout the Subbasin; however, a greater number of wells have nitrate concentrations below the MCL (**Figure 2-32**). A review of figures showing nitrate concentrations by depth zone, provided in **Appendix 2.A.b**, indicated that multiple wells have average and/or maximum concentrations of nitrate exceeding the MCL in the Shallow Aquifer Zone, but no wells classified as Deep Aquifer Zone have nitrate concentrations greater than 10 mg/L.

Several additional maps of TDS, chloride, and nitrate concentrations in different depth zones are provided in **Appendix 2.A.b**.

[5] For the purposes of this discussion, "elevated concentrations" generally refers to the occurrence of concentrations near or above the Secondary Maximum Contaminant Level (SMCL). SMCLs serve as guidelines to assist public water systems in managing drinking water for aesthetic qualities such as taste, color, and odor. Recommended and maximum SMCLs are 500 milligrams per liter (mg/L) and 1,000 mg/L, respectively, for TDS and 250 mg/L and 500 mg/L for chloride.

[6] Primary MCLs are enforceable standards designed to protect the public from health risks. They represent the maximum allowable contaminant concentration in drinking water delivered to the consumer.

Arsenic and Manganese

The map of average arsenic concentrations for all wells deeper than 50 ft (including wells with unknown depths) indicate that multiple wells with arsenic concentrations exceeding the primary MCL[5] occur in the South EBP Subbasin, and in a portion of Richmond near San Francisco Bay in the northern EBP Subbasin. (**Figure 2-33**). Elevated arsenic concentrations have been reported in at least one well in all three aquifer zones (**Appendix 2.A.b**).

Manganese concentrations are elevated throughout the EBP Subbasin (**Figure 2-34**) and in all three aquifer zones (**Appendix 2.A.b**). Manganese is a naturally occurring constituent that is prevalent in EBP Subbasin sediments, and often requires treatment for drinking water supplies.

Several additional maps of arsenic and manganese concentrations in different depth zones are provided in **Appendix 2.A.b**.

Existing and Historical Contaminants

A long history of commercial and industrial activities in the EBP Subbasin has resulted in the release of contaminants into the soil and groundwater system. To characterize the extent of contamination, a review of publicly available data from State of California databases was conducted. The GeoTracker database is the State Water Resources Control Board's (SWRCB) data management system for sites that affect, or have the potential to affect, water quality in California, with an emphasis on groundwater.

GeoTracker was used to plot the location of open contamination sites by site type in the Subbasin (**Figure 2-35**). Although contamination sites are distributed throughout the Subbasin, there is a denser concentration of sites in Emeryville, Oakland, Alameda, and northern San Leandro than in the rest of the Subbasin. Most contamination sites are classified as Cleanup Program Sites and Leaking Underground Storage Tank (LUST) Cleanup Sites; however, there are also several military-related sites in Alameda and western Oakland.

GeoTracker was also used to query groundwater quality data for the contamination sites of greatest concern within the EBP Subbasin, including for the following contaminants:

- Perchloroethene (PCE)
- Trichloroethene (TCE)
- Total petroleum hydrocarbons (TPH)
- Benzene, toluene, ethylbenzene, and xylenes (BTEX)
- Methyl tert-butyl ether (MTBE)
- Hexavalent chromium

The contaminants and dates selected for the query were based on the need to establish current baseline conditions for the most common and potentially impactful contaminants. The largest number of groundwater contamination sites in the EBP Subbasin (by number of sites) has resulted from the release of fuel-related contaminants (gasoline, BTEX, and MTBE) from leaking underground storage tanks. These fuel-related contaminants are typically found in the shallow groundwater system, as their density is less than water and they tend to "float" on the water table. As such, they pose less of a concern to groundwater resources than chlorinated solvents, which tend to sink, as their density is greater than that of water. **Appendix 2.A.b** provides maps and tabulated data for the TPH, BTEX, and MTBE groundwater contamination in the SBP Subbasin as of 2018–2019.

TCE and PCE are present in groundwater at multiple locations in the EBP Subbasin. **Appendix 2.A.b** provides a summary of the sites with current TCE and PCE concentrations above the MCL of 5 µg/L. Current PCE and TCE groundwater contaminant concentrations in the Subbasin range from 0 µg/L to 8,800 µg/L and occur at depths between approximately 3 ft and 121 ft bgs (i.e., isolated to the Shallow Aquifer Zone). The highest concentrations occur at the Chevron Chemical site in the city of Richmond.

Additional data and maps for a variety of other groundwater quality constituents are presented in **Appendix 2.A.b**. Many of these maps highlight distinct areas of local groundwater contamination that should be considered when evaluating potential groundwater quality impacts from implementation of projects and management actions to achieve sustainability.

The environmental site information compiled in Appendix 2.A.b indicates that contaminant plumes in the EBP Subbasin are currently limited in size relative to the scale of the EBP Subbasin and limited to the upper portion of the Shallow Aquifer Zone. Groundwater pumping occurs primarily from the Intermediate and Deep Aquifer Zones and is not expected to impact shallow contaminant plumes. The potential occurrence of new contaminant plumes that may develop in proximity to future GSA projects will be evaluated for potential influences from GSA activities as necessary.

Emerging Issue: PFOS/PFAS

The occurrence and distribution of per- and polyfluoroalkyl substances (PFAS) have become an emerging contaminant issue. According to the U.S. Centers for Disease Control and Prevention, PFAS have potential health effects related to cancer, liver damage, decreased fertility, asthma, and thyroid disease. No regulatory thresholds currently exist but some PFAS compounds have interim final environmental screening levels (ESLs) as non-regulatory guidance used to identify conditions for potential further investigation. A brief summary of currently available site information for the EBP Subbasin is provided below; additional updates on PFAS sites will be provided in future GSP update reports.

A review of available information on PFAS contaminants in the EBP Subbasin as of August 2021 revealed three reported sites located adjacent to San Francisco Bay in the EBP Subbasin: West Contra Costa Landfill (Richmond area), Oakland Airport, and West Winton Landfill (Hayward area). The West Contra Costa Landfill is located adjacent to biosolids drying lagoons for a wastewater treatment plant and had perfluorooctanoic acid (PFOA) detected in shallow brackish groundwater from six wells (up to 47 feet deep) and perfluorooctane sulfonate (PFOS) detected in four of six wells (up to 21 feet deep) at concentrations consistent with the range expected in municipal solid waste leachate. No additional sampling was recommended as of July 2020 (Geosyntec, 2020). The Oakland Airport site report indicated detection of PFAS compounds in soil and groundwater (in monitoring wells up to nine feet deep) in four different areas of the site. Additional investigation was ongoing at the time of the latest available report (CH2M Hill, December 2020). The West Winton Landfill site has been evaluated under a SWRCB order for PFAS sampling of landfill leachate and groundwater. Relatively low concentrations of PFAS compounds were detected in shallow brackish groundwater from monitoring wells up to 27 feet deep (Wood, April 2020).

The SWRCB is actively pursuing efforts to evaluate and reduce human exposure to PFAS, including:

On February 16, 2021, DDW issued General Order DW-2021-0001-DDW for public water systems to sample and report PFAS within and adjacent to Department of Defense facilities in California.

On March 5, 2021, DDW issued a drinking water notification level and response level of 0.5 parts per billion (ppb) and 5 ppb, respectively for perfluorobutane sulfonic acid (PFBS).

On March 12, 2021, the State Water Board issued Investigative Orders to Refineries and Bulk Fuel Terminals (161) for a one-time sampling effort to determine whether soil, groundwater, surface water, and influent and effluent wastewater at their locations were impacted by PFAS. These Orders included the required sampling for 31 PFAS compounds.

On July 1, 2021, The Department of Toxic Substances Control (DTSC) designated carpets and rugs containing per- or polyfluoroalkyl substances (PFASs) that are manufactured in or imported to California as a Priority Product. This designation requires domestic and foreign carpet and rug manufacturers that use PFAS and related chemicals in their products to submit a Priority Product Notification (PPN) for the affected products by August 30, 2021, with the goal of reducing human exposure to PFAS.

On July 22, 2021, The Office of Environmental Health Hazard Assessment (OEHHA) announced the release of a draft document for public review describing Public Health Goals (PHGs) for perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS) in drinking water. A PHG is a non-regulatory level of a contaminant in drinking water that does not pose a significant health risk. The public comment period for the draft document begins July 30, 2021 and ends September 28, 2021.

The EBP Subbasin GSAs will continue to monitor new developments related to PFAS and coordinate with the RWQCB in evaluating potential impacts on the EBP Subbasin.

2.2.2.4. Seawater Intrusion

Generally, aquifers interfacing with seawater have the potential to experience seawater intrusion when groundwater levels decline below msl. However, geologic conditions and the connection between aquifers and the seabed are equally important in determining the potential occurrence of seawater intrusion. Thus, an evaluation of seawater intrusion potential requires a detailed understanding of both groundwater level conditions and geologic conditions relating to the nature and occurrence of aquifers and aquitards.

Figure 2-36 depicts conceptual seawater intrusion scenarios for aquifers in a coastal basin. Typically, an unconfined aquifer in a coastal groundwater basin can be subject to seawater intrusion when groundwater levels fall below sea level. In this case, there is no hydraulic barrier of fine-grained units to slow or prevent inland migration of saline water to pumping wells.

In a multilayered aquifer/aquitard system, similar to the EBP Subbasin, where an unconfined aquifer is underlain by confined aquifers, the potential for seawater intrusion is a function of both groundwater elevations (or pressure head in a confined aquifer) and stratigraphic relationships. If the confined aquifer outcrops or intersects the seabed, significant potential for seawater intrusion exists when the confined aquifer's pressure heads are maintained below sea level.

A confined aquifer is also susceptible to seawater intrusion when the confining layers are not continuous or when improperly abandoned wells form conduits between an upper unconfined aquifer that may be intruded and the confined aquifer. However, if a confined aquifer does not intersect the seabed and has adequate confining layer(s), it may not experience seawater intrusion even when pressure heads are consistently below sea level.

The shallow and intermediate zones in the EBP Subbasin are primarily fine-grained without well-defined aquifers. As a result, saline bay water that may flow into the EBP Subbasin encounters shallow, disconnected coarse-grained zones that limit lateral inflow, and substantial impedance to vertical flow from the presence of thick layers of fine-grained sediments such as clay.

Although seawater intrusion has occurred in locally small areas of the Shallow Aquifer Zone near the bay margin in the EBP Subbasin (as indicated in TDS maps provided in **Appendix 2.A.b**), seawater was generally unable to migrate downward into the Intermediate and Deep Aquifer Zones because of the presence of relatively thick and continuous clay layers. From at least the 1950s through the 1970s, groundwater elevations in the EBP Subbasin were substantially below sea level in the Intermediate and Deep Aquifer Zones; however, this extended period of low groundwater elevations in the Subbasin did not result in seawater intrusion into the Intermediate and Deep Aquifer Zones.

2.2.2.5. Land Subsidence

Land subsidence is a decline in ground surface elevation, which can occur from natural or human-induced causes. Natural causes of land subsidence include natural consolidation of sediment and tectonics (seismic activity); human-induced causes are numerous and include oil and gas extraction, geothermal energy development, and groundwater pumping (LSCE et al., 2014). Groundwater pumping induces subsidence when the pumping reduces fluid pressure, which causes fine-grained materials (clay/silt particles) to be rearranged (flatten), thereby resulting in the compaction (reduction in thickness) of a fine-grained layer (**Figure 2-37**).

The groundwater pumping–induced compaction that causes land subsidence can be either elastic or inelastic. *Elastic* compaction or deformation is reversible when fluid pressures increase again; by contrast, *inelastic* deformation from compaction at lower fluid pressures is permanent and will not be reversed with future increases in fluid pressure. Small amounts of seasonal elastic deformation are quite common and typically do not cause problems with infrastructure (e.g., production wells, canals, and building foundations). Permanent land subsidence can result if current groundwater pumping lowers groundwater levels below the lowest historical groundwater elevation (i.e., historic low).

Similar to seawater intrusion, land subsidence is an undesirable result that can occur with certain groundwater level and geologic conditions. Although the groundwater level conditions that can lead to seawater intrusion are similar to those that can lead to land subsidence (i.e., significant declines in groundwater elevation), the geologic conditions conducive to land subsidence are different. In general, thick and continuous clay layers can serve as important aquitards to help prevent seawater intrusion; however, these same thick, continuous clay layers may provide geologic conditions susceptible to land subsidence.

It is important to recognize that some clay layers are much more susceptible to compaction (and thus to land subsidence) than others. Some groundwater basins have 200 ft or more of decline in groundwater elevations yet have not experienced significant subsidence. Thus, it is very important to understand the properties of clay layers when evaluating land subsidence. Although land subsidence has not been documented historically or reported as being a problem in the EBP Subbasin, the potential for future increased pumping of the Subbasin's Deep Aquifer system requires further evaluation and management of the potential for land subsidence.

The future potential for land subsidence in the EBP Subbasin as a result of groundwater withdrawal would exist only in areas where future groundwater levels are drawn down below historic lows. Information available to evaluate the potential for subsidence in the EBP Subbasin includes conditions when groundwater levels were at their historical lows, extensometer data collected during an eight-week regional pumping test completed in 2010, well logs and geologic cross sections, and clay properties documented by USGS (2015). These data and other information on subsidence are discussed in more detail in **Appendix 2.A.b**.

Available data indicate that the EBP Subbasin is not particularly susceptible to land subsidence. Nonetheless, land subsidence has at least the potential to occur should pumping cause groundwater levels to fall below historical lows.

2.2.2.6. Surface Water/Groundwater Interaction

The characterization of surface water/groundwater interactions is dependent on the availability of streamflow data, shallow groundwater level data, and an understanding of stratigraphic relationships within the EBP Subbasin. Available data relative to these three key data components are described in **Appendices 2.A.a and 2.A.b**. This section provides an overview of surface water/groundwater interactions, which is a key sustainability indicator and is important for assessment of GDEs.

The general occurrence and distribution of the major aquifers and aquitards in the EBP Subbasin are described in Section 2.2.1.3. The Upper Shallow Aquifer (i.e., the upper 50 ft of sediments or Water Table Aquifer Zone), where the streams interact most directly with and recharge/discharge to shallow groundwater, can generally be characterized as having a greater proportion of fine-grained sediments (clay and silt) with interbedded and discontinuous lenses of coarse-grained deposits (sand and gravel). A review of lithologic logs for shallow boreholes that emphasize characterization of the shallow zone lithology (e.g., environmental sites) indicates that the shallow zone's stratigraphy is quite variable among different streams and at different locations along the same stream.

As described in Section 2.2.2.1, available groundwater level data have been evaluated for four different depth zones: 0–50 ft, 50–200 ft, 200–400 ft, and greater than 400 ft. A review of hydrogeologic conditions in the EBP Subbasin in terms of geology and groundwater levels indicates that groundwater levels within the Upper Shallow Aquifer Zone are generally shallow **(Figure 2-38)**. In general, depths to groundwater in the Upper Shallow Aquifer Zone are less than 20 ft bgs in most of the EBP Subbasin, although there are some areas with groundwater levels between 20 ft and 30 ft bgs or more. Overall, depth to groundwater generally decreases from northeast (near the East Bay Hills) to southwest (San Francisco Bay) across the Subbasin, albeit with significant local variations. Thus, it can be expected that the potential for surface water/groundwater connection increases from east to west. In addition, where a surface water/groundwater connection is present, it can be expected that losing conditions are more likely in the eastern portion of the Subbasin and gaining conditions have more potential to occur in the western portion of the Subbasin. It should also be noted that portions of creek lengths are lined within the EBP

Subbasin; in particular, for San Lorenzo Creek where a majority of the creek bed is lined until about one mile inland from the Bay Margin.

2.2.2.7. Groundwater Dependent Ecosystems

SGMA requires GSAs to identify GDEs in their GSPs and to consider impacts on GDEs when managing groundwater. GDEs are defined under SGMA as "ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR Section 351[m]). GDE types include seeps and springs; wetlands and lakes; terrestrial vegetation connected to shallow groundwater; and rivers, streams, and estuaries.

A detailed analysis of potential GDEs was conducted in accordance with guidance from The Nature Conservancy (TNC) and is described in detail in **Appendix 2.A.b**. The analysis resulted in identification of potential GDEs covering a total of 147 acres (**Table 2-5** and **Figure 2-39**). Potential GDEs were concentrated around four waterways: San Pablo Creek, San Leandro Creek, Wildcat Creek, and Arroyo Viejo; and to a lesser extent, in wetlands located in Richmond. San Pablo Creek made up the majority of potential GDE area, totaling 127 acres. Additional monitoring and evaluation would be required to confirm, refine, and identify additional potential GDEs. Information about future data collection and management actions is described in further detail in Chapter 4 Section 4.1.2. The next step following identification of potential GDEs is to characterize GDE condition by assessing their hydrologic and ecological conditions. Characterization of the GDE conditions can be used to inform the establishment of sustainable management criteria, and the assessment of monitoring networks.

Table 2-5. Potential Groundwater Dependent Ecosystems

Waterway/Tributary	Habitat Classification Based on Imagery Analysis	Area (acres)
San Leandro Creek	Riparian Mixed Shrub/Hardwood	7.1
San Pablo Creek	Riparian Mixed Hardwood	32.2
Unnamed wetland	Riparian Mixed Hardwood	1.4
Wildcat Creek	Riparian Mixed Hardwood	1.3
San Pablo Creek	Riparian Mixed Hardwood	5.7
San Pablo Creek	Riparian Mixed Hardwood	19.9
San Pablo Creek	Riparian Mixed Hardwood	60.5
San Pablo Creek	Riparian Oak Woodland	8.9
Arroyo Viejo	Riparian Mixed Hardwood	6.9
Arroyo Viejo	Riparian Mixed Hardwood	2.8
	Total	**147**

Available data indicate that historical groundwater pumping from the Intermediate and Deep Aquifer Zones in the southern EBP Subbasin may have had minimal effects on the shallow zone's groundwater levels; however, there are no historical data on groundwater pumping and shallow groundwater levels for a similar assessment in the northern EBP Subbasin.

The ecological value of a GDE is higher for those that possess more natural or near-natural conditions or include species or habitats that have legal protection.[7] Accounting for ecological value allows GDEs to be ranked so they can be prioritized when determining potential effects of groundwater management activities. Alteration of groundwater levels can impact the extent and quality of GDE habitats for wildlife and plant species by reducing access to groundwater for vegetation and altering temperature and flow regimes necessary for spawning or rearing habitat for native fish. Reduction in vegetation may also negatively affect species that rely on riparian canopy, root systems, and understory vegetation for cover or shading.

As described in Appendix 2.A.b, a preliminary assessment of ecological condition was conducted for potential GDEs by reviewing intersecting records of special-status plant and wildlife species as well as critical habitat designated by the U.S. Fish and Wildlife Service.

Table 2-6 includes a list of special-status aquatic species and other special-status species frequently associated with wetland/riparian habitats with occurrence records overlapping mapped potential GDEs. Records for steelhead (*Onchorhynchus mykiss*), California red-legged frog (*Rana draytonii*), western pond turtle (Emys marmorata), and San Pablo song sparrow (*Melospiza melodia samuelis*) were associated with potential GDEs. The remaining_special-status species included in the **Table 2-6** had records that intersected with GDE features that require further field review.

Critical habitat for species associated with riparian or other aquatic habitats was not found to overlap with the East Bay Plain Subbasin boundary, with one exception. Critical habitat for the Central California Coast Distinct Population Segment (DPS) of steelhead occurs at the tidal portion of San Pablo Creek and San Lorenzo Creek. This critical habitat designation does not extend into non-tidal portions of these creeks and does not overlap with any mapped GDEs.

Table 2-6. Special-Status Species within Mapped GDE Polygons

Common Name	Scientific Name	Status[1] (Federal/ State/ Other)	Habitat Requirements	GDE locations
Birds				
San Pablo Song Sparrow	*Melospiza melodia samuelis*	-/SSC/BCC	Found in the brackish marshes vegetated with pickleweed and gumplant along San Pablo Bay.	Brackish marshes and salt marshes at San Pablo Creek and Wildcat Creek
Alameda song sparrow	*Melospiza melodia pusillula*	-/SSC/BCC	Found in the brackish marshes vegetated with pickleweed along the southern portion of the San Francisco Bay.	San Lorenzo Creek*

[7] Serov, P., Kuginis, L. and Williams, J.P., 2012. Risk assessment guidelines for groundwater dependent ecosystems.

Table 2-6. Special-Status Species within Mapped GDE Polygons				
Common Name	Scientific Name	Status[1] (Federal/ State/ Other)	Habitat Requirements	GDE locations
California Ridgway's rail	*Rallus obsoletus obsoletus*	FE/SE/-	Ranges along the Pacific Coast within Monterey and San Luis Obispo Counties. Found in the tidal mudflats and sloughs of the San Francisco Bay-Delta.	Salt marsh north of Sulphur Creek* San Lorenzo Shoreline marshes* Bay Shore in Richmond*
Fish				
Steelhead (Central California Coast DPS)	*Onchorhynchus mykiss*	FT/-/-	Spawns and rears in coastal streams between the Russian River and Aptos Creek, as well as drainages tributary to San Francisco Bay, where gravelly substrate and shaded riparian habitat occurs.	San Pablo Creek Wildcat Creek San Leandro Creek San Lorenzo Creek*
Longfin smelt	*Spirinchus thaleichthys*	FC/ST/-	Juvenile and subadults predominately inhabit brackish water areas of the estuary and nearshore coastal waters. Adults return to spawn in the freshwater regions of the lower Sacramento River, near or downstream of Rio Vista, and the lower San Joaquin River downstream of Medford Island.	Occurrence records in South San Francisco Bay (may overlap GDEs mapped along bay edge)*
Mammals				
Pallid bat	*Antrozous pallidus*	-/SSC/WBWG: High	A wide variety of habitats is occupied, including grasslands, shrublands, woodlands, and forests from sea level up through mixed conifer forests. The species is most common in open, dry habitats with rocky areas for roosting. Roosts in buildings, caves, tree hollows, crevices, mines, and bridges. Sensitive to human disturbance.	Mixed riparian habitat along Cerrito Creek*
Hoary bat	*Lasiurus cinereus*	-/*/WBWG: Medium	Solitary rooster in tree foliage. Habitats include woodlands, forests, and riparian habitats with dense foliage. Winters along the coast and in Southern California. During migration can be found throughout California.	Mixed riparian habitat along Cerrito Creek*
Salt marsh harvest mouse	*Reithrodontomys raviventris*	FT/SSC/-	Inhabit pickleweed habitat and other salt marsh vegetation within the greater San Francisco Bay region.	Salt marsh north of Sulphur Creek* San Lorenzo diked wetland*

Table 2-6. Special-Status Species within Mapped GDE Polygons

Common Name	Scientific Name	Status[1] (Federal/ State/ Other)	Habitat Requirements	GDE locations
Salt marsh wandering shrew	*Sorex vagrans halicoetes*	--/SSC/--	Salt marsh habitat 6-8 feet above sea level, with abundant pickleweed and driftwood.	Johnson and Hayward Landings* Oakland Airport*
Amphibians				
California red-legged frog	*Rana draytonii*	FT/SSC/-	Breeds in fresh emergent and seasonal wetlands, and slow-moving streams. Requires 11–20 weeks of permanent water for larval development. Aestivation habitat includes oak woodlands and grasslands. Species will travel more than 1 mile from breeding habitat to access aestivation habitat.	San Pablo Creek
Reptiles				
Western pond turtle	*Emys marmorata*	--/SSC/--	Found in slow-moving rivers, streams, lakes, ponds, wetlands, reservoirs, and brackish estuarine waters with deep pools and rocks, logs, and other exposed surfaces for basking.	San Pablo Creek
Plants				
Western leatherwood	*Dirca occidentalis*	-/-/CRPR 1B.1	Broadleafed upland forest, Closed-cone coniferous forest, Chaparral, Cismontane woodland, North Coast coniferous forest, Riparian forest, Riparian woodland	Kennedy Grove Regional Park, located along San Pablo Creek

NOTES:

1 Description of status codes:
ESU = Evolutionarily Significant Unit, DPS = Distinct Population Segment

* These occurrence records were associated with GDE features that were flagged for further review

Federal Listings	State Listings	Other
FE = Listed as endangered under the FESA FT = Listed as threatened under the FESA FC = Candidate for listing under the FESA BCC = Bird of Conservation Concern (USFWS)	SE = Listed as endangered under the CESA ST= Listed as threatened under the CESA SSC = Species of Special Concern (CDFW) CE = Candidate Endangered (CDFW) FP = Fully Protected (CDFW)	BCC = USFWS Birds of Conservation Concern WBWG = Western Bay Working Group California Rare Plant Rank (CRPR) (e.g., 1B.1)

Additional field surveys are proposed to fill hydrologic and ecological condition data gaps (see Chapter 4 Section 4.1.2). These surveys will help to further characterize and validate potential GDEs, including identification of habitats and specific plant species, and to evaluate the potential for special-status species to occur. More detail about proposed biological surveys can be found in Chapter 4 Section 4.1.2.1.4. This data will be used to determine whether groundwater conditions in the basin may have potential effects on GDEs and whether undesirable changes may result. Determining potential effects on GDEs will help set minimum thresholds for sustainability indicators that can prevent adverse impacts to GDEs (a beneficial use and user of groundwater) and can inform which indicators and targets could be incorporated into the basin's monitoring network.

2.2.3. Water Budget Information

(23 CCR Section 354.18)

A water budget is a tabulation of all the components of inflow (recharge) and outflow (discharge) from the groundwater basin. Data collected during water budget calculations were summarized in **Appendices 2.A.a and 2.A.b**. This section describes the approach to the water budget analysis, identifies the water budget analysis period, and quantifies recharge and discharge (i.e., inflow and outflow) components for both historical, current, and projected future conditions. While the water balance presented in this section focuses on the groundwater system water budget, the surface water (imported surface water and local streamflow) contributions to groundwater recharge are included in the water budgets described below. However, a separate accounting of the surface water system budget that provided input to the groundwater system budget described below is provided in **Appendix 2.A.f.**

2.2.3.1. Water Budget Analysis Approach

The water budget evaluation for this GSP is based on results of previous studies and additional analyses to verify and/or update previous calculations. Water budget components that were derived before and independent of the groundwater model are described in detail in **Appendix 2.A.b** and summarized in this section of the GSP. These components were used as initial input to the groundwater model and were subsequently modified to some extent during the model calibration process. Because certain components of a water budget require output from a model (e.g., lateral subsurface inflow/outflow), the initial, pre-model water budget did not include these components. The final water budget for the GSP was derived from the calibrated model, which is described in detail in **Appendix 6.E**. The results of the modeled water budget are also summarized in this section, along with a comparison of the pre- and post-modeled water budgets.

The primary components of groundwater recharge in the EBP Subbasin are:

- Rainfall infiltration,
- Streamflow infiltration (i.e., losing streams),
- Leaking pipes from water and sewer systems,
- Irrigation return flows, and
- Inflow from fractured bedrock (not accounted-for in previous studies).

The primary components of groundwater discharge in the EBP Subbasin include:

- Groundwater pumping,
- Subsurface outflow towards San Francisco Bay,
- Net inflow/outflow across the southern EBP Subbasin's boundary with the Niles Cone (not accounted-for in previous studies),
- Streamflow discharge (i.e., gaining streams), and
- Sewer pipe outflow (i.e., groundwater entering non-pressurized systems).

As noted above, inflow from bedrock and net inflow/outflow across the southern EBP Subbasin's boundary with the Niles Cone were either discounted or not included in previous studies. Based on the LSCE Team's experience with studies in other basins and a review of DWR well logs for the East Bay Hills, groundwater present in fractured bedrock should be included as a component of inflow to the groundwater basin. Net inflow/outflow between the EBP Subbasin and Niles Cone is important and can be best estimated using a groundwater model; hence, the new groundwater model was used as a tool to quantify components of the water budget.

2.2.3.2. Water Budget Analysis Period

Precipitation records for three stations within the EBP Subbasin with relatively long periods of record were reviewed for average annual precipitation and the occurrence of wet, normal, and dry years. Cumulative departure from mean curves were prepared to evaluate the occurrence of different water year types and to select a representative hydrologic period (**Appendix 2.A.b**). A review of precipitation data since 1950 for the three stations (Richmond, Berkeley, and San Leandro) generally shows an average rainfall period from 1951 to 1958, followed by sequences of overall dry and wet years. Dry-year sequences occurred in 1959–1966, 1974–1977, 1984–1994, and 2007–2015. Wet-year sequences occurred in 1967–1973, 1978–1983, 1995-2006, and 2016–2019.

Based on review of the departure from mean curves, the 26-year period from 1990 to 2015 was selected for the historical water budget analysis period for the following reasons:

- It begins and ends with dry years, when the amount of water in transit within the vadose (unsaturated) zone is minimized;
- Rainfall during this period is close to long-term average conditions, which provides a time period representative of long-term average hydrologic conditions;
- This period includes a range of hydrologic conditions (dry, wet, average), which helps for the model calibration and evaluation of hypothetical scenarios.

2.2.3.3. Initial Quantification of Recharge and Discharge Components

The primary components of recharge in the EBP Subbasin that require quantification are rainfall infiltration, excess infiltration of applied irrigation water, streamflow infiltration, pipe leakage, bedrock inflow, and lateral subsurface inflows. The primary discharge components in the Subbasin that require quantification are groundwater pumping, lateral subsurface outflows, discharge to streams, and sewer pipe outflow.

Most of these recharge and discharge components were quantified initially to provide input to the groundwater model. Each water balance component was evaluated further during development and calibration of the groundwater model. **Table 2-7** and **Table 2-8**, respectively, summarize initial quantification of the recharge and discharge components of the water balance. More detailed information about the derivation of each water balance component is provided in **Appendix 2.A.b**.

Table 2-7. Initial Quantification of Recharge Components for the Historical Water Balance

Inflows	Average Annual (AFY[1])	Potential Range	Comments
Rainfall Infiltration	4,800	3,000–8,000	Builds on Muir (1994) analysis, with refinements to the San Lorenzo/San Leandro areas and inclusion of the Richmond area.
Irrigation Return Flows—Large Parcels	750	500–1,000	Based only on area of relatively large, irrigated parcels (e.g., parks, golf courses, cemeteries), 2.5 ft of applied irrigation water, and 15% return flows.
Irrigation Return Flows—Residential Parcels	1,600	1,000–2,000	Based only on area of residential properties, after removal of building/road area, assumes one-third of remaining area irrigated, 2.0 ft of applied irrigation water, and 10% return flows.
Leaking Pipes - Water	4,350	2,000–7,500	Based on Muir analysis for 1990s and water audit data for 2017, assumes 50% of annual leakage is lost to evapotranspiration by trees, utility trench inflow, runoff to storm drains, etc.
Leaking Pipes - Sewer	3,000	1,500–5,000	Based on Muir analysis for 1990s, wastewater treatment plant data for 2015, and a sewer pipe leak rate estimated to be 5%. The estimate was reduced by one-third to account for losses via evapotranspiration, utility trench inflow, etc.
Stream Infiltration	2,350	1,000–5,000	Based on review of previous studies and data, estimated infiltration rates of 0.5 to 0.8 cfs[2]/mile for unlined stream channels.
Fractured Bedrock	2,600	1,000–4,000	Darcy's Law calculation based on bedrock WCR specific capacity data. For comparison, 2,600 AFY of bedrock inflow equates to 0.9 inches per year of recharge over 34,000 acres of hills bordering the subbasin (3% to 4% of average annual rainfall) in adjacent bedrock areas.
Recharge Totals	**19,450**	**10,000–32,500**	--

[1] AFY = acre-feet per year.

[2] cfs = cubic feet per second.

Table 2-8. Initial Quantification of Discharge Components for the Historical Water Balance			
Outflows	Average Annual (AFY)	Potential Range	Outflows
Groundwater Pumping	3,150	2,000–4,000	Based on analyses conducted by Muir (1996), EBMUD (2018), and WRIME (2005).
Subsurface Outflow towards San Francisco Bay	13,500	8,000–17,000	Based on estimate by Muir (1996); refined value was determined during model development/ calibration; value can vary widely (and possibly outside listed range) depending on amount of groundwater pumping.
Stream Outflow and Sewer Pipe Outflow	2,800	500–4,000	Calculated as residual of water balance; will be determined during model development and calibration; value can vary widely (and possibly outside the listed range) depending on amount of groundwater pumping.
Discharge Totals	**19,450**	**10,500–25,000**	

The EBP Subbasin has not undergone significant changes that would change the water balance since 1990, in terms of either land use or other factors. The Subbasin's urban, commercial, and industrial uses were largely developed by 1990, and subsequent changes have been relatively minor (see Section 2.1.3). As of 1990, sources of water supply for the Subbasin were dominated by surface water imported by EBMUD and from Hetch Hetchy (for Hayward), a condition that continues today. Groundwater pumping for industrial, agricultural/irrigation, and domestic uses has remained relatively steady from the 1990s to present. Therefore, the current water budget is essentially the same as the historical water budget.

Total recharge (and discharge) in the EBP Subbasin was initially estimated to be approximately 19,450 AFY under historical (1990 to 2015) and current conditions. Various components of the water balance were modified as part of the model calibration phase. The final water balance derived from the calibrated groundwater flow model is described below and in **Appendix 6.E**.

2.2.3.4. Final Quantification of Recharge and Discharge Components

The initial estimates for the historical budget summarized in **Tables 2-7 and 2-8** provided the basis for initial inputs to the groundwater model that is described in **Appendix 6.E**. Some additional work was conducted as part of model development to develop the annual variation in rainfall recharge based on fluctuations in rainfall over the historical model calibration base period. In addition, stream recharge and discharge were not direct inputs to the model, but rather were simulated in the model to quantify these components (as a function of differences between shallow groundwater levels and stream stage). Stream recharge and discharge are more of an output from the modeling calibration effort than an input during model development. This is also the case for the amount of subsurface outflow to San Francisco Bay. During calibration of the groundwater model, aquifer parameters (e.g., hydraulic conductivity, storage coefficient) and water balance components were adjusted to optimize the match between model-simulated and observed (field-measured) groundwater levels. As a result of groundwater model calibration, some modest adjustments were made to initial water budget model inputs to achieve a final water budget for the historical calibrated model. The final modeled historical water balance is described in detail in **Appendix 6.E** and summarized in **Tables 2-9 and 2-10**.

Table 2-9. Initial and Final Quantification of Recharge Components for the Historical Water Balance

<table>
<tr><th>Inflows</th><th>Initial Average[1] Annual (AFY)</th><th>Final Transient Average[2] Annual (AFY)</th><th>Difference of Initial and Final (AFY)</th><th>Comments</th></tr>
<tr><td>Precipitation Recharge</td><td>4,800</td><td rowspan="5">14,400</td><td rowspan="5">-100</td><td rowspan="5"></td></tr>
<tr><td>Excess Irrigation Recharge—Large Parcels</td><td>750</td></tr>
<tr><td>Excess Irrigation Recharge—Residential Parcels</td><td>1,600</td></tr>
<tr><td>Water Pipe Leaks</td><td>4,350</td></tr>
<tr><td>Sewer Pipe Leaks</td><td>3,000</td></tr>
<tr><td>Stream Infiltration</td><td>2,350</td><td>2,500</td><td>+150</td><td></td></tr>
<tr><td>Bedrock Inflow</td><td>2,600</td><td>1,850</td><td>-750</td><td></td></tr>
<tr><td>Inflow from Niles Cone</td><td>NE[3]</td><td>950</td><td>NA[4]</td><td>When combined with outflow (Table 2-9), there is a net outflow from EBP to Niles Cone of 1,450 AFY.</td></tr>
<tr><td>Total</td><td>19,450</td><td>18,750</td><td>-700</td><td>Totals do not include inflow from Niles Cone</td></tr>
</table>

[1] Derived from analyses presented in **Appendix 2.A.b**; represents initial estimate of historical (1991-2015) water budget

[2] Derived from calibrated groundwater model presented in **Appendix 6.E**; based on transient (1991-2015) groundwater model run; represents final estimate of historical (1991-2015) water budget

[3] Not Estimated

[4] Not Applicable

Table 2-10. Initial and Final Quantification of Discharge Components for the Historical Water Balance

Discharges	Initial Average[1] Annual (AFY)	Final Transient Average[2] Annual (AFY)	Average Annual Difference (AFY)	Comments
Groundwater Pumping	3,150	3,850	+700	
Subsurface Outflow toward San Francisco Bay	13,500	8,450	-5,050	This difference is related, in part, to the increase in groundwater storage from 1991 to 2015.
Stream Discharge and Sewer Pipe Outflow	2,800	2,950	+150	
Outflow to Niles Cone	NE[3]	2,350	+2,350	This difference should be combined with difference in Subsurface Outflow toward SF Bay
Total	**19,450**	**17,600**	**-1,850**	

[1] Derived from analyses presented in **Appendix 2.A.b**; represents initial estimate of historical (1990-2015) budget.

[2] Derived from calibrated groundwater model presented in **Appendix 6.E**; based on transient (1991-2015) groundwater model run; represents final estimate of historical (1991-2015) water budget.

[3] Not Estimated (NE): this component is effectively incorporated into the estimate of Subsurface Outflow toward San Francisco Bay.

2.2.3.5. Future Projected Water Budget

The future projected water budget includes the anticipated influences of climate change, land use changes, and changes related to implementation of GSA projects and management actions**.** The analysis of each of these components is described briefly in this section, and additional details are provided in other sections and appendices of this GSP.

2.2.3.5.1. *Climate Change*

Several documents describing climate change in California, the San Francisco Bay region, and the East Bay Plain Subbasin were reviewed as described in **Appendix 6.D**. The anticipated effects of future climate change were considered both in terms of expected sea level rise and expected changes in hydrology (i.e., precipitation, evapotranspiration or ET, and streamflow)**.** Projections of sea level rise expected by 2070 include significant uncertainty, with estimates ranging from 1.5 to 3.5 feet by 2070**.** The DWR climate change guidance document was given greater weight and provides an estimated sea level rise of 1.5 feet by 2070. However, this GSP uses a slightly greater assumed sea level rise of 2.0 feet by 2070, which is conservative and includes consideration of other studies indicating somewhat higher estimates of sea level rise.

Several climate changes studies were also reviewed with respect to anticipated changes in various components of hydrology, including precipitation, ET, and streamflow; the results are documented in **Appendix 6.D**. Overall, these studies indicate a tendency towards greater precipitation and streamflow along with higher ET. The DWR climate change guidance included specific change factors for the EBP Subbasin with regard to all three hydrologic components (**Appendix 6.D**). The change factors indicate a higher percentage of increase for precipitation than for ET, especially in the key months of December to March when most groundwater recharge occurs. In addition, future streamflow is expected to be greater than historically. However, there is significant uncertainty associated with these change factors, and to be more conservative in the implications of future hydrology for groundwater conditions, groundwater recharge and streamflow in the future were assumed to remain the same as historical levels (i.e., less recharge and streamflow than forecasted) for analysis in this GSP.

2.2.3.5.2. *Land Use Changes*

A detailed review of several land use planning documents and General Plans covering the EBP Subbasin is provided in Appendix 2.A.e and a brief summary is provided in Section 2.1.3. As described in these other sections, vacant land typically comprises less than 5% of the total land area, with potentially developable vacant land on the order of 2% of total land area. The majority of future population growth is expected to occur via redevelopment. Furthermore, green infrastructure is emphasized in all land use and general plans, including retention/detention and percolation of storm runoff and use of pervious pavement that likely will locally increase groundwater recharge. Overall, the net effect of anticipated land use changes and the emphasis on green infrastructure is most likely to increase overall groundwater recharge across the EBP Subbasin as a whole. Even if a net increase in impervious area of 2% is assumed, the net decline in groundwater recharge would only be on the order of 100 AFY (based on a 2% reduction in the total area subject to precipitation recharge; 44,864 ac x 0.02 = 900 ac x .107 AFY/ac = 96 AFY reduction). This small change in total groundwater recharge is due, in part, to the fact that precipitation recharge only accounts for approximately 25% of total recharge to the EBP Subbasin and is the primary recharge component that would be reduced by an increase in impervious area.

2.2.3.5.3. *Projected Future Water Budget*

Projected future water budgets were derived from the groundwater model after accounting for anticipated climate change and land use changes as described above. In addition, future water budgets were estimated both without GSA groundwater development projects (i.e., baseline) and with GSA projects (i.e., future scenario with projects). **Table 2-11** shows recharge components for the projected future model runs compared to the historical and current model water budgets. The historical water budget period is 1991 to 2015, the current water budget period is 2016 to 2021, and the projected future water budgets cover the period from 2022 to 2071. Differences in recharge components among these various water budgets are relatively small and illustrate the stable groundwater conditions in the EBP Subbasin.

<table>
<tr><th colspan="5">Table 2-11. Recharge Components for Historical, Current, and Projected Water Balances</th></tr>
<tr><th>Inflows</th><th>Final Historical Transient Average[1] Annual (AFY)</th><th>Final Current Transient Average[2] Annual (AFY)</th><th>Projected Future Baseline[3](AFY)</th><th>Project Future Scenario with Projects[4] (AFY)</th></tr>
<tr><td>Precipitation Recharge</td><td rowspan="5">14,400</td><td rowspan="5">14,300</td><td rowspan="5">14,400</td><td rowspan="5">14,400</td></tr>
<tr><td>Excess Irrigation Recharge—Large Parcels</td></tr>
<tr><td>Excess Irrigation Recharge—Residential Parcels</td></tr>
<tr><td>Water Pipe Leaks</td></tr>
<tr><td>Sewer Pipe Leaks</td></tr>
<tr><td>Stream Infiltration</td><td>2,500</td><td>2,550</td><td>2,400</td><td>2,400</td></tr>
<tr><td>Bedrock Inflow</td><td>1,850</td><td>1,850</td><td>1,850</td><td>1,850</td></tr>
<tr><td>Injection</td><td>0</td><td>0</td><td>0</td><td>50</td></tr>
<tr><td>Inflow from Niles Cone</td><td>950</td><td>775</td><td>650</td><td>750</td></tr>
<tr><td>Total</td><td>19,700</td><td>19,475</td><td>19,300</td><td>19,450</td></tr>
</table>

[1] Derived from calibrated groundwater model presented in **Appendix 6.E**; based on transient (1991-2015) groundwater model run; represents final estimate of historical (1991-2015) water budget.

[2] Derived from calibrated groundwater model presented in **Appendix 6.E**; based on the transient (2016-2021 conditions) groundwater model run; represents final estimate of current water budget.

[3] Derived from calibrated groundwater model presented in **Appendix 6.E**; base on the transient (2022-2071) groundwater model run; represents projected future water budget baseline without GSA projects.

[4] Derived from calibrated groundwater model presented in Appendix 6.E; base on the transient (2022-2071) groundwater model run; represents projected future water budget baseline with GSA projects.

Table 2-12 shows water budget discharge components for the simulations of future conditions compared to the historical and current conditions. The primary differences are an increase in groundwater discharge to San Francisco Bay from historical conditions to current and projected future conditions (primarily due to ongoing recovery of groundwater levels in the 1990s and early 2000s from previous lows), and a slight increase in stream discharge and sewer pipe outflow under projected future conditions due to rising sea level. In addition, the model simulations show no difference between groundwater discharge to streams for the baseline future simulation and the groundwater resources development scenario: both of the 50-year transient simulations show an average total stream discharge of 3,625 AFY**.** Total recharge and total discharge to/from the EBP Subbasin show minimal changes (250 AFY or less out of about 19,500 AFY) between current and projected future water balance conditions**.**

Table 2-12. Discharge Components for Historical, Current, and Projected Future Water Balances

Discharges	Final Historical Transient Average[1] Annual (AFY)	Final Current Transient Average[2] Annual (AFY)	Projected Future Baseline[3] (AFY)	Project Future Scenario with Projects[4] (AFY)
Groundwater Pumping	3,825	3,625	3,625	3,900
Subsurface Outflow toward San Francisco Bay	8,425	10,050	9,750	9,700
Stream Discharge and Sewer Pipe Outflow	2,975	3,100	3,625	3,625
Outflow to Niles Cone	2,325	2,225	2,025	2,025
Total	**17,550**	**19,000**	**19,025**	**19,250**

1 Derived from calibrated groundwater model presented in **Appendix 6.E**; based on transient (1991-2015) groundwater model run; represents final estimate of historical (1991-2015) water budget.

2 Derived from calibrated groundwater model presented in **Appendix 6.E**; based on the transient (2016-2021 conditions) groundwater model run; represents final estimate of current water budget.

3 Derived from calibrated groundwater model presented in **Appendix 6.E**; base on the transient (2022-2071) groundwater model run; represents projected future water budget baseline without GSA projects.

4 Derived from calibrated groundwater model presented in **Appendix 6.E**; base on the transient (2022-2071) groundwater model run; represents projected future water budget baseline with GSA projects.

2.2.3.6. Sustainable Yield

The estimate of sustainable yield is based on:

- previous studies (Muir, 1996; Norfleet, 1998),
- the water balance analysis provided in the GSP HCM (**Appendix 2.A.b**), and
- the groundwater model developed for this GSP.

Muir conducted studies in the 1990s on the Alameda County portion of the EBP Subbasin from Berkeley in the north to Hayward in the south. Muir prepared three studies on recharge (1994), discharge (1996), and groundwater yield (1996), which are all summarized in **Appendix 2.A.b**. Muir defined the “yield of the groundwater reservoir” in the East Bay Plain to be based on the amount of groundwater that could be pumped “…year after year without decreasing groundwater in storage to the point where the intrusion of seawater from San Francisco Bay would occur.” Muir (1996) concluded that the groundwater yield of the East Bay Plain was approximately 10,000 AFY. The area covered by Muir’s study is the pre-2016 southern EBP Subbasin boundary in the south to the Alameda County line in the north and did not include the portion of the EBP Subbasin north of Berkeley.

Norfleet (1998) documented historical groundwater use in the East Bay Plain, including in the Richmond area at the northern end of the EBP Subbasin in an area that was not included in Muir’s study. Records of total groundwater pumping in the Richmond area prior to 1930 indicated total groundwater pumping as high as 3 to 4 MGD (equivalent to 2,100 to 2,800 gpm, or 3,400 to 4,500 AFY). However, it was determined that this pumping rate was not sustainable, and that the "safe yield" for the Richmond area was approximately 2 MGD (1,400 gpm or 2,200 AFY). The areas covered by the Muir (1996) and Norfleet (1998) reports did not include the area between Berkeley and Richmond (i.e., El Cerrito and Albany).

The water balance analysis conducted for this GSP (and documented in **Appendix 2.A.b**) included various components of recharge (infiltration from precipitation, infiltration from applied irrigation water, stream infiltration, pipe leaks, and bedrock inflow) and discharge (groundwater pumping, discharge towards the Bay, discharge to streams, sewer inflow/infiltration). The initial estimate of total recharge comprising the five major recharge components was 19,450 AFY. The estimated total discharge was also 19,450 AFY with groundwater pumping accounting for 3,150 AFY, subsurface outflow towards the Bay accounting for 13,500 AFY, and the remaining amount of 2,800 AFY is associated with stream discharge and sewer pipe outflow. Allowing for a relatively large and conservative subsurface outflow of 4,000 to 5,000 AFY towards the Bay and 3,000 AFY for stream discharge/sewer outflow indicates sustainable yield may be on the order of 12,000 to 13,000 AFY.

The EBP Subbasin groundwater model developed for this GSP used a steady-state groundwater model run to evaluate sustainable yield for the EBP Subbasin. Hypothetical wells were distributed fairly evenly over the extent of the Subbasin, and pumping rates were assigned in proportion to transmissivity of the major aquifers at each well location. The assigned pumping rates were adjusted in three areas (northern EBP Subbasin, and the northern and southern areas of the southern EBP Subbasin) to satisfy three criteria to estimate the sustainable yield:

1. Maintain simulated groundwater elevations in the Shallow Aquifer Zone along the Bay margin above the elevation of San Francisco Bay;
2. Maintain net neutral to positive groundwater flow towards the Bay in each of the three areas; and
3. No intrusion of saline water into the EBP Subbasin**.**

This analysis with the groundwater model resulted in an estimated sustainable yield of approximately 12,500 AFY for the entire EBP Subbasin. Based on best available data at this time, this estimated sustainable yield represents a maximum amount that assumes approximately evenly spaced pumping throughout the Subbasin that is unlikely to actually occur. This initial estimate of sustainable yield will be refined in the future with collection of additional field data, refinement of the water balance, development of a better understanding of surface water depletion, updates to the groundwater model, and additional model simulations of transient model runs with specific proposed projects and management actions.

2.2.4. Management Areas *(23 CCR Section 354.20)*

No management areas are proposed for the EBP Subbasin because there is hydraulic connection between the northern and southern EBP Subbasin (groundwater pumping in the southern EBP Subbasin can affect the northern EBP Subbasin and vice versa) and there are data gaps in the northern EBP Subbasin that would make developing separate management areas very difficult. Management areas may be considered in the future if new data indicates it is necessary.

2.3. References

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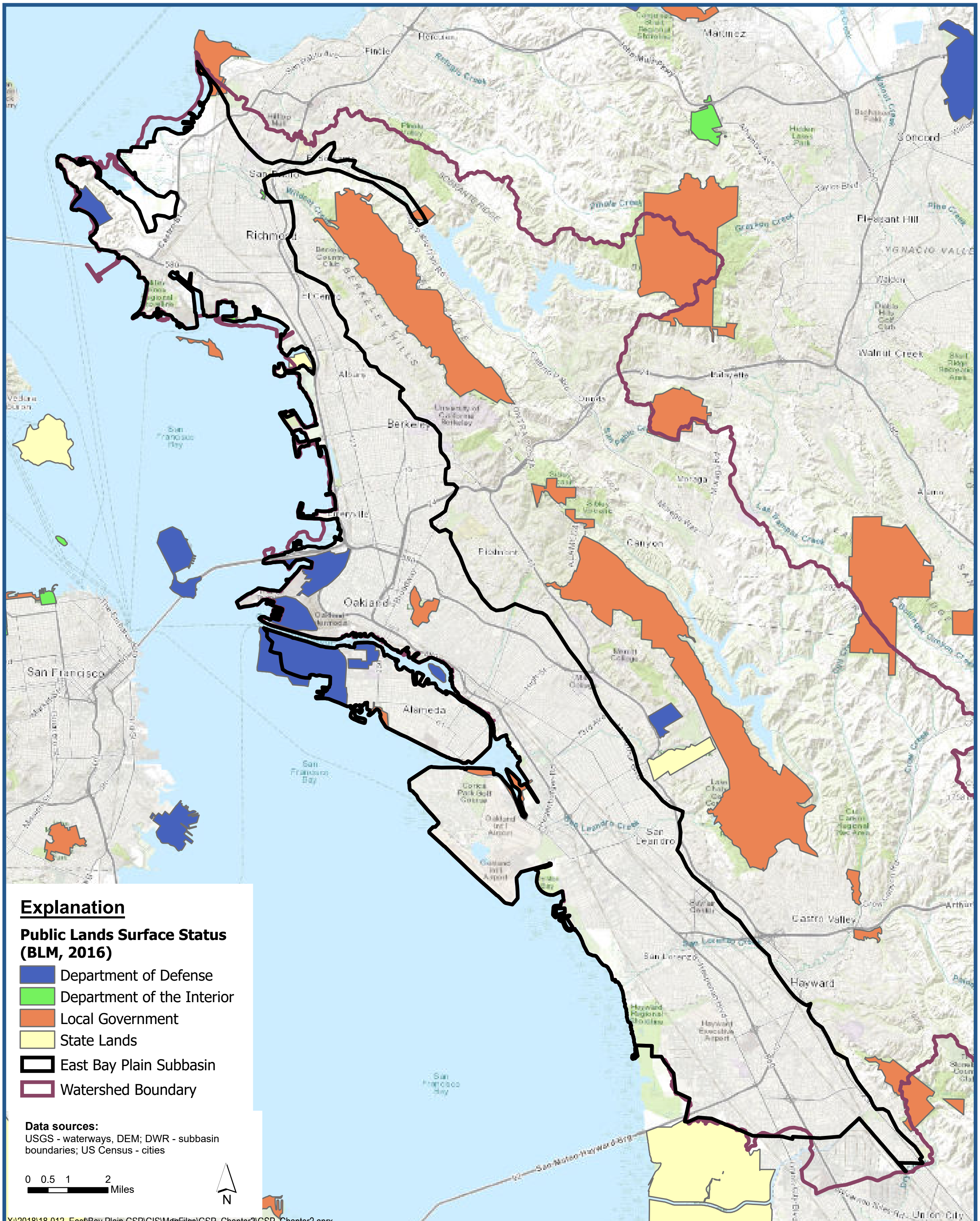
FIGURES

Figures 2-1 through 2-7 and 2-10 through 2-39

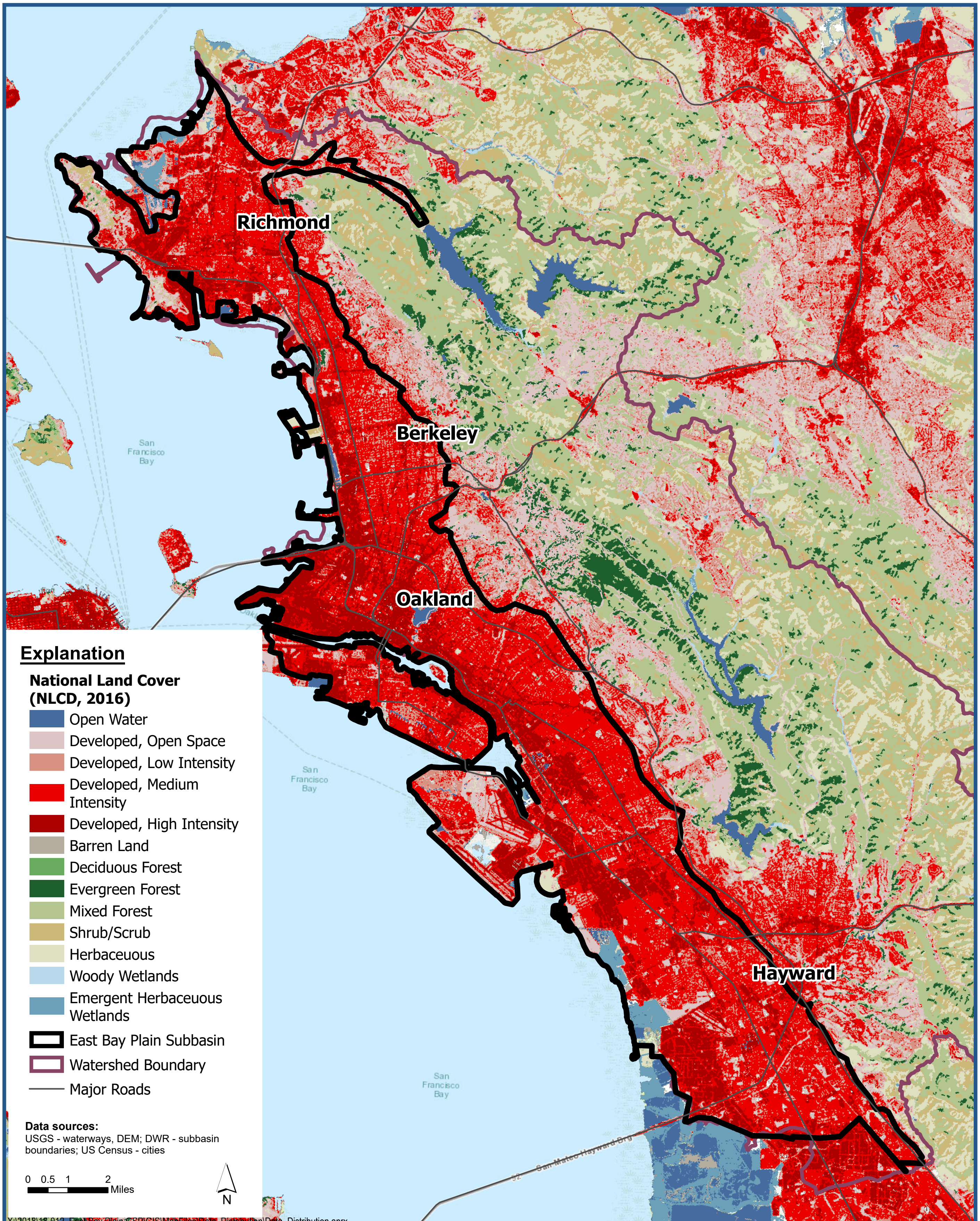


LSCE TEAM

East Bay Plain Subbasin State and Federal Lands

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-1

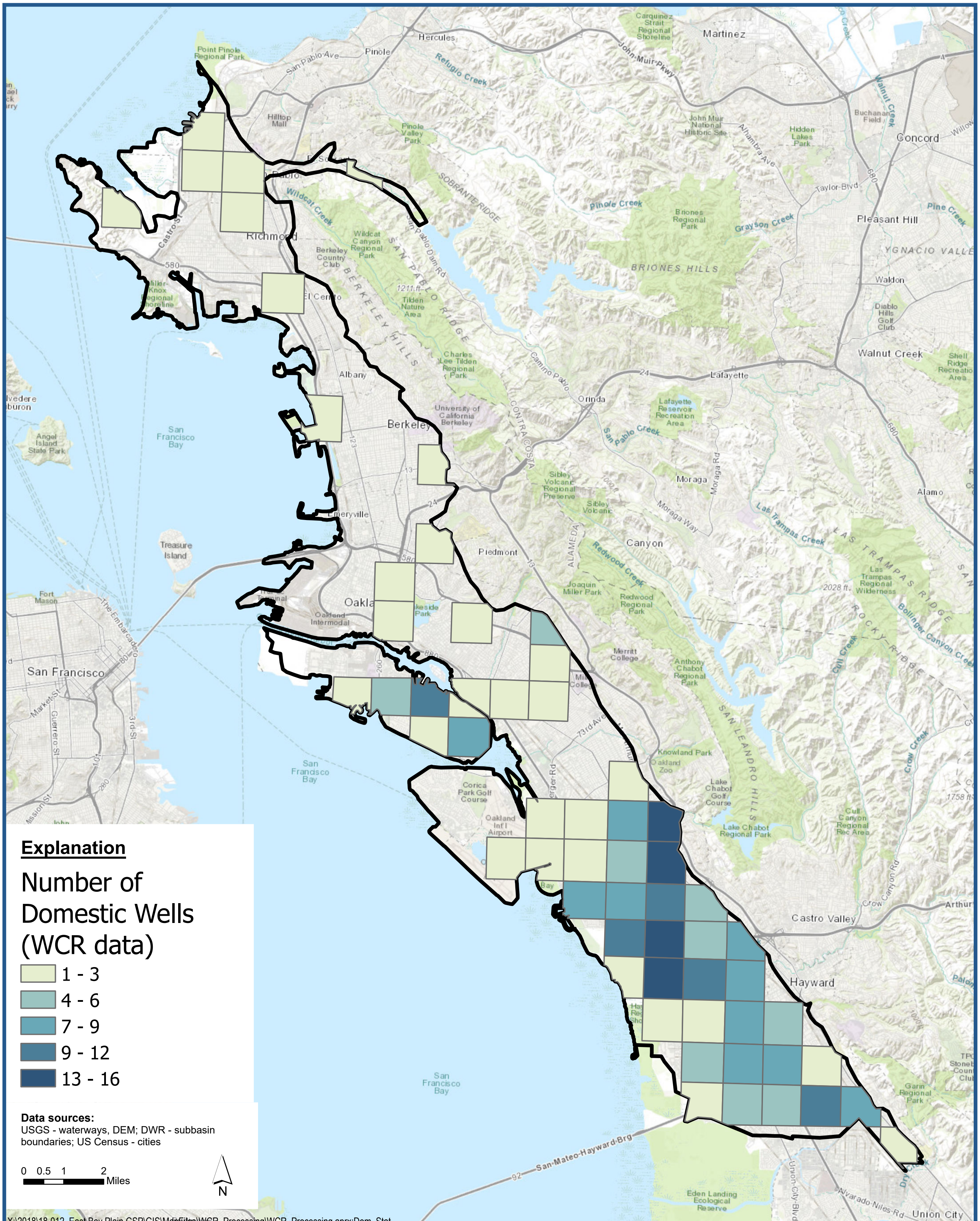


LSCE TEAM

East Bay Plain Subbasin Land Use Map

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-2

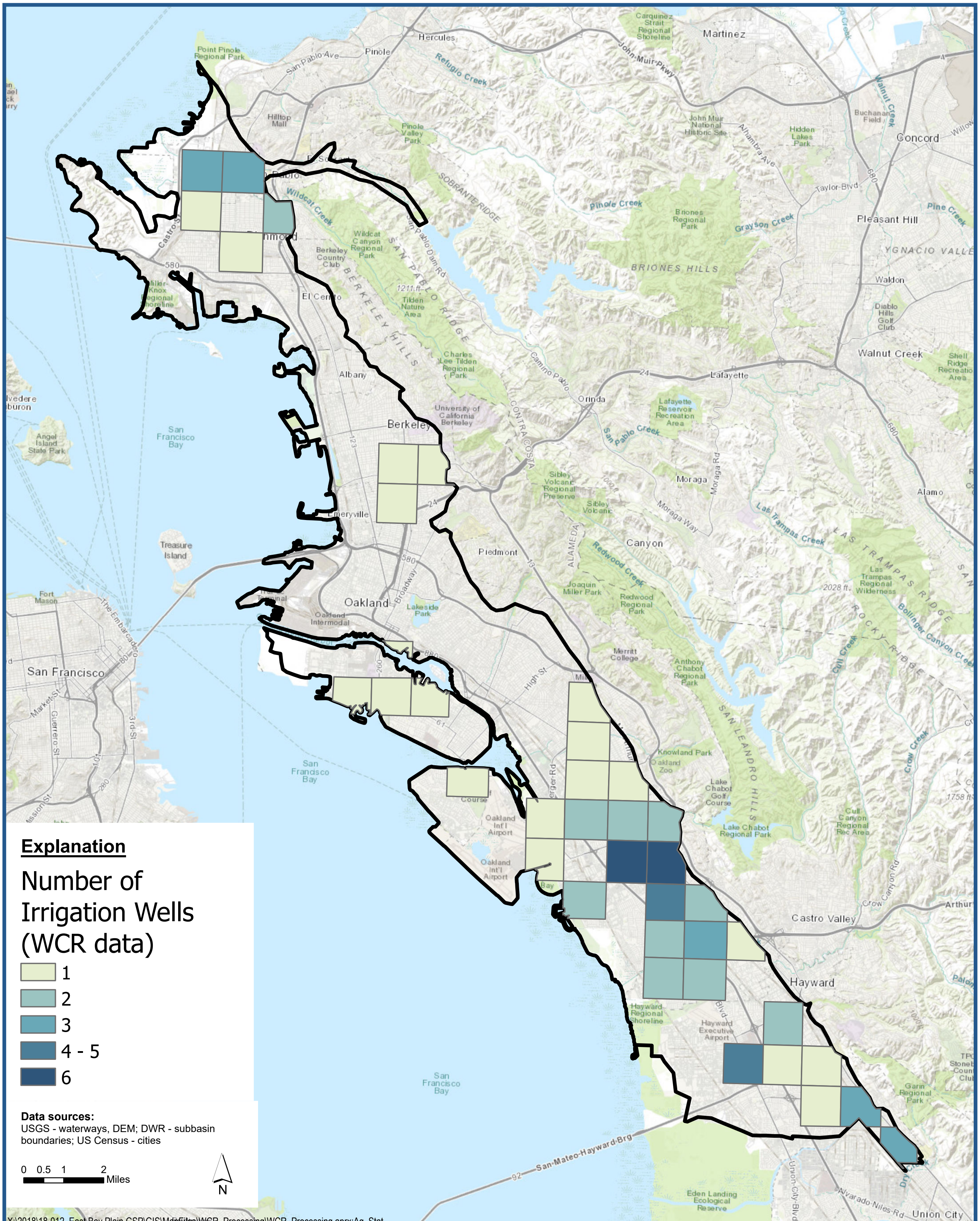


LSCE TEAM

Map of Well Information by Section: Number of Domestic Wells (from WCR data)

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-3

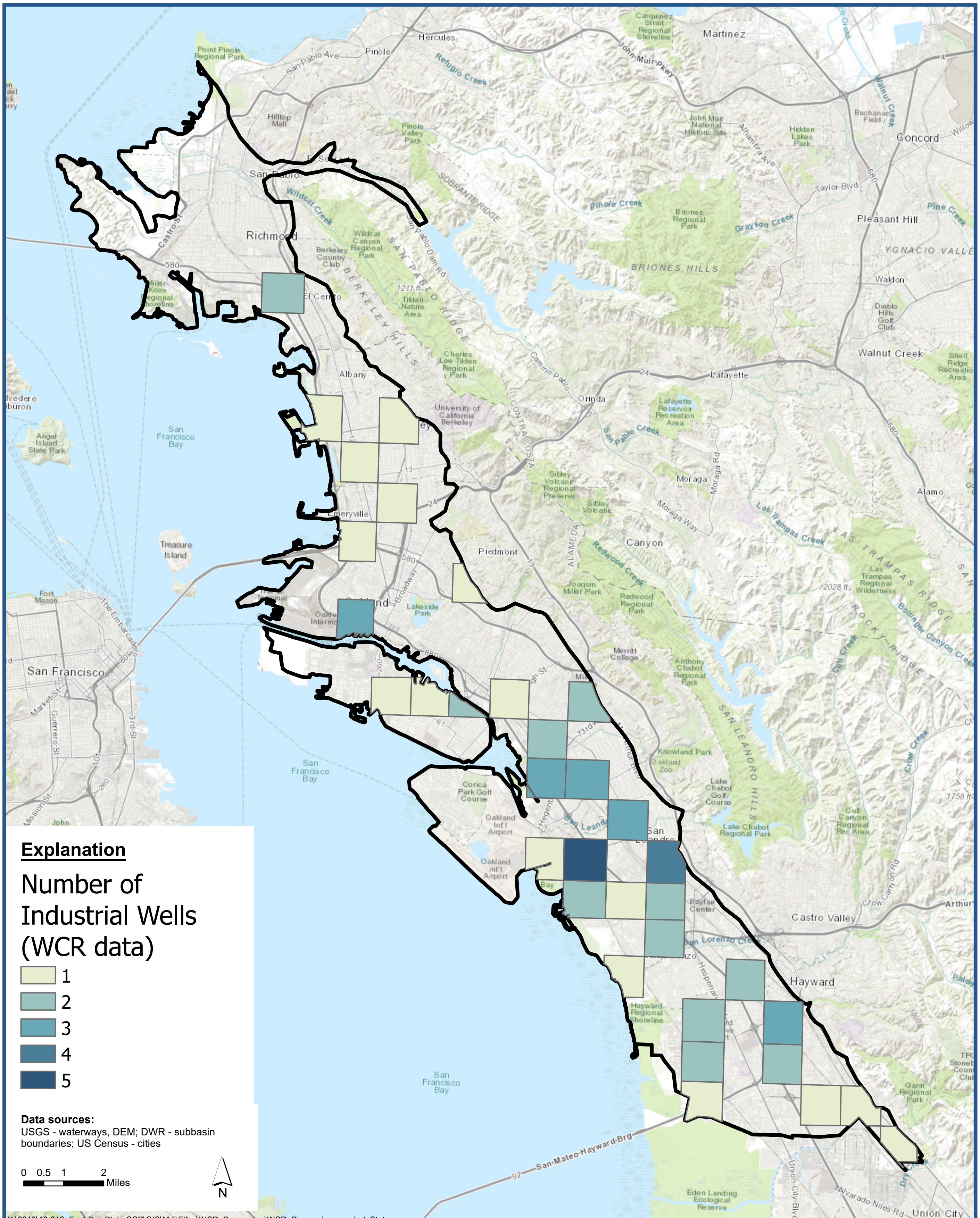


LSCE TEAM

Map of Well Information by Section: Number of Irrigation Wells (from WCR data)

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-4



Map of Well Information by Section: Number of Industrial Wells (from WCR data)

Figure 2-5

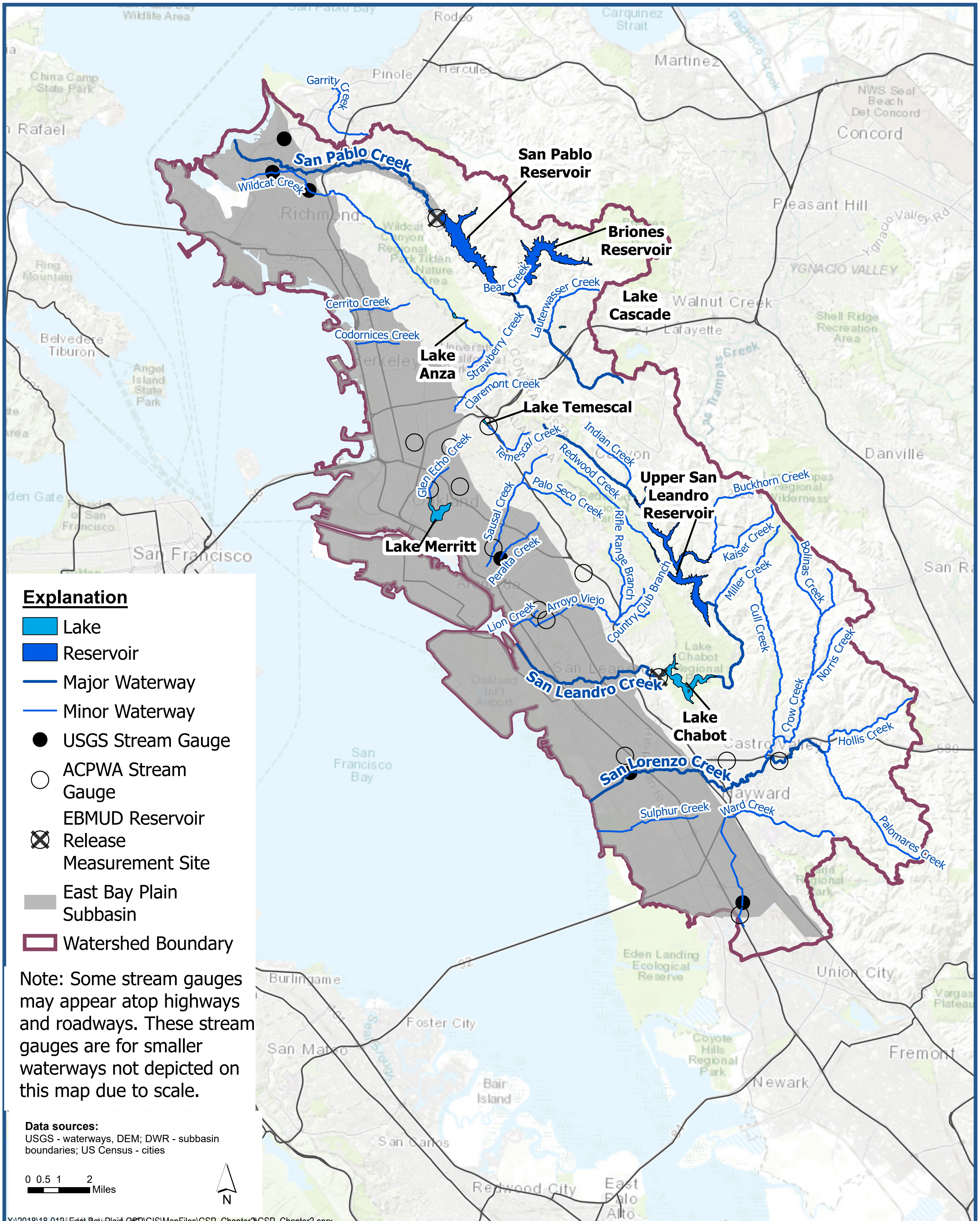
LSCE TEAM

East Bay Plain Subbasin
Groundwater Sustainability Plan

Map of Well Information by Section: Number of Public Supply Wells (from WCR data)

Figure 2-6

Groundwater Sustainability Plan
East Bay Plain

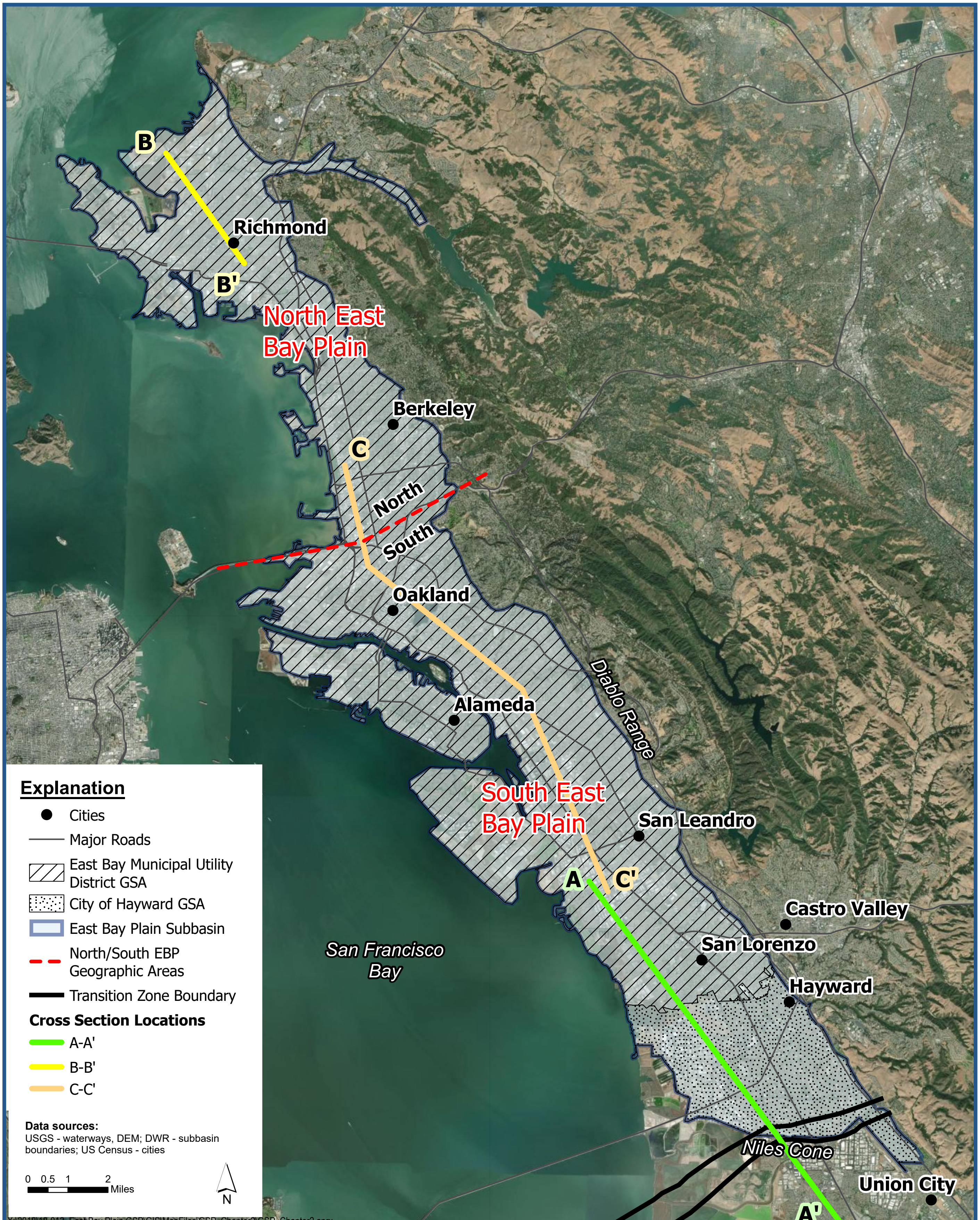


LSCE TEAM

Map of Stream Gauge Locations

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-7

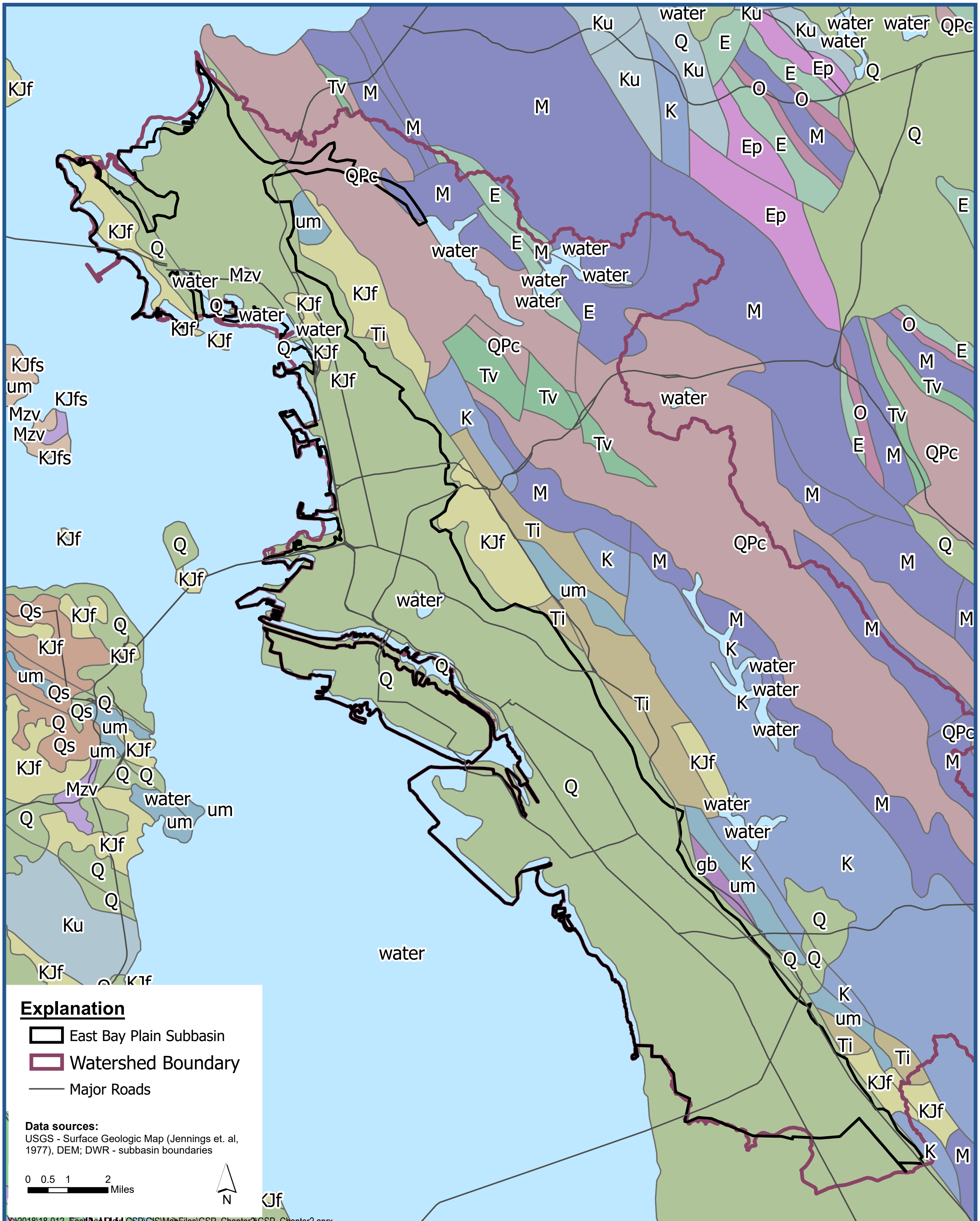


LSCE TEAM

East Bay Plain Subbasin Location Map and Cross-Section Locations

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-10



LSCE TEAM

Surface Geologic Map

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-11a

Explanation

E	Eocene marine rocks
Ep	Paleocene marine rocks
J	Jurassic marine rocks
K	Cretaceous marine rocks (in part nonmarine)
KJf	Franciscan Complex
KJfm	Franciscan melange
KJfs	Franciscan schist
Kl	Lower Cretaceous marine rocks
Ku	Upper Cretaceous marine rocks
M	Miocene marine rocks
Mzv	Mesozoic volcanic rocks
O	Oligocene marine rocks
P	Pliocene marine rocks
Q	Quaternary alluvium and marine deposits
QPc	Plio-Pleistocene and Pliocene loosely consolidated deposits
Qs	Quaternary sand deposits
Ti	Tertiary intrusive rocks (hypabyssal)
Tv	Tertiary volcanic flow rocks
Tvp	Tertiary pyroclastic and volcanic mudflow deposits
gb	Mesozoic gabbroic rocks
grMz	Mesozoic granitic rocks
um	Ultramafic rocks, chiefly Mesozoic
Water	

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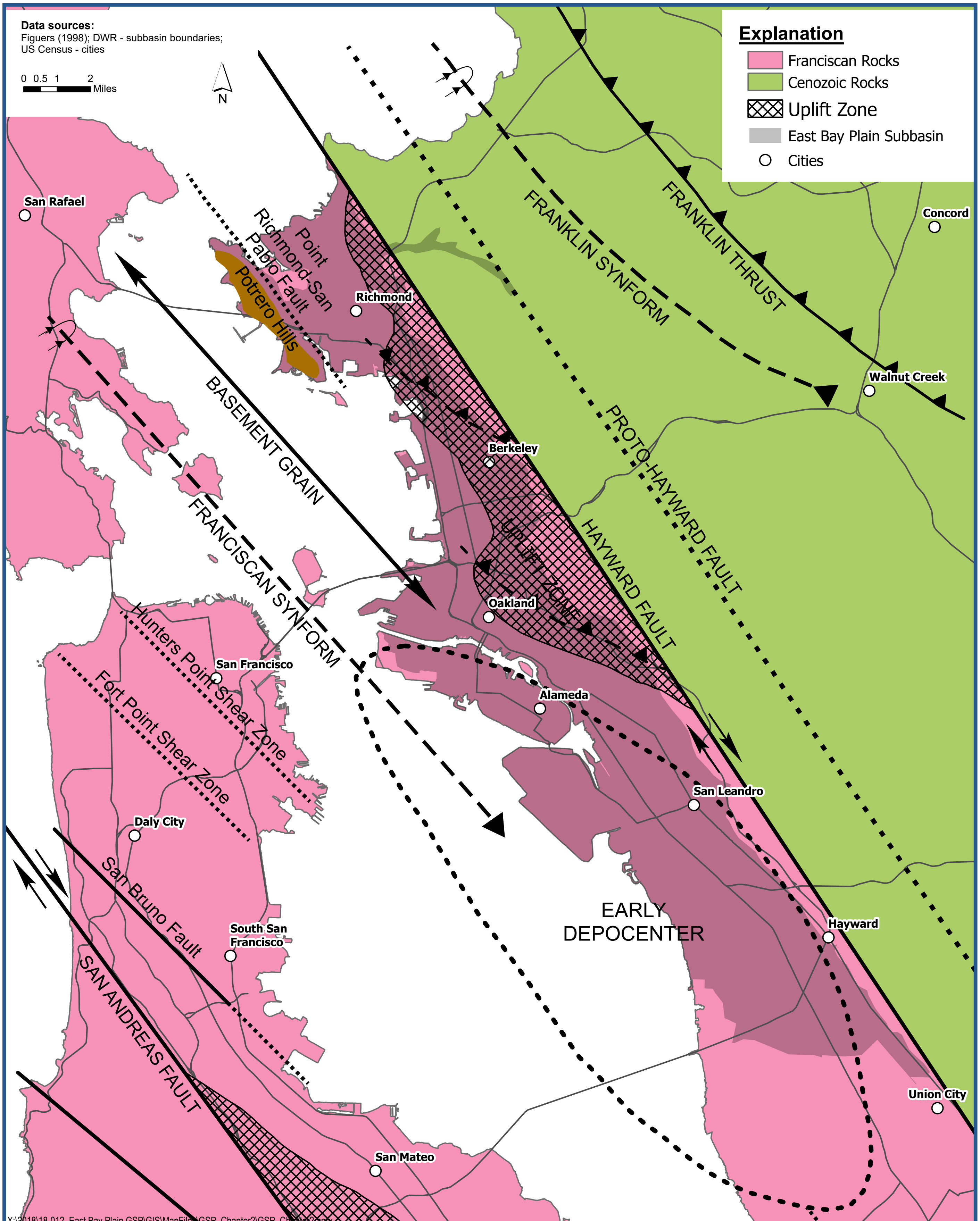
LSCE TEAM

Surface Geologic Map - Legend

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-11b

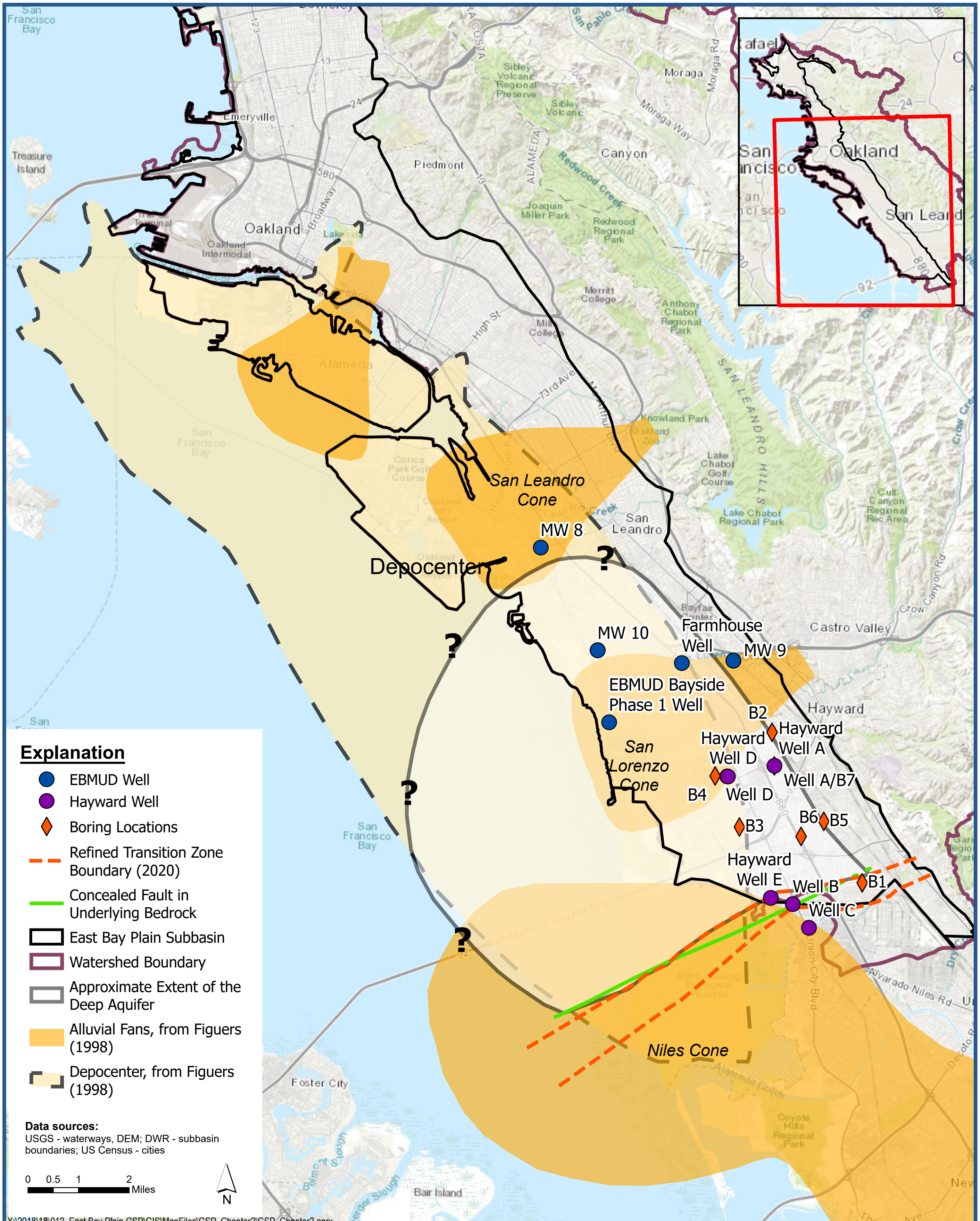


LSCE TEAM

Structural Geology of San Francisco Bay Area

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-12

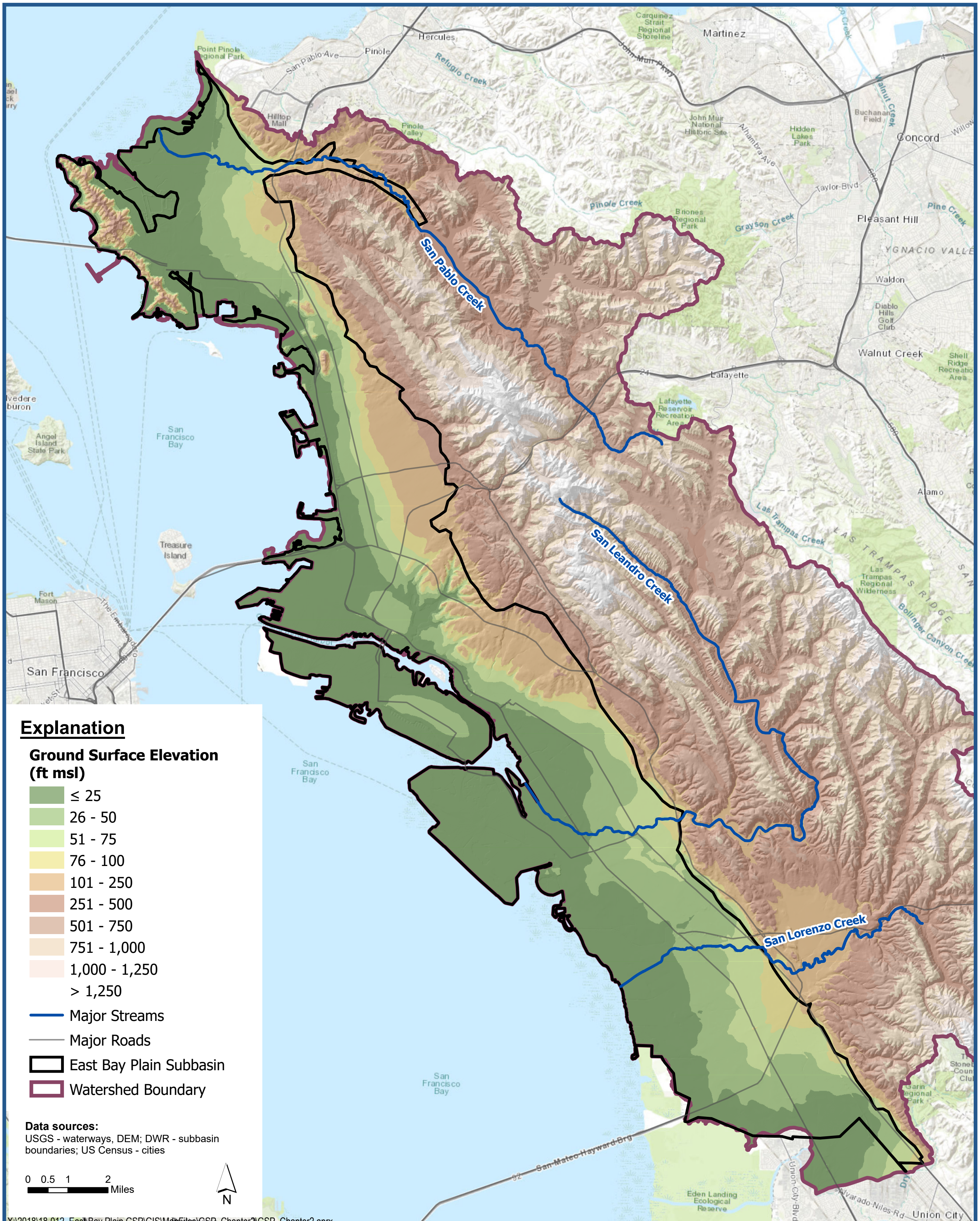


LSCE TEAM

Map of Depositional Centers and Deep Aquifer Extent

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-13

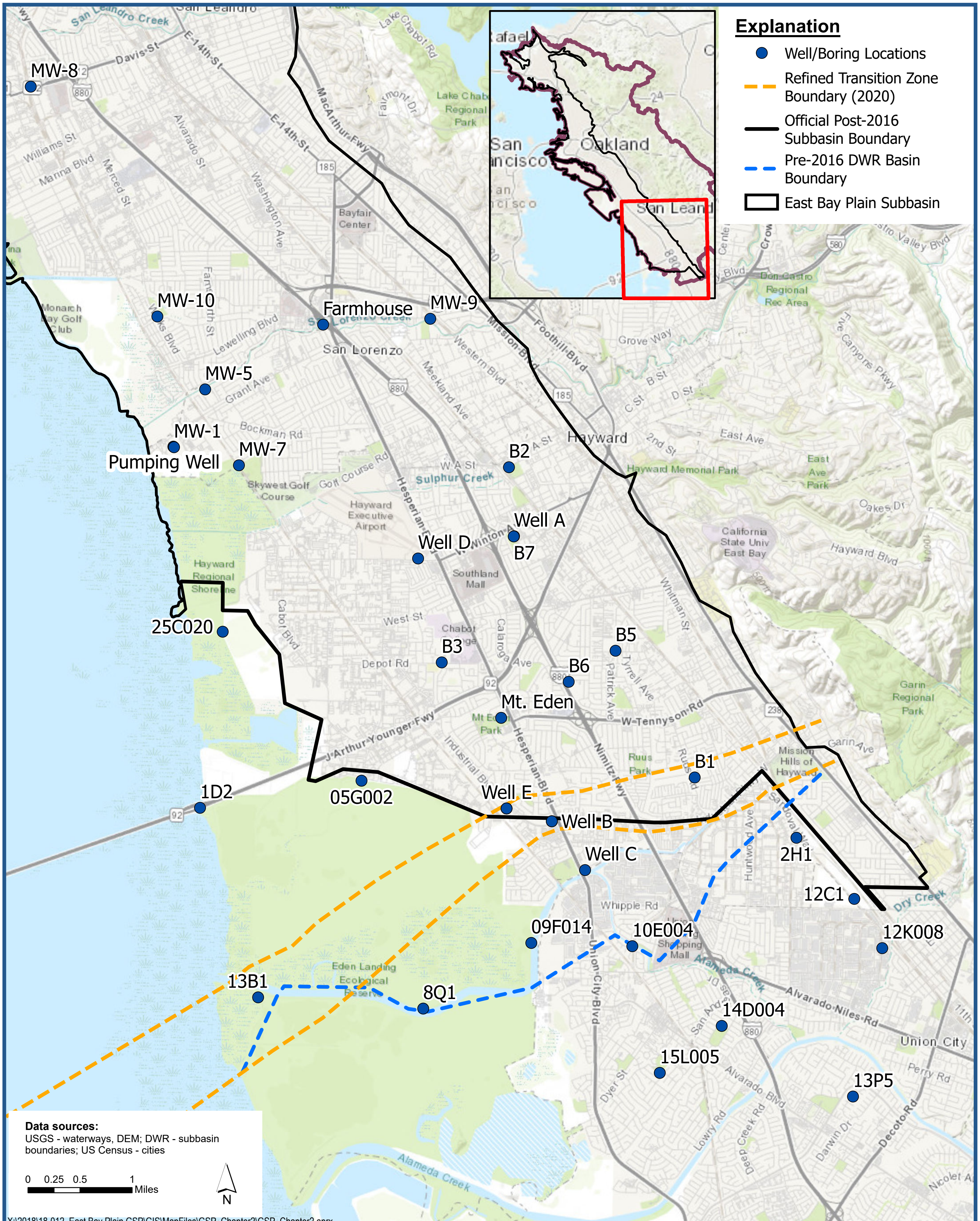


Topography of East Bay Plain Subbasin and Surrounding Watershed

East Bay Plain Subbasin Groundwater Sustainability Plan

LSCE TEAM

Figure 2-14

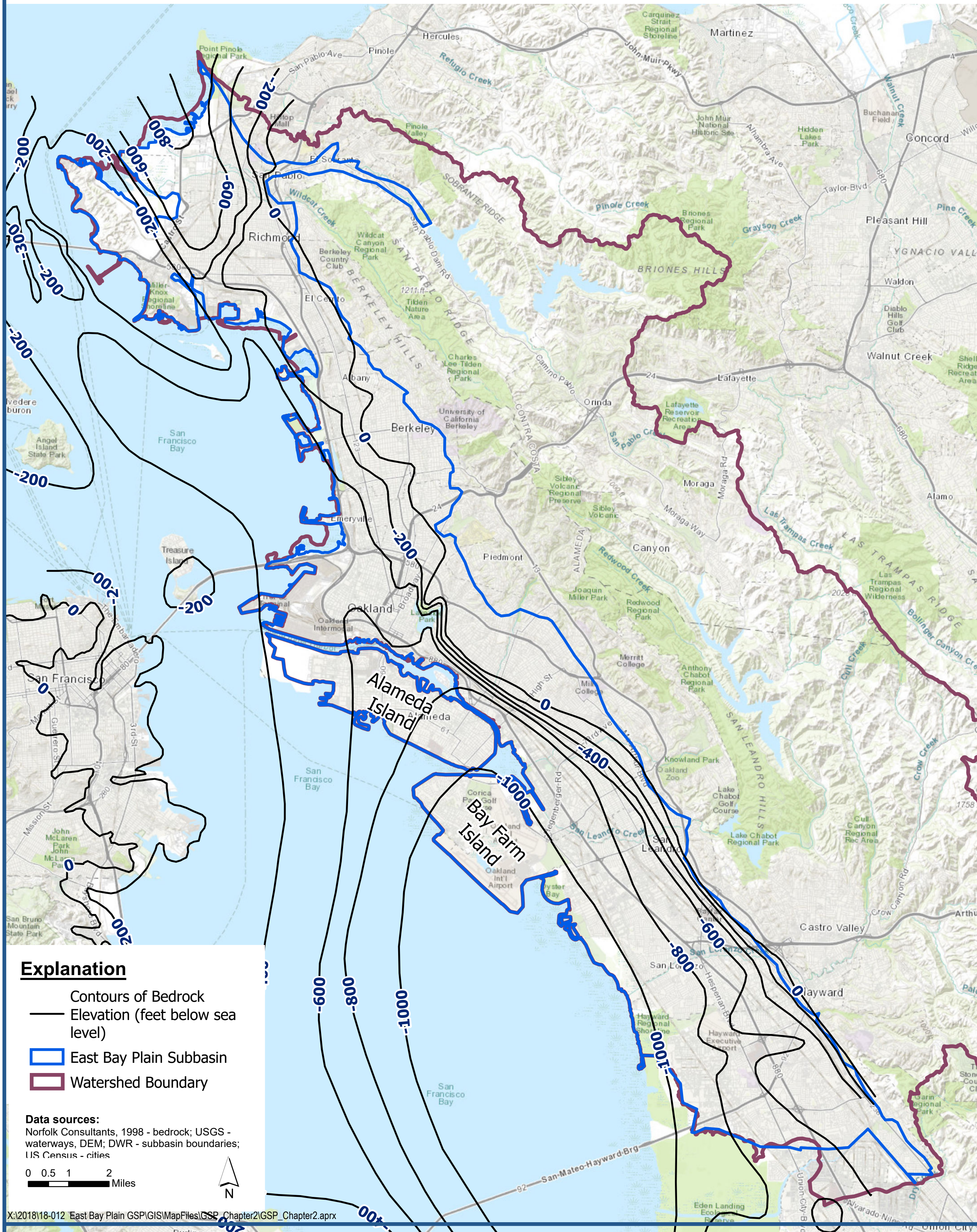


LSCE TEAM

Map of Pre- and Post-2016 DWR Basin Boundary

East Bay Plain Subbasin
Groundwater Sustainability Plan

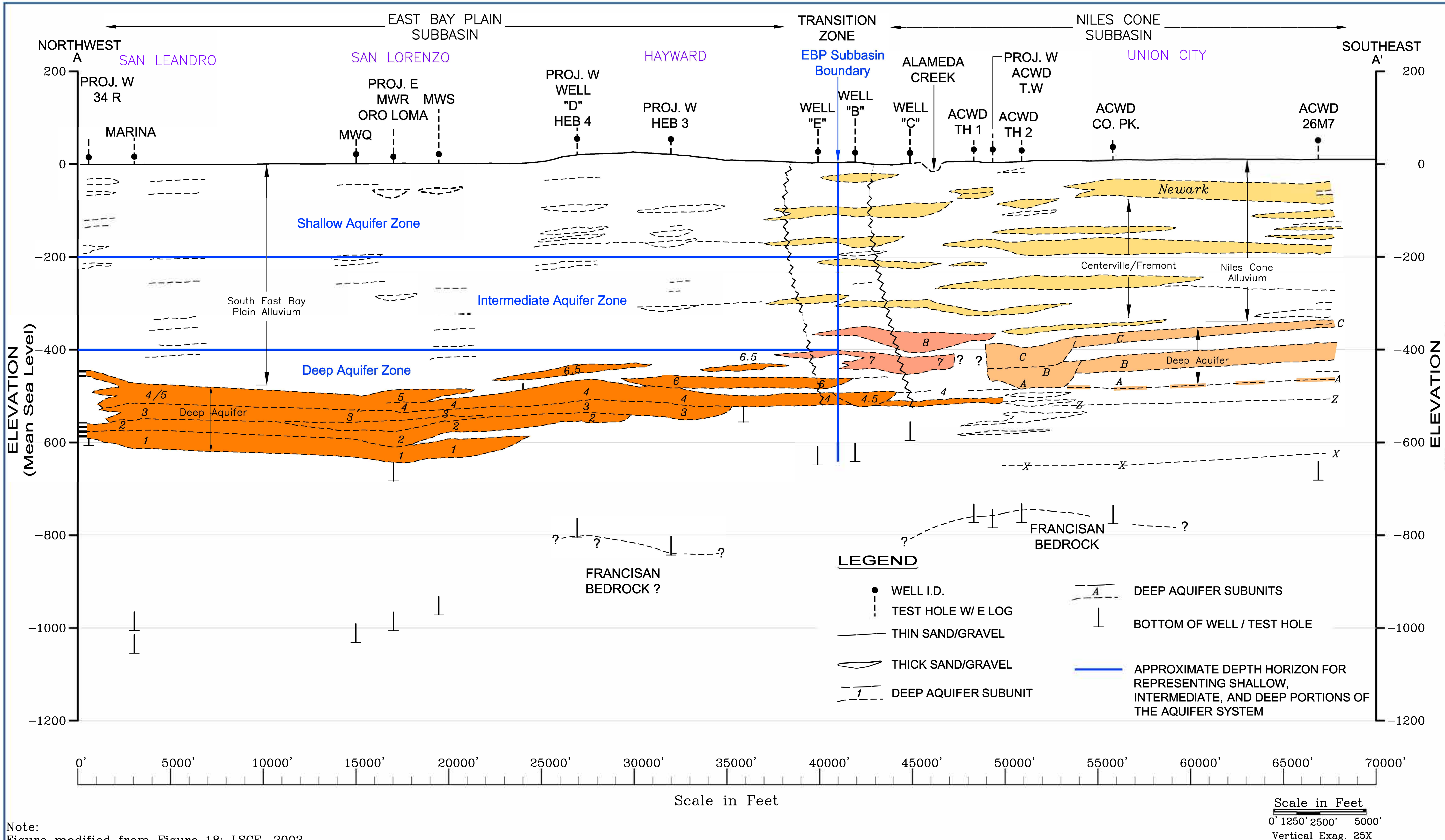
Figure 2-15



Map of Bedrock Elevation in East Bay Plain Subbasin

Figure 2-16

East Bay Plain Subbasin
Groundwater Sustainability Plan



Note:
Figure modified from Figure 18; LSCE, 2003.

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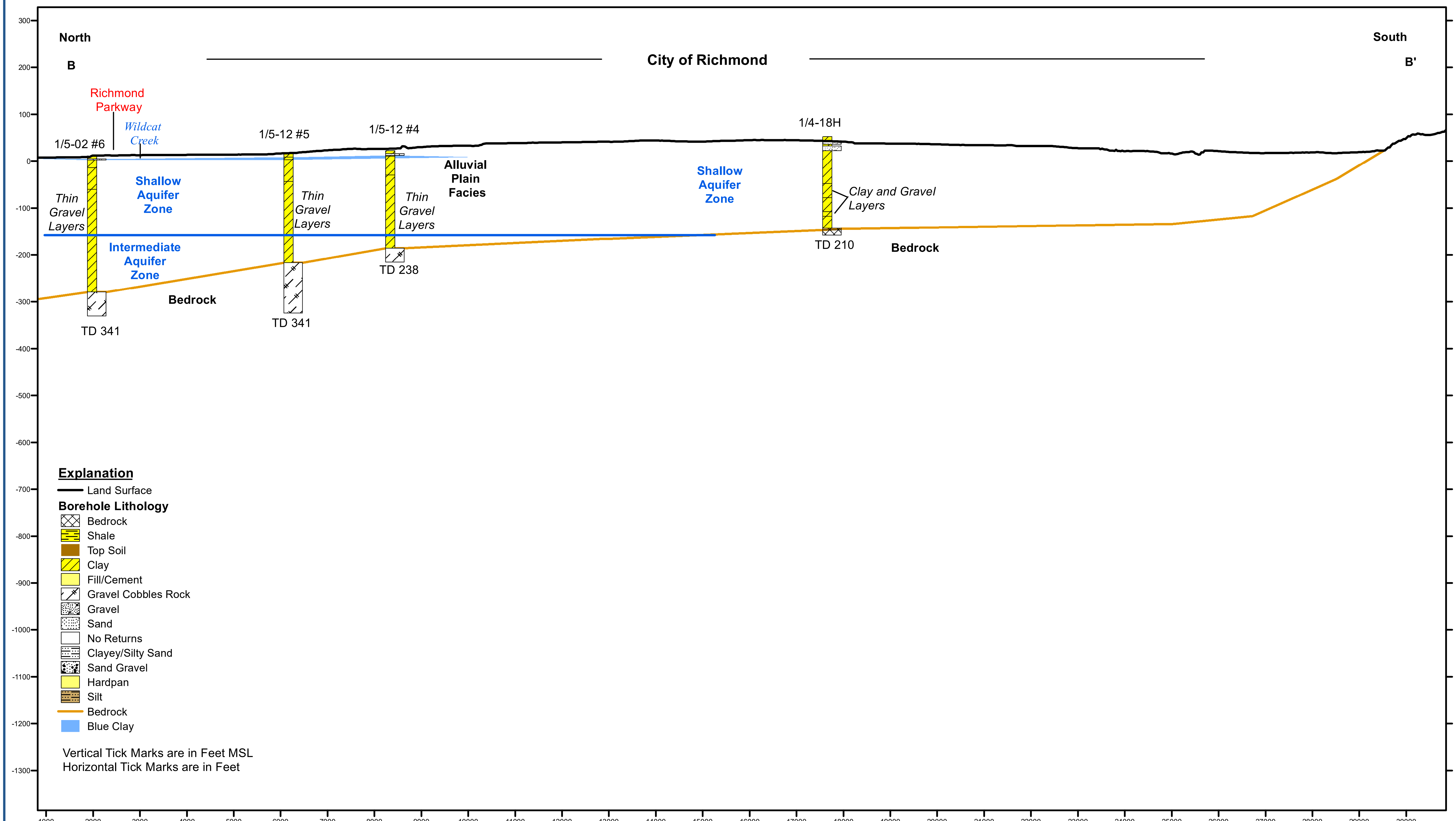
LSCE TEAM

Geologic Cross Section A-A' of Southern East Bay Plain

East Bay Plain Subbasin Groundwater Sustainability Plan

Figure 2-17

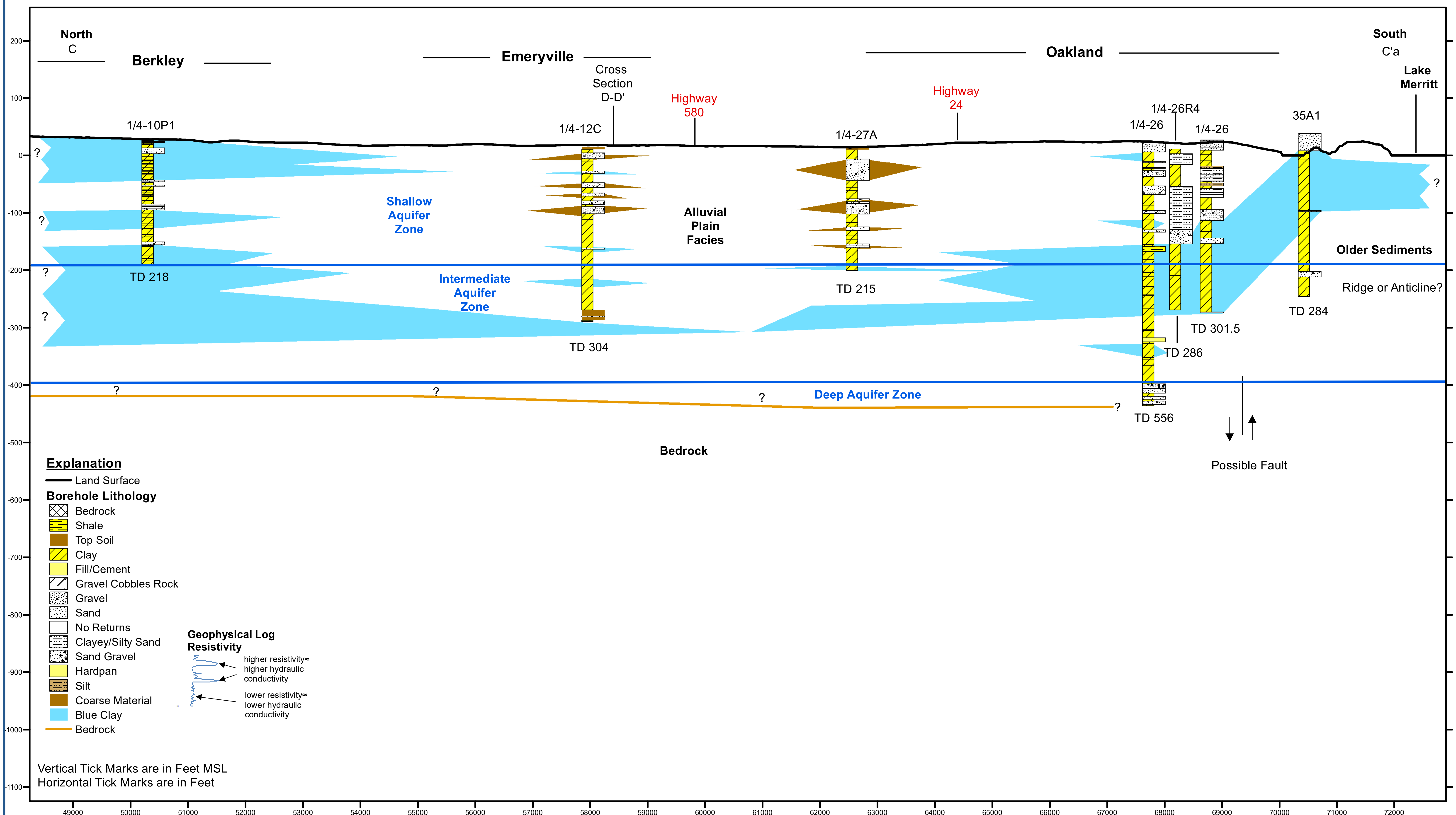


LSCE TEAM

Geologic Cross Section B-B' of Northern East Bay Plain

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-18

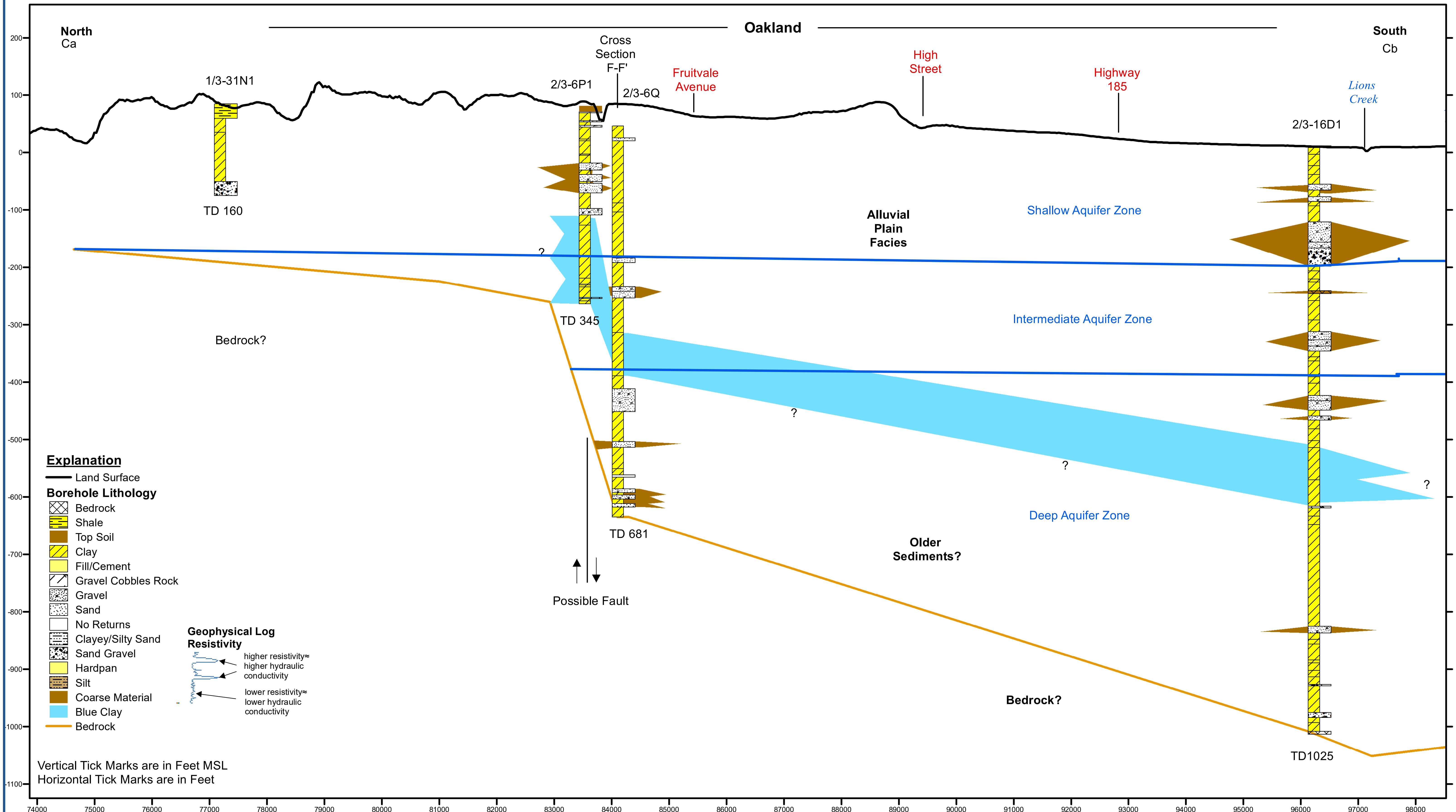


LSCE TEAM

Geologic Cross Section C-C' of the Northern and Southern East Bay Plain

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-19a

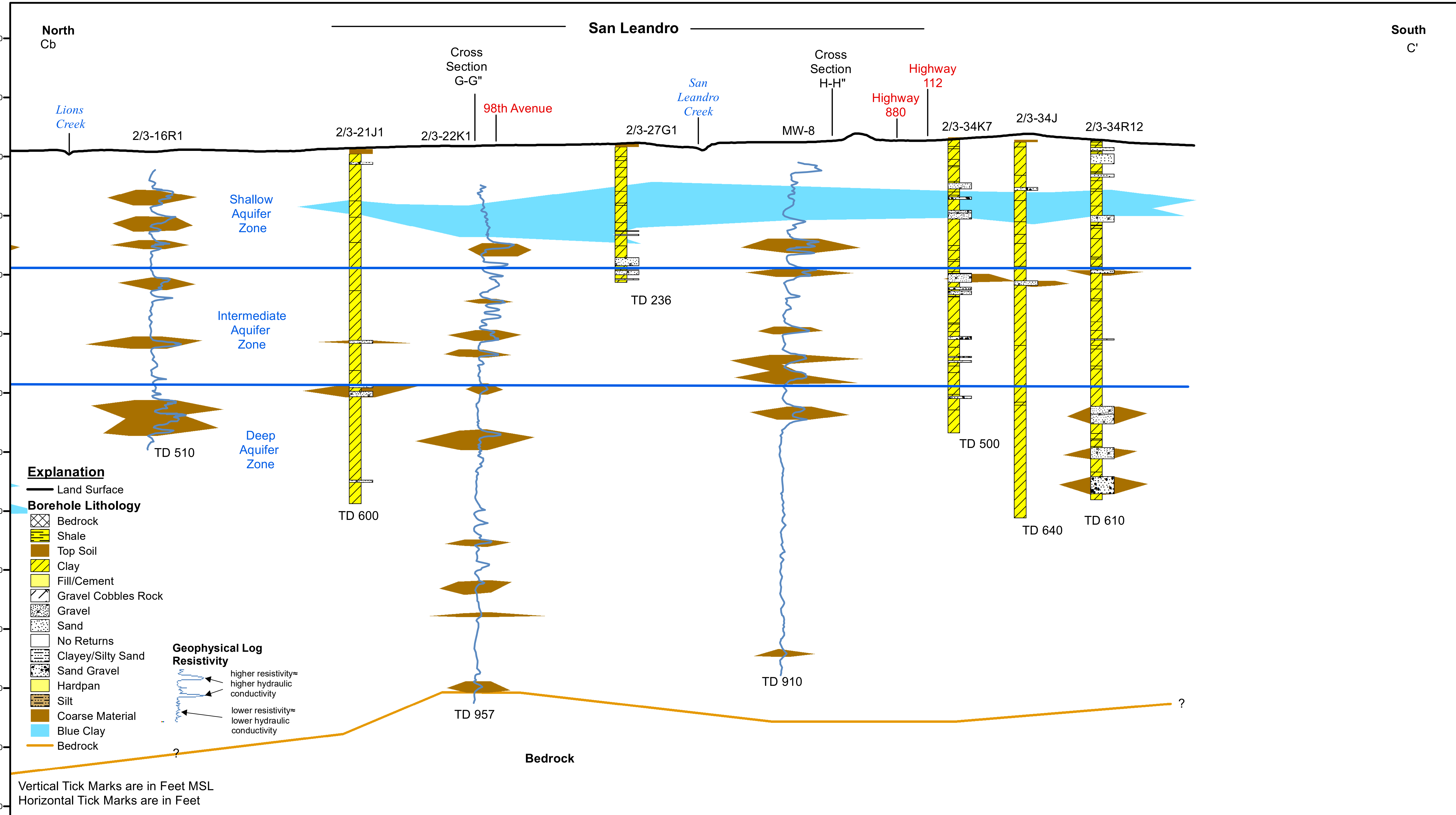


LSCE TEAM

Geologic Cross Section C-C' of the Northern and Southern East Bay Plain

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-19b



Geologic Cross Section C-C' of the Northern and Southern East Bay Plain

East Bay Plain Subbasin
Groundwater Sustainability Plan

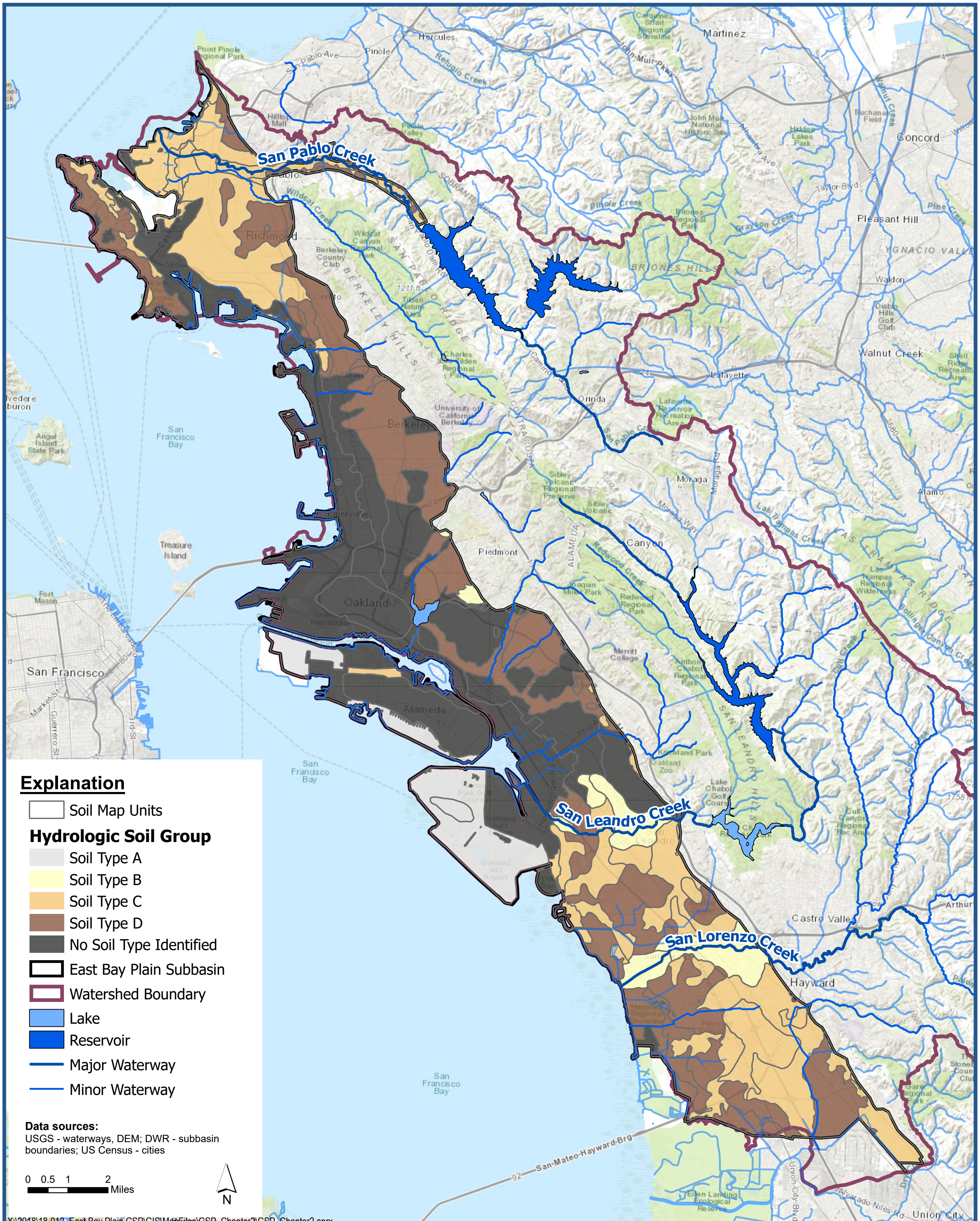
Figure 2-19c

LSCE TEAM

Distribution of Transmissivity Values in Deep Aquifer

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-20



LSCE TEAM

Mapping of the Distribution of Hydrologic Soils Groups

East Bay Plain Subbasin
Groundwater Sustainability Plan

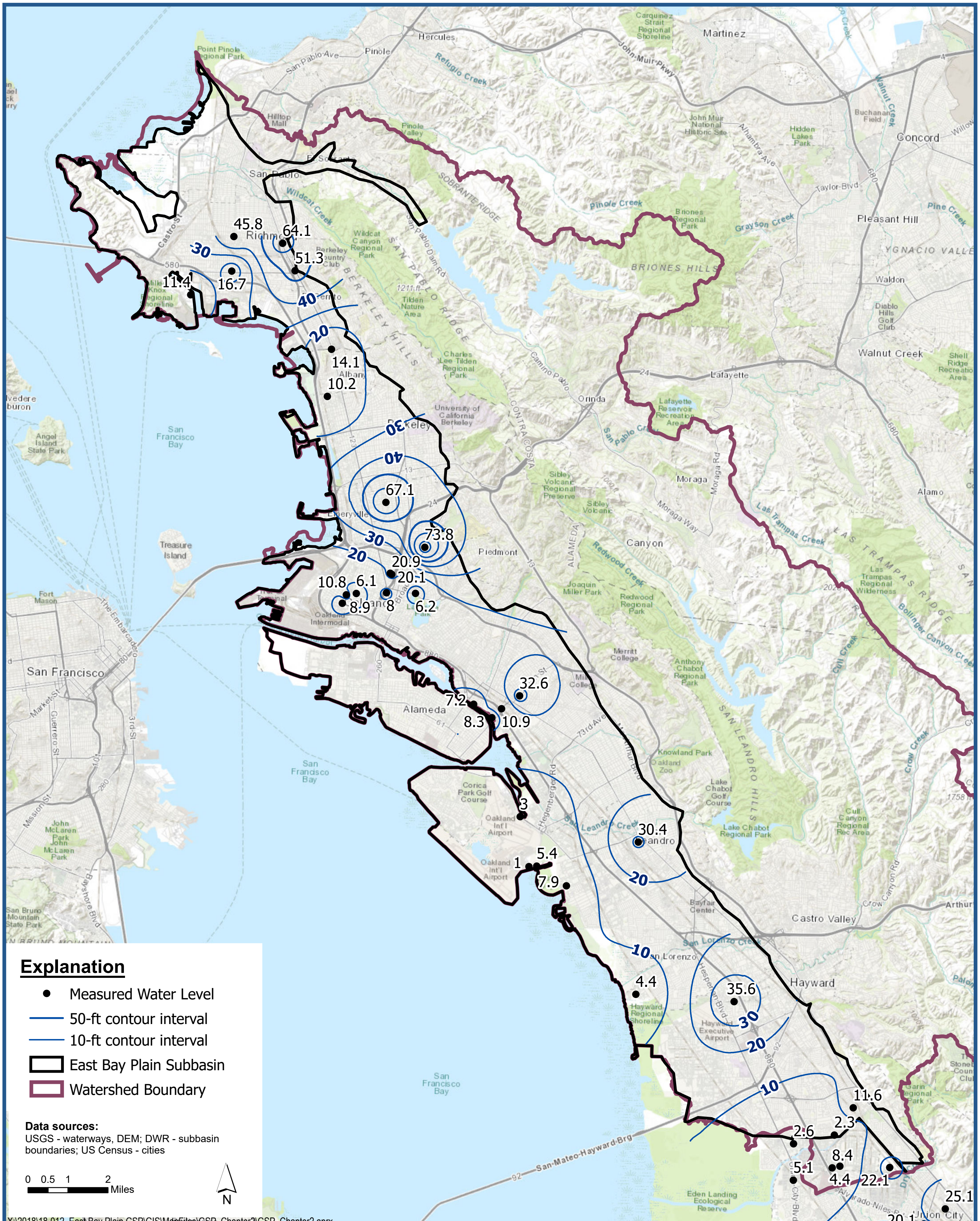
Figure 2-21

LSCE TEAM

Map of Surface Water Bodies

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-22

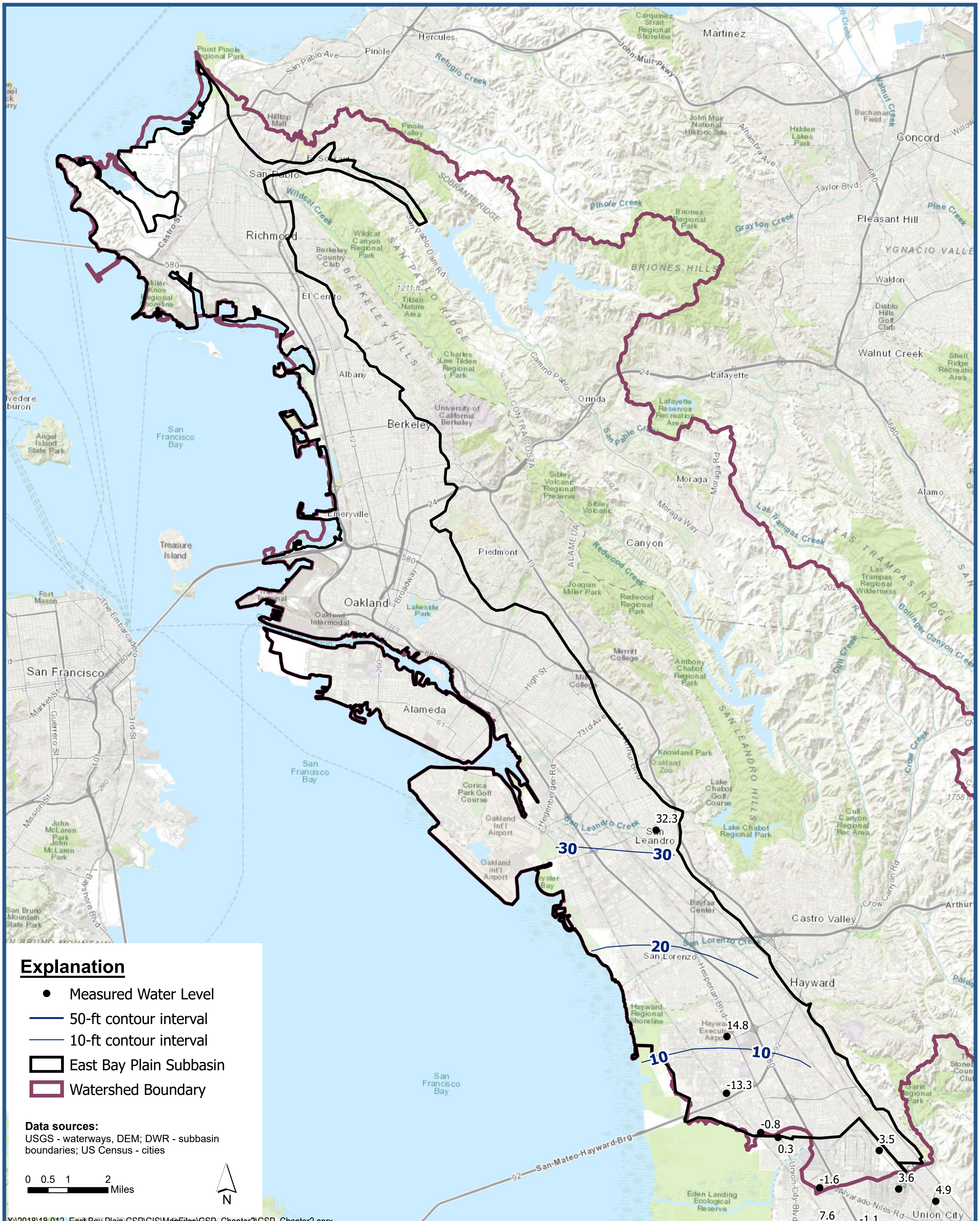


LSCE TEAM

Water Table Aquifer Groundwater Elevation Contour Map – Spring 2018

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-23

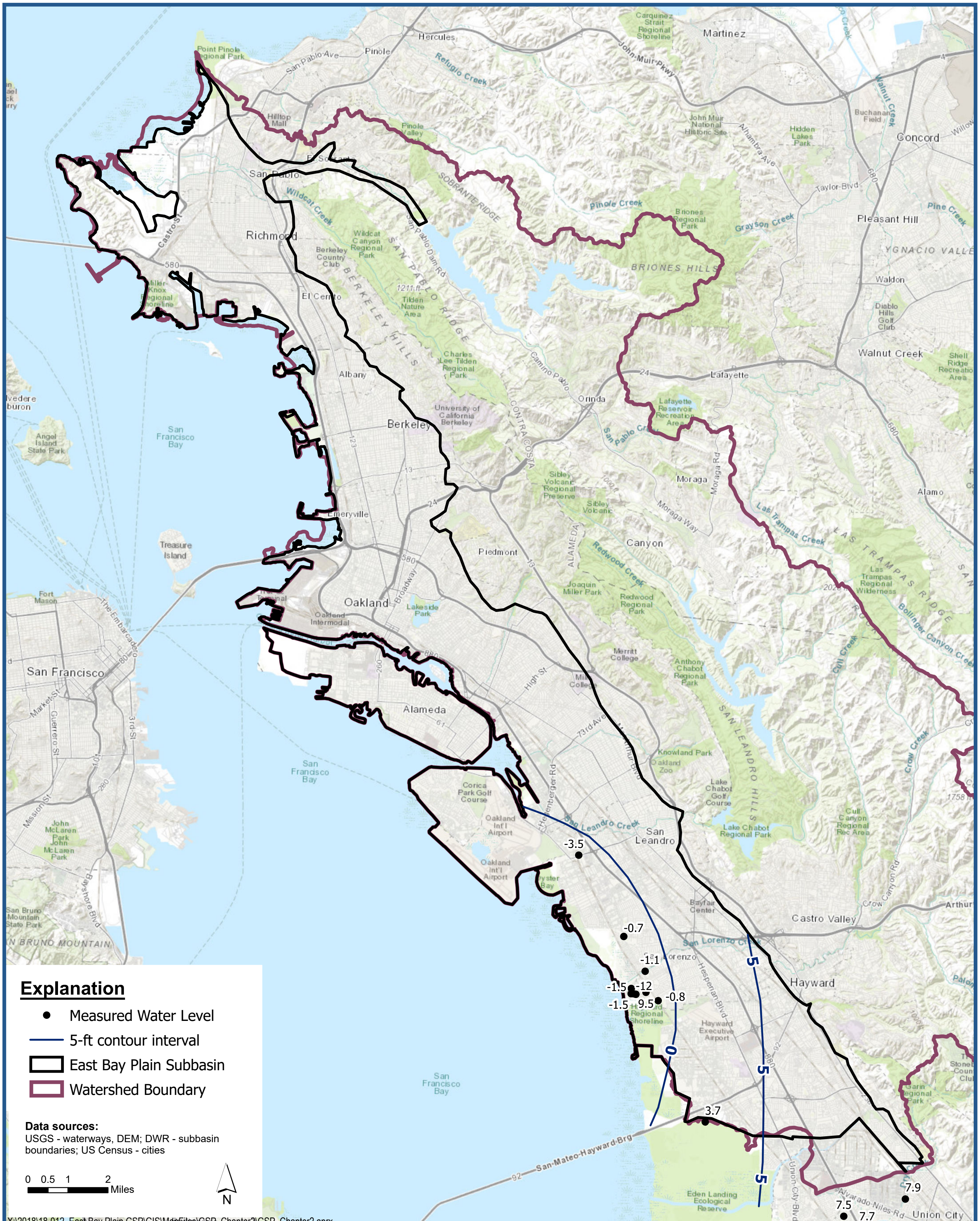


Deep Aquifer Groundwater Elevation Contour Map
Spring 2002

East Bay Plain Subbasin
Groundwater Sustainability Plan

LSCE TEAM

Figure 2-24



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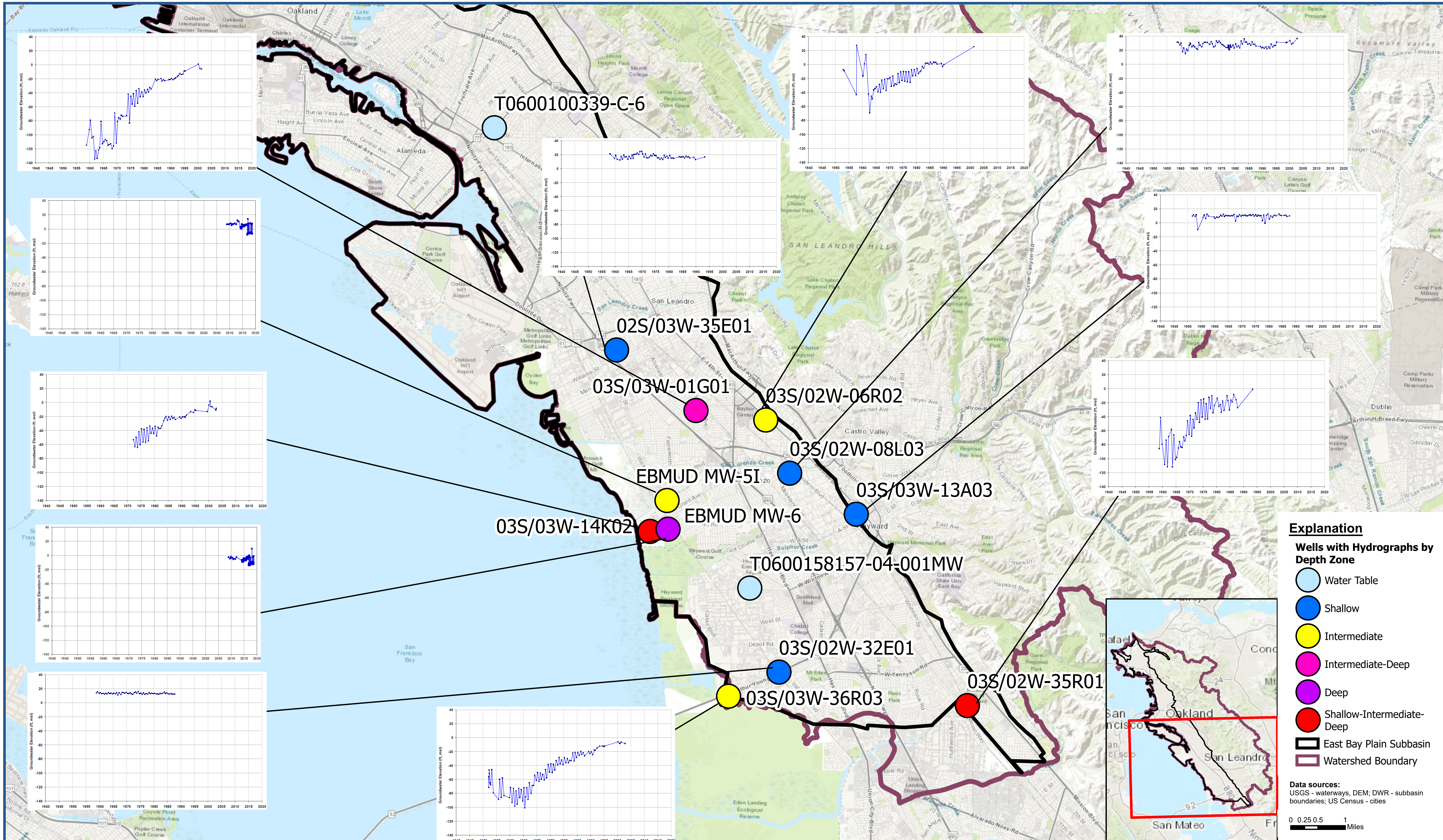
Deep Aquifer Groundwater Elevation Contour Map
Spring 2018

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-25

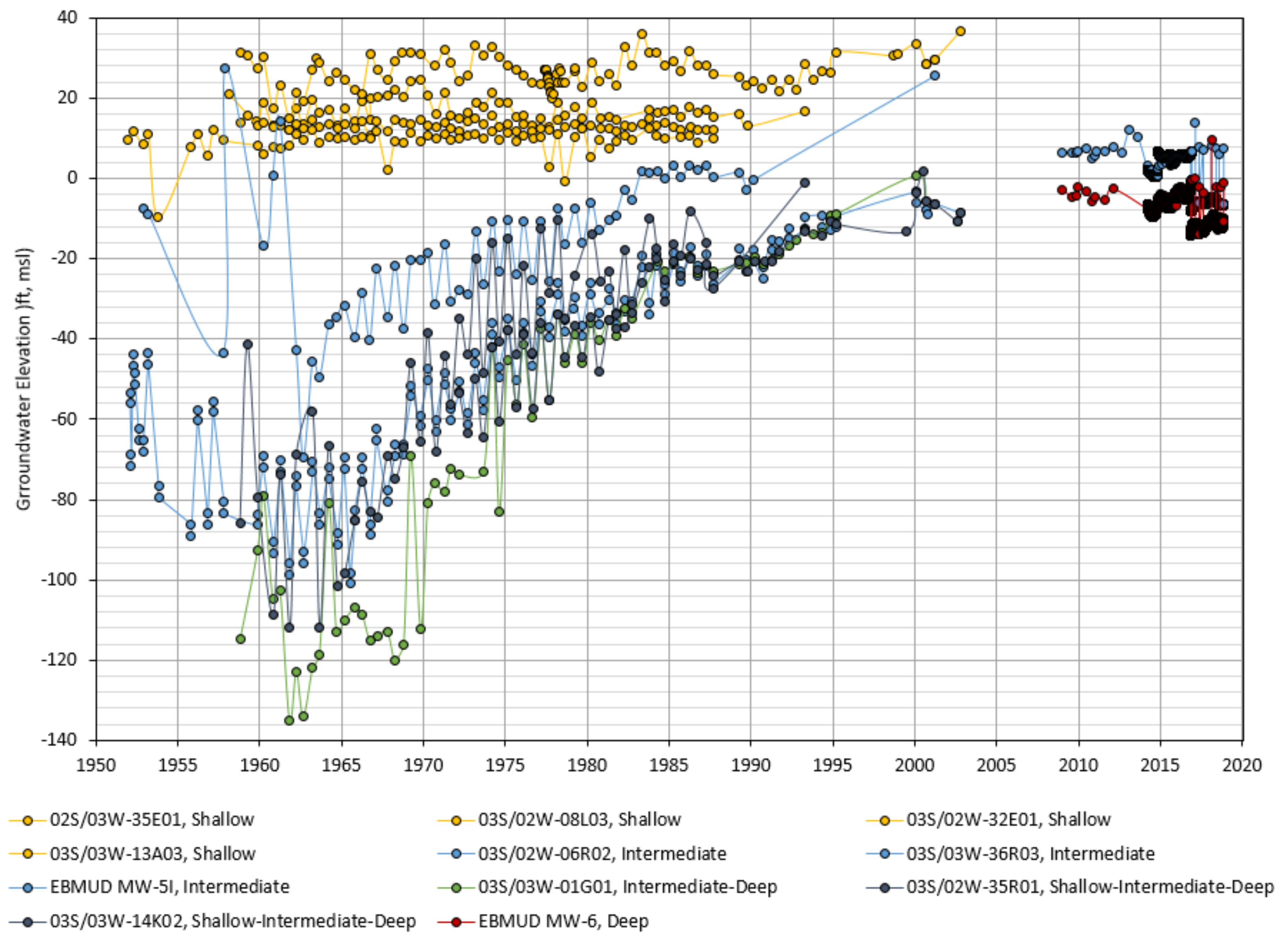


LSCE TEAM

Selected Groundwater Hydrographs for Shallow, Intermediate, and Deep Zones in Southern EBP Subbasin

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-26



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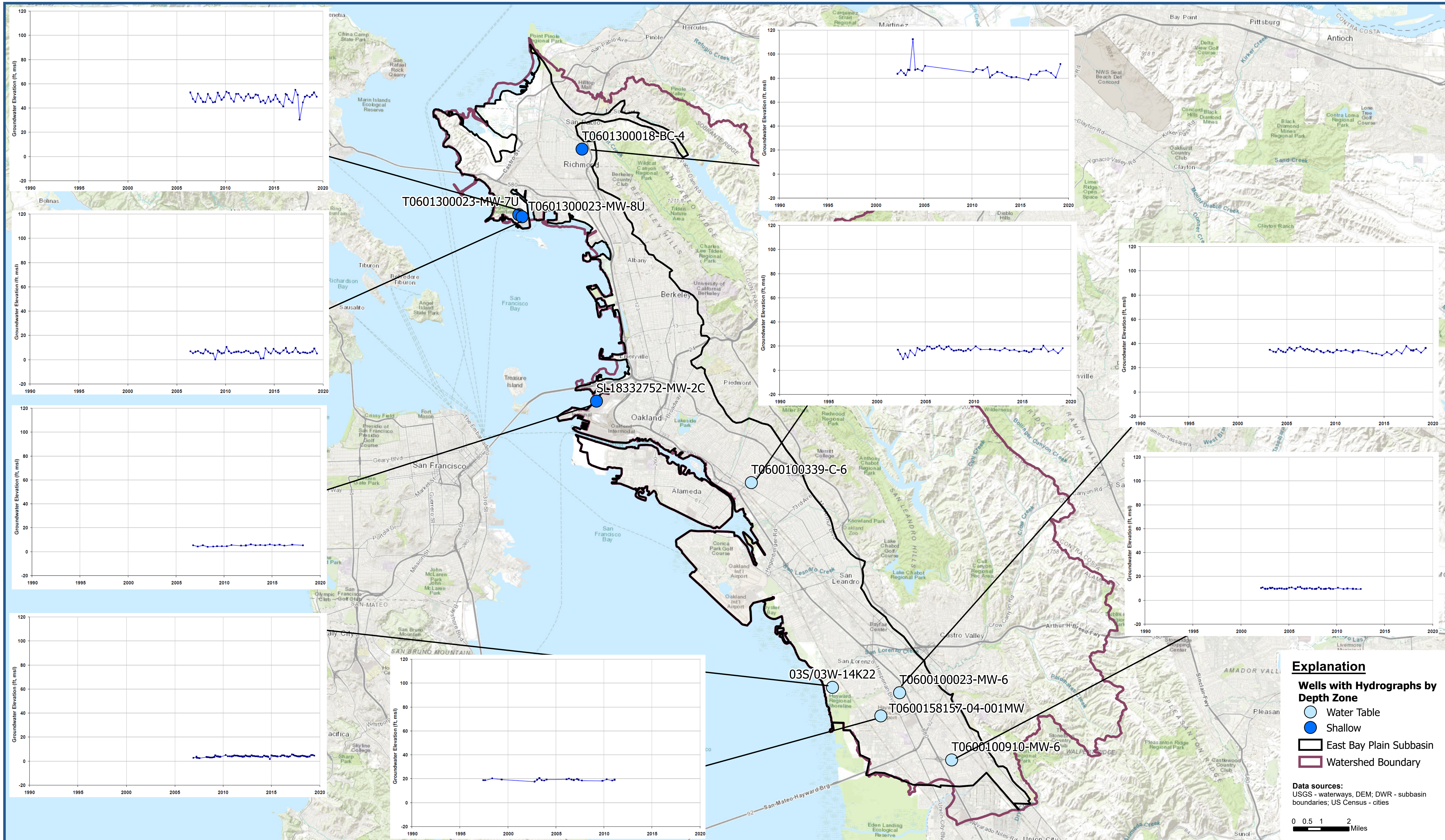
LSCE TEAM

Composite Groundwater Hydrograph for Shallow, Intermediate, and Deep Zones in Southern EBP Subbasin

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-27

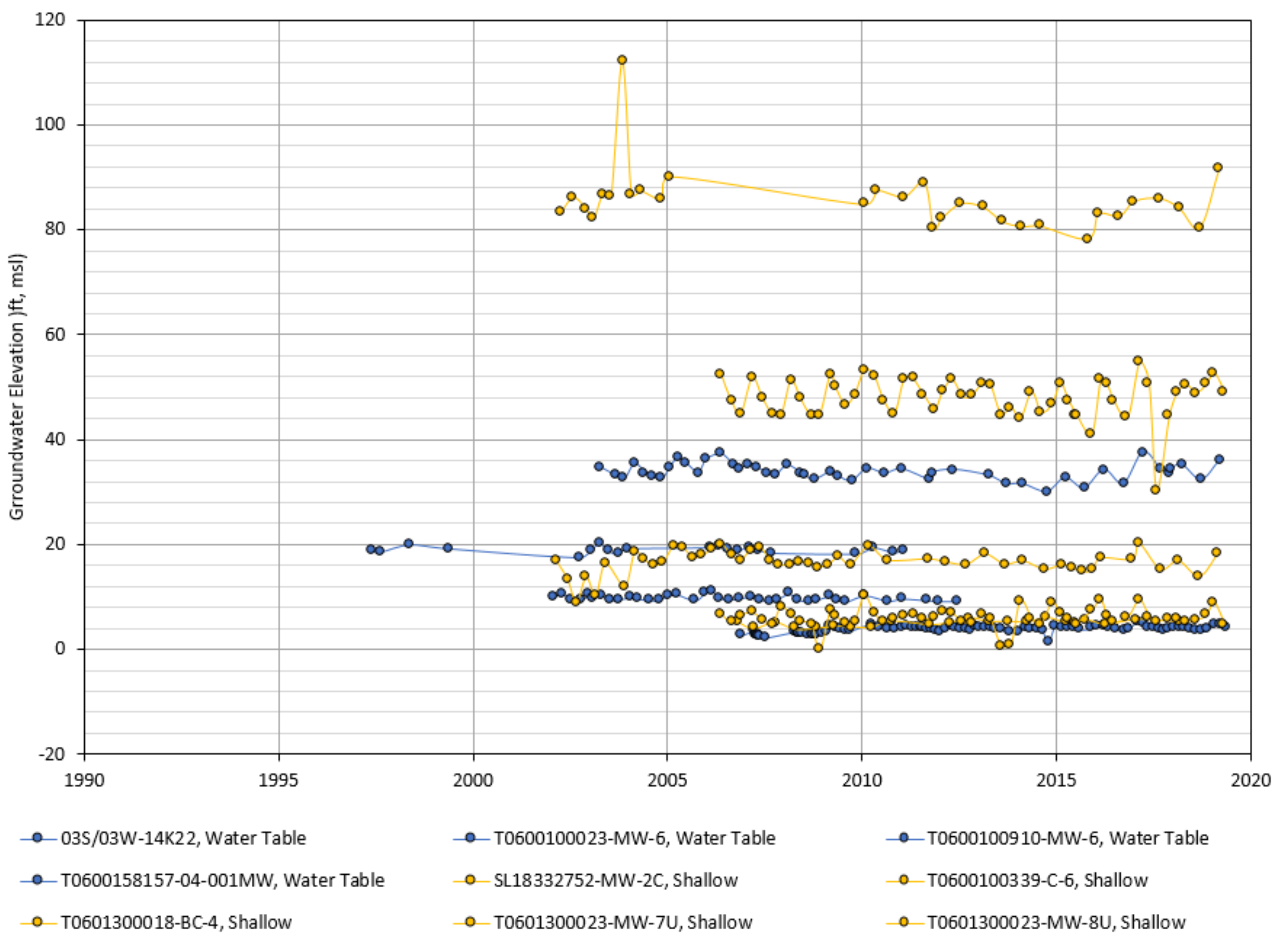


LSCE TEAM

Selected Groundwater Hydrographs for Shallow Zone in EBP Subbasin

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-28



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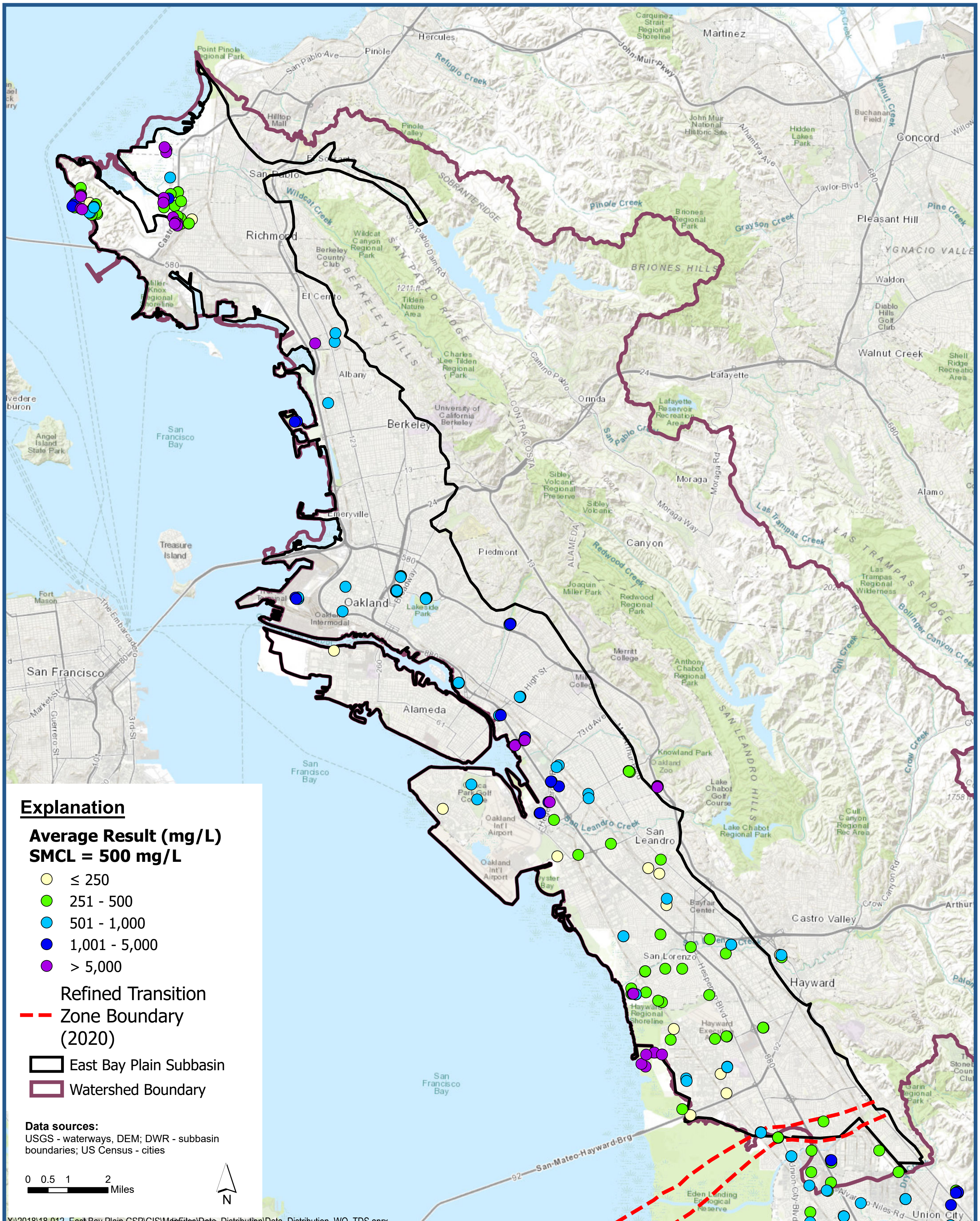
LSCE TEAM

Composite Groundwater Hydrograph for Shallow Zone in EBP Subbasin

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-29

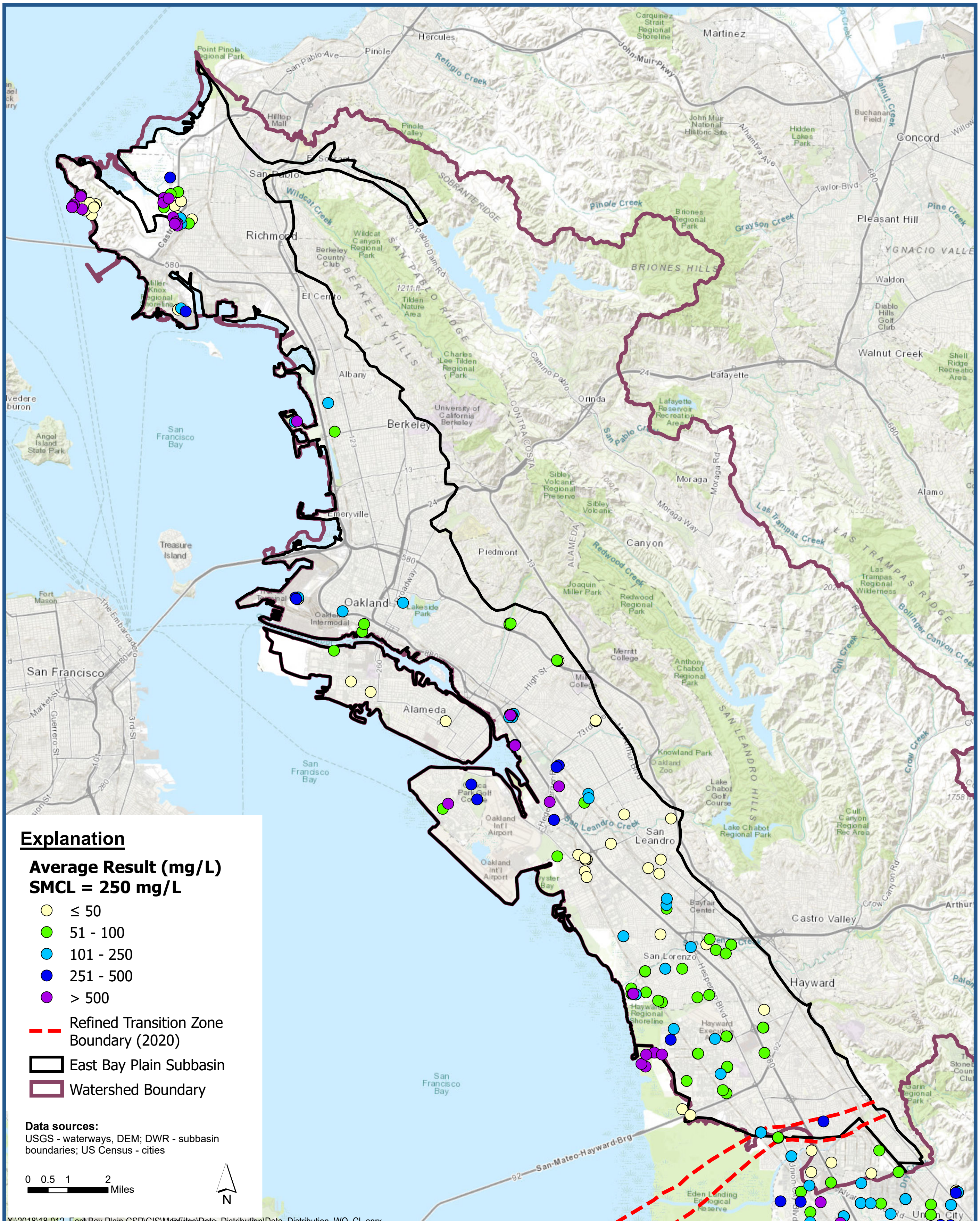


Average Total Dissolved Solids (TDS) Measurement for Wells Deeper than 50-feet

LSCE TEAM

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-30

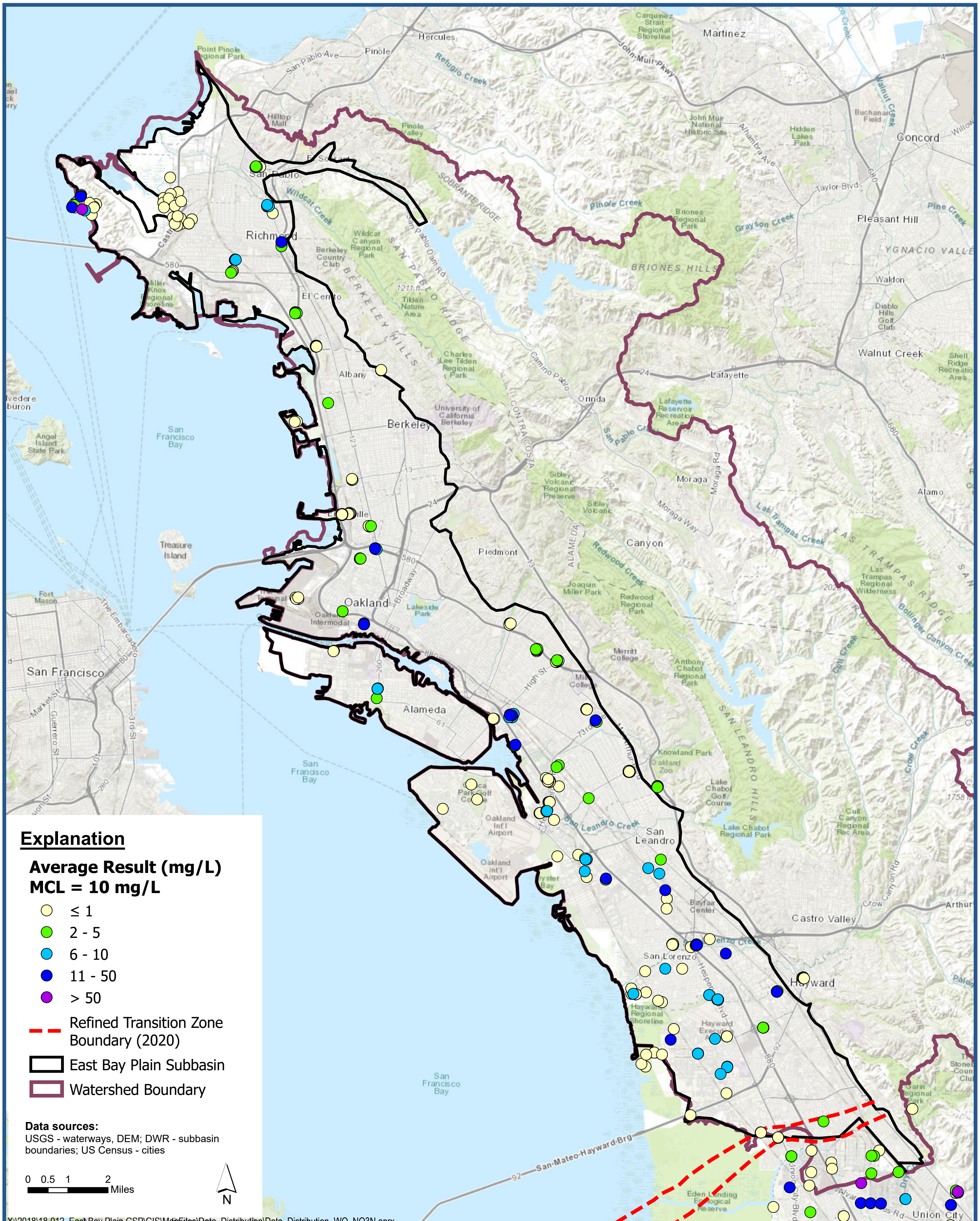


LSCE TEAM

Average Chloride (Cl) Measurement for Wells Deeper than 50-feet

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-31

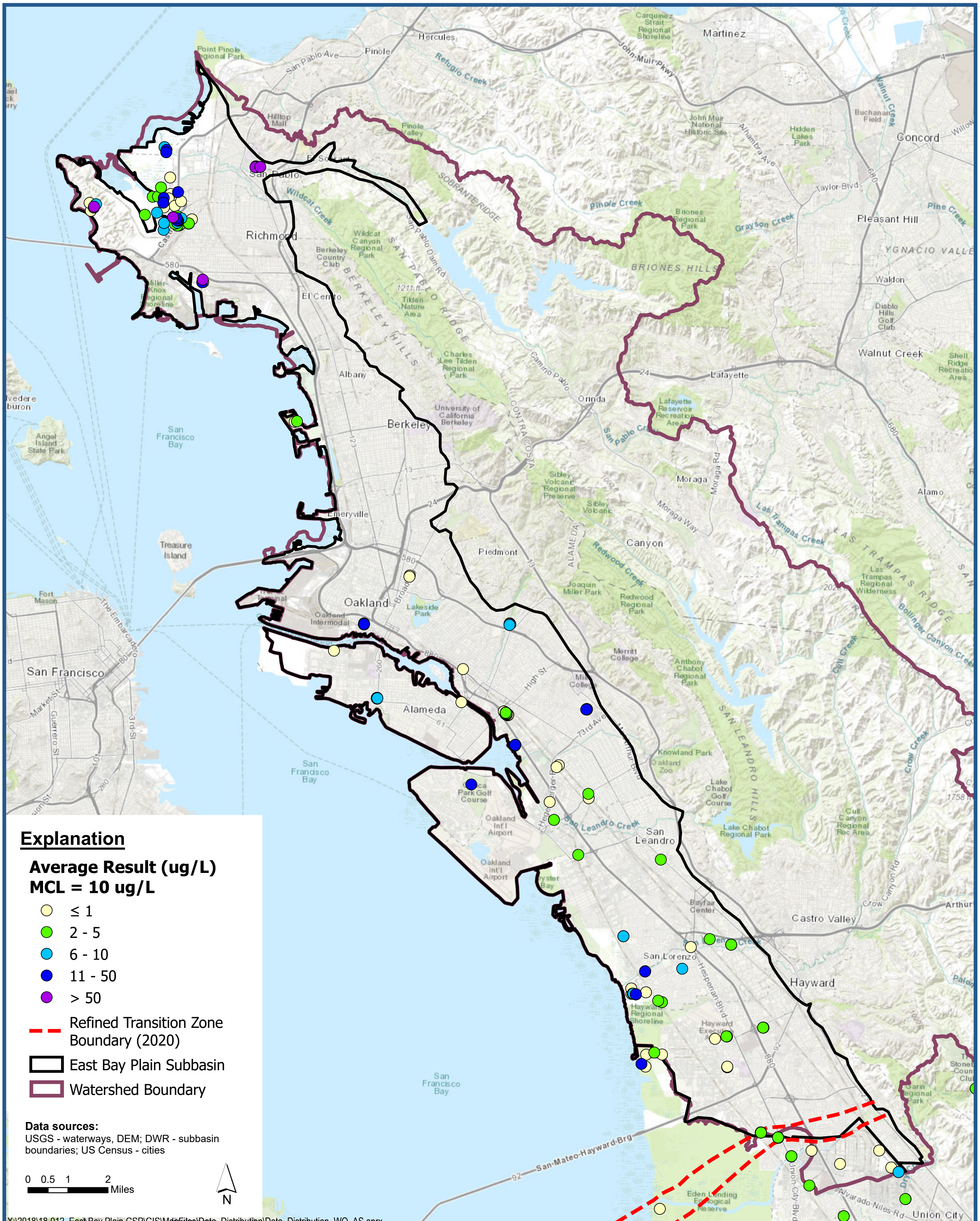


LSCE TEAM

Average Nitrate (NO_3N) Measurement for Wells Deeper than 50-feet

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-32

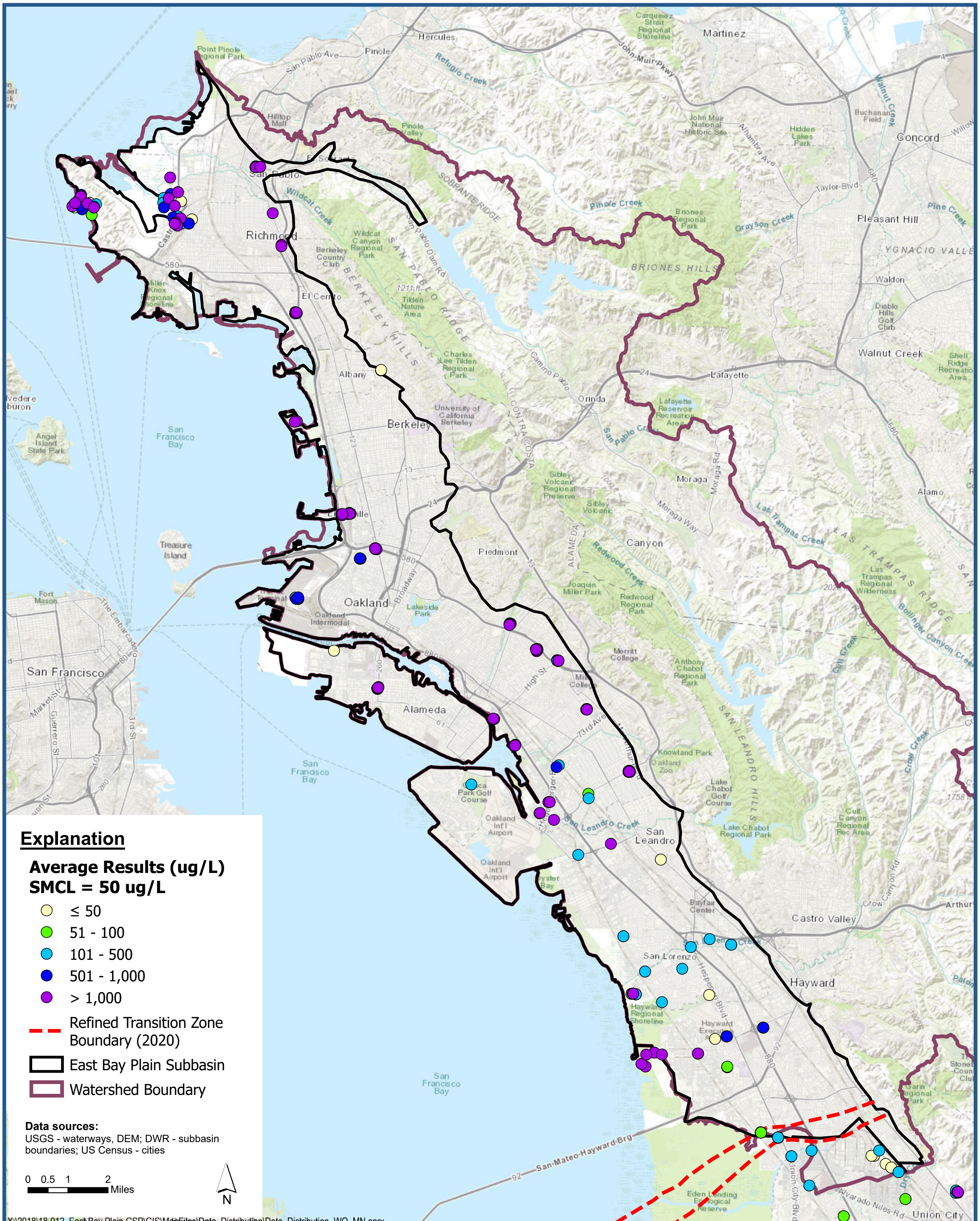


LSCE TEAM

Average Arsenic (As) Measurement for Wells Deeper than 50-feet

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-33

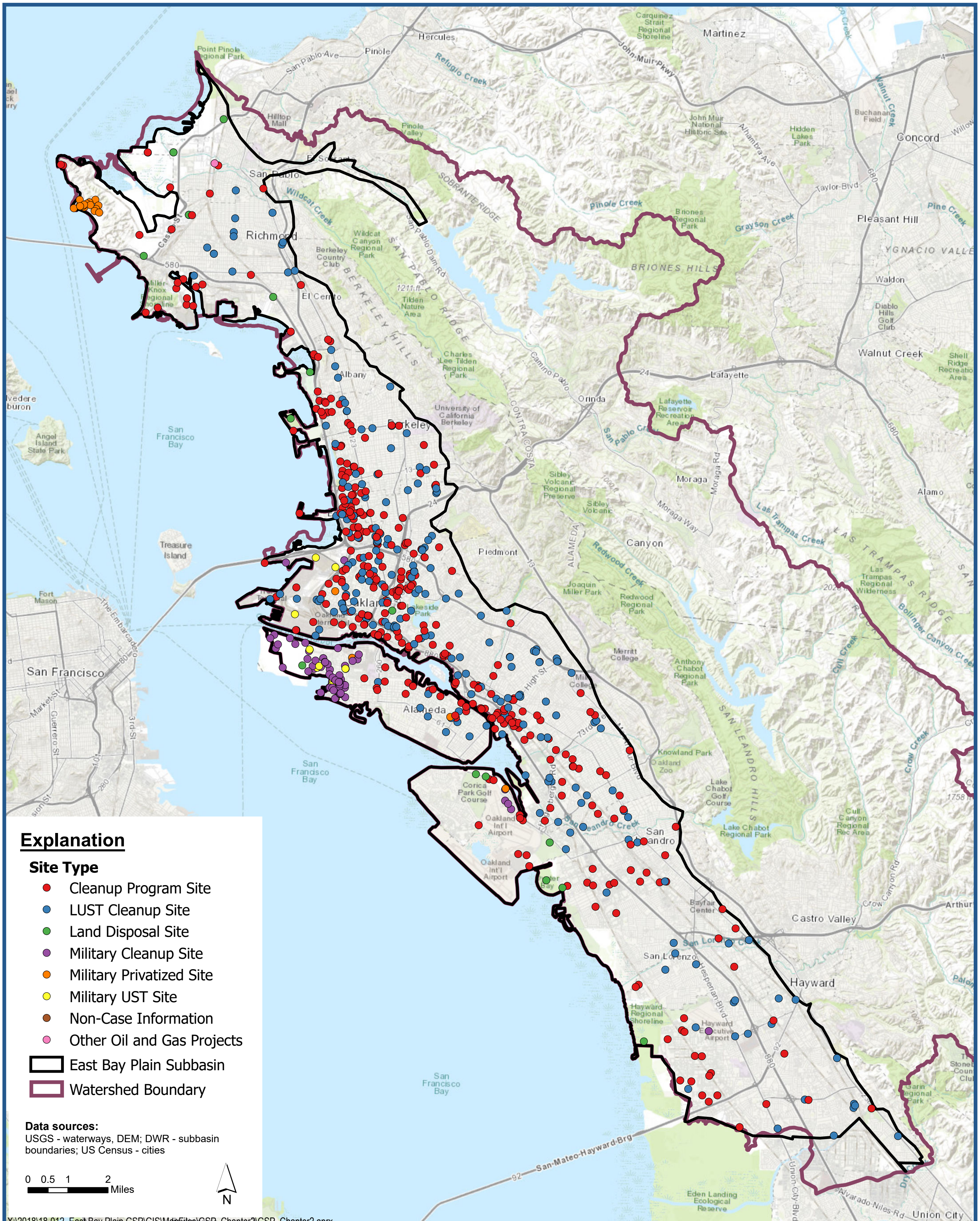


LSCE TEAM

Average Manganese (Mn) Measurement for Wells Deeper than 50-feet

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-34

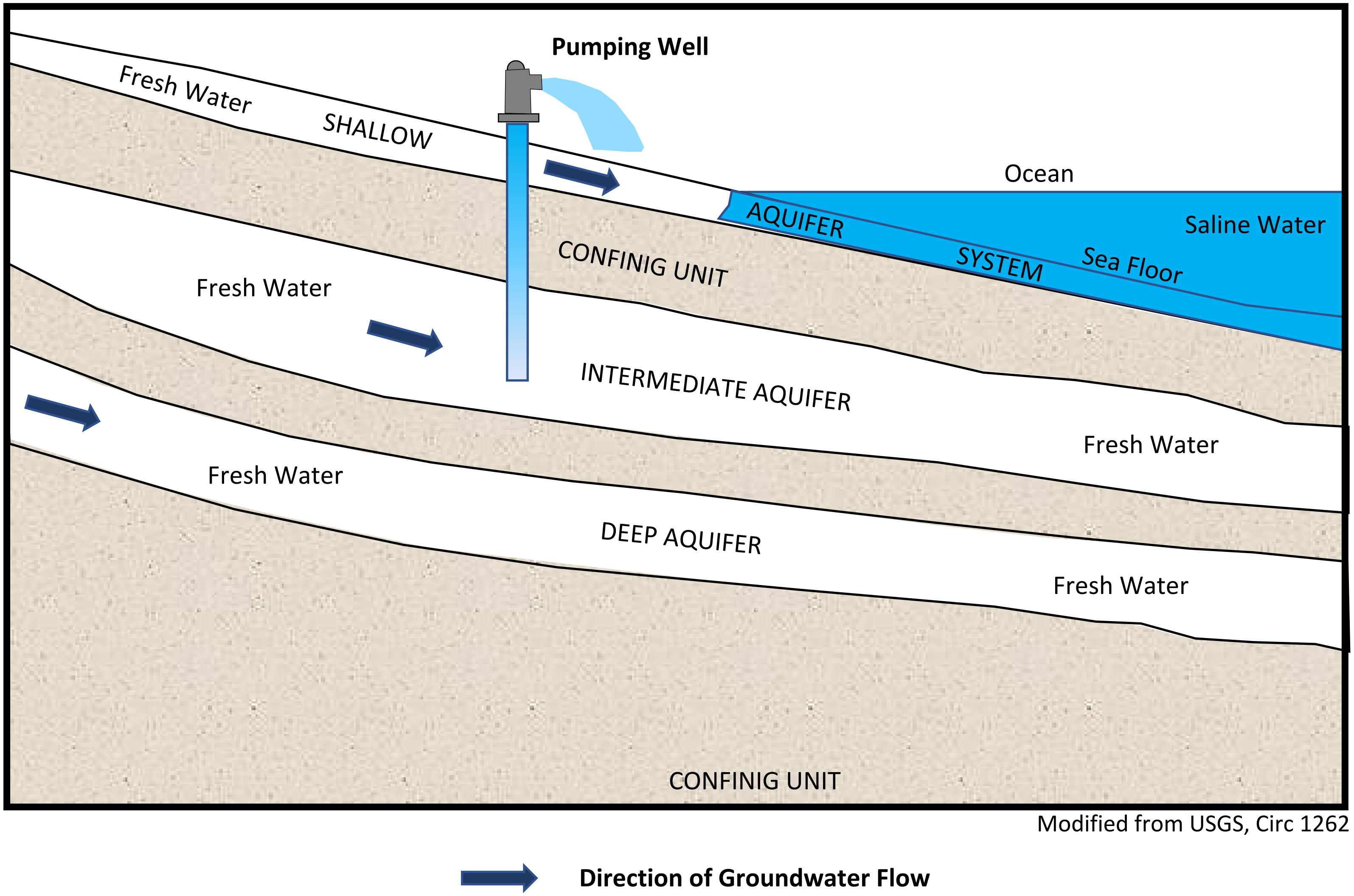


LSCE TEAM

Map of Environmental Site Locations

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-35



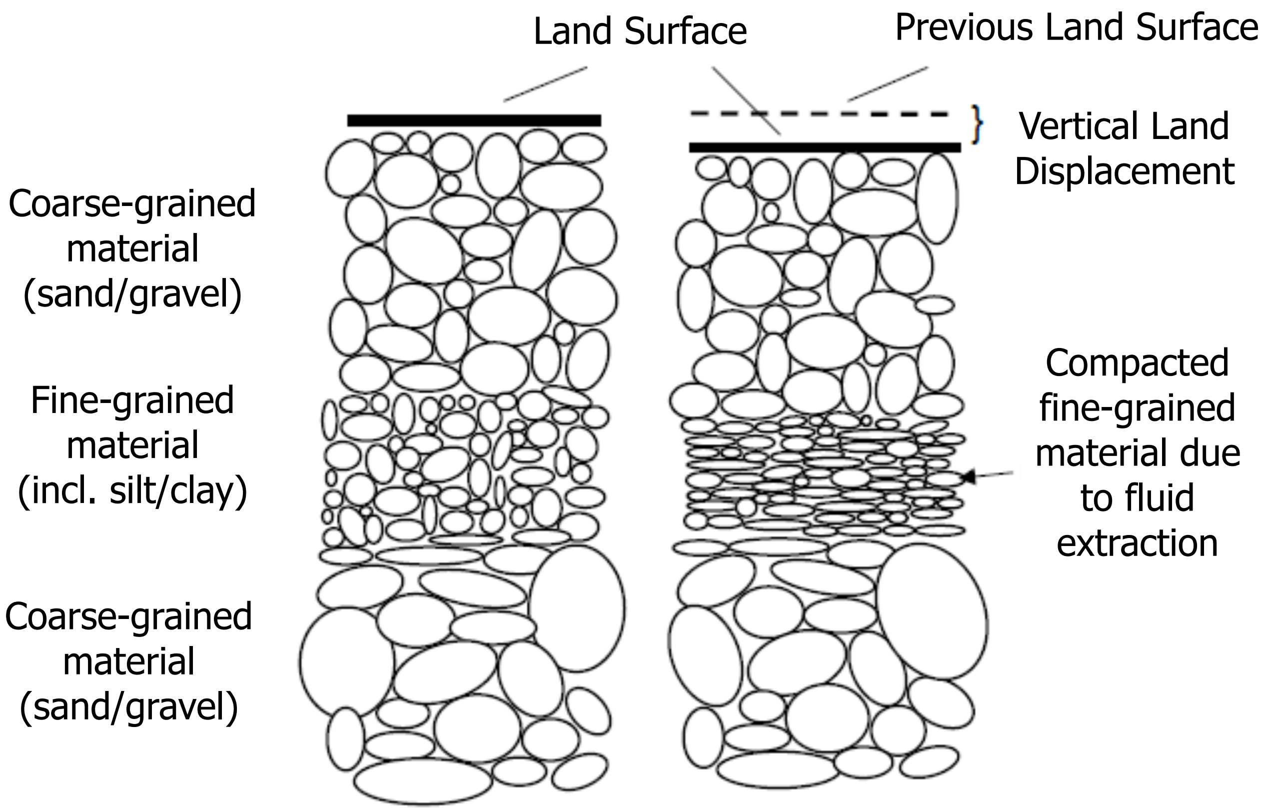
Modified from USGS, Circ 1262

Example Conceptual Cross-Section of Salt Water Intrusion in Coastal Margin Aquifers

Figure 2-36

LSCE TEAM

East Bay Plain Subbasin
Groundwater Sustainability Plan



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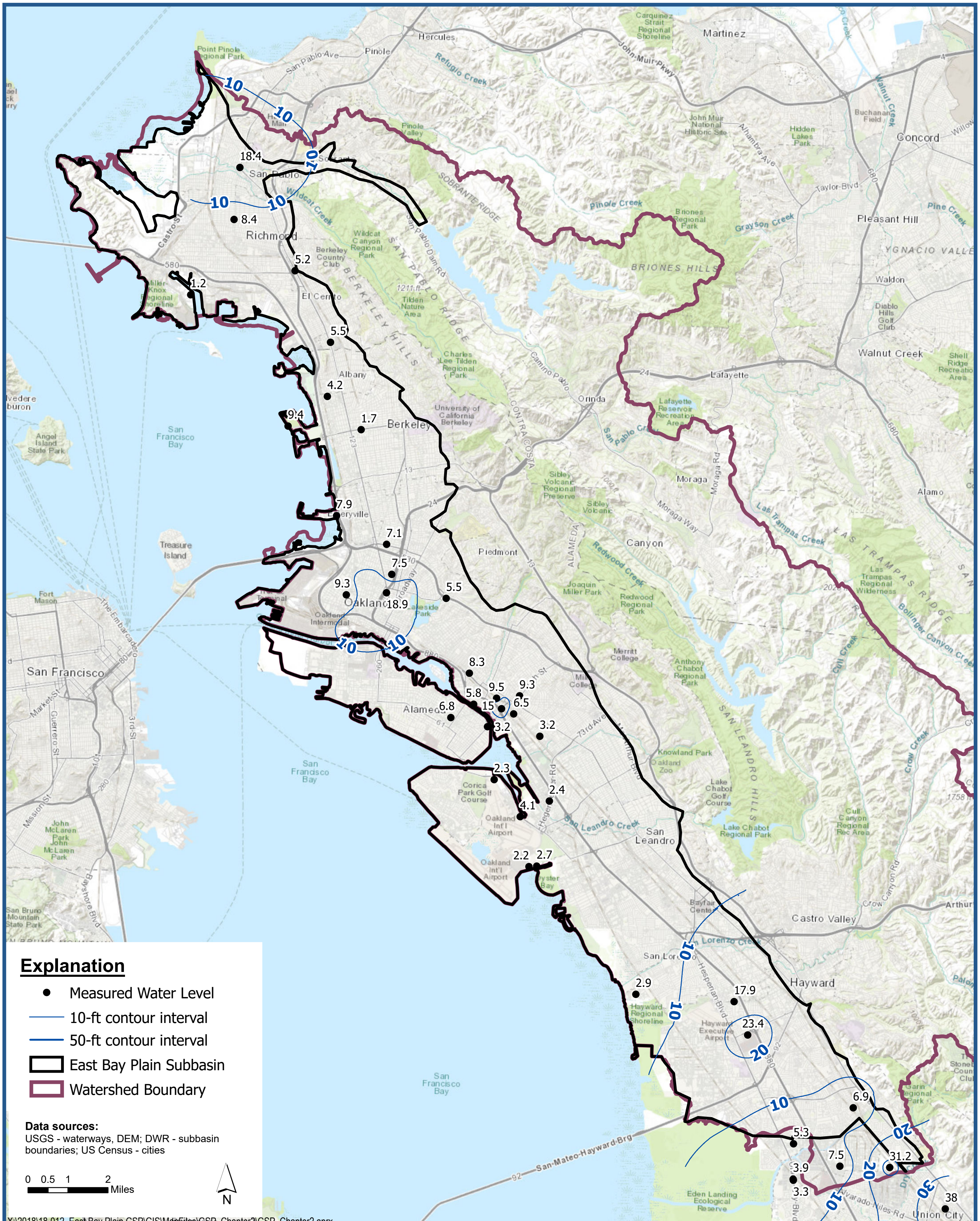
Compaction Diagram

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-37



Map of Depth to Water Table – Spring 2015

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 2-38

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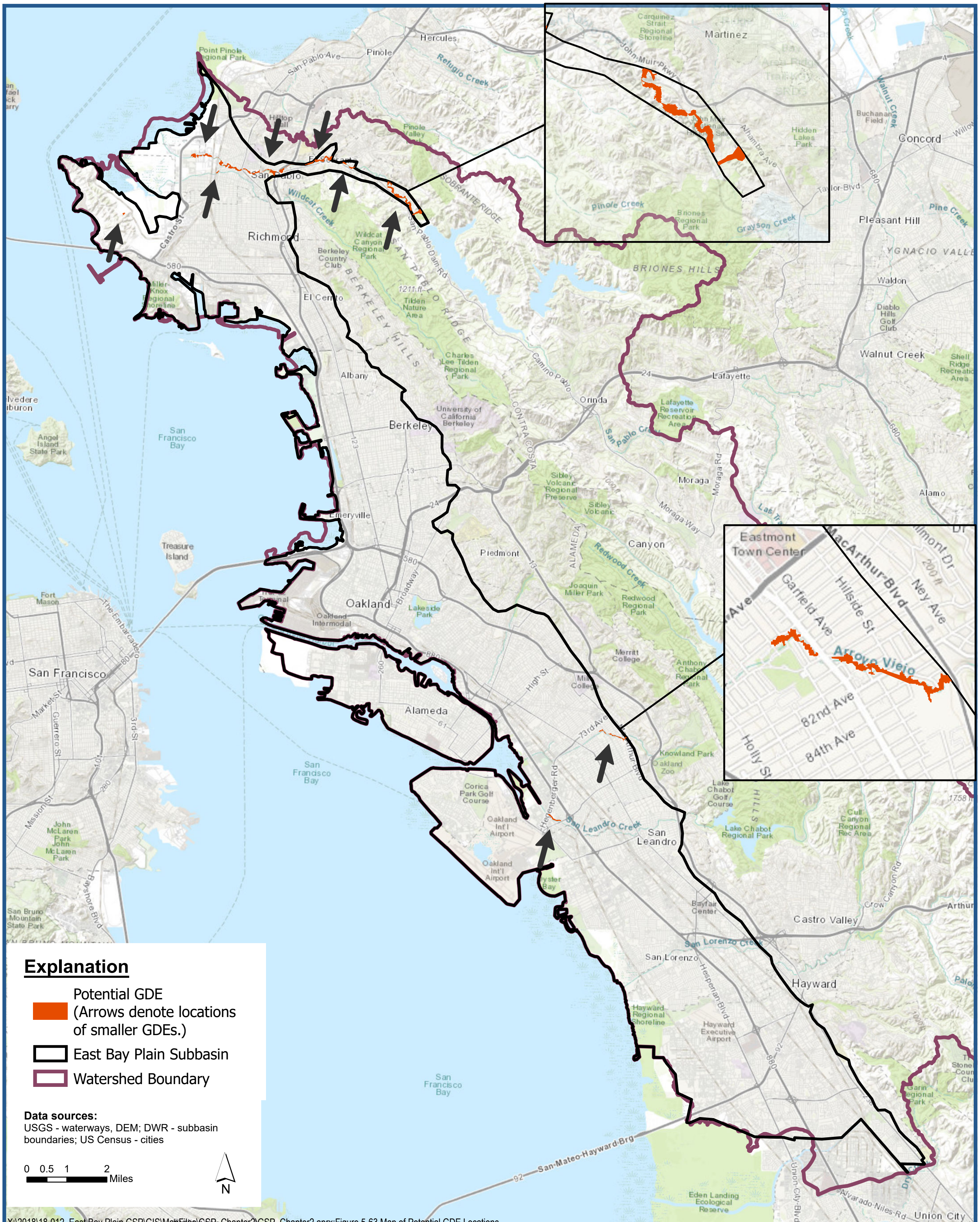


Map of Potential Groundwater Dependent Ecosystem (GDE) Locations

Groundwater Sustainability Plan
EBMUD/East Bay Plain Subbasin

Figure 2-39

LSCE TEAM

JANUARY 2022

EAST BAY PLAIN SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN
CHAPTER 3—SUSTAINABLE MANAGEMENT CRITERIA

PREPARED FOR

EAST BAY MUNICIPAL UTILITY DISTRICT GSA AND
CITY OF HAYWARD GSA

EBMUD

HAYWARD

PREPARED BY

LUHDORFF & SCALMANINI CONSULTING ENGINEERS
GEOSYNTEC
BROWN AND CALDWELL
ENVIRONMENTAL SCIENCE ASSOCIATES
DR. JEAN MORAN
FARALLON GEOGRAPHICS

LSCE TEAM

3. SUSTAINABLE MANAGEMENT CRITERIA

This chapter of the Groundwater Sustainability Plan (GSP or Plan) provides a discussion of the Sustainable Management Criteria (SMC), including: the sustainability goal, undesirable results, minimum thresholds, measurable objectives, interim milestones, and the monitoring networks for the six sustainability indicators within the Plan area encompassed by the two GSAs: East Bay Municipal Utility District (EBMUD) and City of Hayward (Hayward). These two GSAs (and the Plan area) comprise the entire 71,300 acres in the Subbasin. Undesirable results occur when significant and unreasonable effects for any sustainability indicator defined by the Sustainable Groundwater Management Act (SGMA) are caused by groundwater conditions occurring in the Plan area.

This chapter defines sustainability in the Plan area, and it addresses significant regulatory requirements for this GSP. The undesirable results (UR), minimum thresholds (MT), interim milestones (IM), and measurable objectives (MO) presented in this chapter define the future sustainable conditions in the Plan area and commit the associated GSAs (EBMUD and Hayward) to actions that will achieve these future conditions.

The development of and definitions for the SMC require considerable analysis and evaluation of many factors. This chapter presents the data and methods used to develop the SMC and demonstrates how they relate to beneficial uses and users. The SMC presented in this chapter are based on the best available data and science. However, due to very limited data for many of the sustainability indicators, the SMC presented in this chapter are considered “interim” while data gaps are addressed, and additional analyses are conducted during the initial five years of the GSP Implementation Period. The SMC will be revisited in the January 2027 five-year update report, and SMC presented here will either be confirmed or refined based on additional data/analyses conducted during the next five years.

The EBP Subbasin has a history of consistent annual groundwater pumping volumes over the past 30 years of about 3,000 to 4,000 acre-feet per year (AFY), which is well below the initial estimate of sustainable yield of 12,500 AFY (see Chapter 2). The GSAs have no immediate plans to develop new groundwater supplies over the initial 10 years of the GSP Implementation Period; therefore, there is ample time to collect additional data and conduct further hydrogeologic analyses to refine the basis for long-term SMC.

As noted above and elsewhere in this GSP, data gaps and uncertainty exist in the characterization of the hydrogeologic conceptual model and groundwater conditions. Uncertainties associated with the various sustainability indicators were considered when developing the SMC; thus, the SMC presented herein are considered interim pending refinement and will be updated by January 2027. The GSAs will periodically review and update this GSP, assess changing conditions in the Plan area that may warrant modifications of the GSP or management objectives, and may adjust GSP components accordingly. The GSAs will focus their evaluation on determining whether the actions under the GSP are meeting the Plan’s sustainability goal.

This chapter is organized to address all the SGMA regulations regarding SMC and is organized in accordance with California Department of Water Resources (DWR) GSP annotated outline. This chapter includes a description of:

- How undesirable results were developed, including:

  - The criteria defining when and where the effect of the groundwater conditions cause undesirable results based on a quantitative description of the combination of minimum threshold exceedances
  - The potential causes of undesirable results
  - The effect of these undesirable results on the beneficial uses and users.
- How locally defined significant and unreasonable conditions were developed
- How minimum thresholds were developed, including:
  - The information and methodology used to develop minimum thresholds
  - The relationship between minimum thresholds and the relationship of these minimum thresholds to other sustainability indicators
  - The effect of minimum thresholds on neighboring basins
  - The effect of minimum thresholds on beneficial uses and users
  - How minimum thresholds are related to relevant Federal, State or local standards
  - The method for quantifying measurable minimum thresholds
- How measurable objectives were developed, including:
  - The methodology for setting measurable objectives
  - Interim milestones

The SMC presented in this chapter were developed using information from stakeholder and public input and correspondence with the GSAs, public meetings, hydrogeologic analysis, groundwater dependent ecosystem analysis, and meetings with GSA Technical Team representatives. The general process for establishing SMC included:

- GSA public meetings (i.e., Stakeholder Communication and Engagement Meetings) that outlined the GSP development process and introduced stakeholders to the SMC
- Development of draft proposed SMC by the consultant team, GSA staff, and GSA technical representatives
- Review of draft proposed SMC by GSA steering committees
- TAC meetings to review initial proposed SMC for each sustainability indicator
- Reviewing TAC input on preliminary SMC methodologies with GSA Technical Team representatives
- Conducting GSP public meetings to present proposed methodologies to establish minimum thresholds and measurable objectives and receive additional public input. Two public meetings on SMC were held in the Plan area.
- Reviewing public input on preliminary SMC methodologies with GSA Technical Team representatives
- Providing the Draft GSP for public review and comment

- Establishing and modifying MT, IMs, and MOs, and definitions for UR based on feedback from TAC meetings, public meetings, public/stakeholder review of the Draft GSP, and input from GSA Technical Team representatives.

To ensure the Plan area continues to meet its sustainability goal by 2042, the GSAs have proposed projects and management actions (MAs) described in Chapter 4 that are intended to avoid UR. The projects and MAs expected to be implemented will include wells for groundwater extraction and groundwater injection and various actions (e.g., collection of additional streamflow data, installation of additional representative monitoring sites (RMS)). In addition, Chapter 4 outlines various projects that may be considered in the future, pending development of more extensive monitoring networks and further evaluation of groundwater basin conditions that result from implementation of initial projects and MAs. The overarching sustainability goal and the absence of UR are expected to be maintained through and beyond 2042 with implementation of the projects and MAs. The sustainability goal will be maintained through proactive monitoring and management by the GSAs as described in this and the following chapters.

Table 3-1 summarizes whether each of the six UR has occurred, is occurring, or is expected to occur in the future in the Plan area without and with GSP implementation.

Table 3-1. Summary of Undesirable Results Applicable to the Plan Area

Sustainable Indicator	Pre-Historical Period (1950s to 1989)	Historical Period (1990 to 2015)	Existing Conditions (2016 to 2021)	Future Conditions without GSP Implementation (after 2042)	Future Conditions with GSP Implementation (after 2042)
Chronic Lowering of Groundwater Levels	No	No	No	No	No
Reduction of Groundwater Storage	No	No	No	No	No
Land Subsidence	No	No	No	No	No
Seawater Intrusion	Yes[1]	No	No	No	No
Degraded Water Quality	Yes[2]	Yes[2]	Yes[2]	No[4]	No[4]
Depletion of Interconnected Surface Water	Yes[3]	No[5]	No[5]	No	No

[1] Small local areas of seawater intrusion were reported in the Shallow Aquifer Zone near the San Francisco Bay margin prior to 1930, at which time EBMUD began importation of surface water supplies from outside of the EBP Subbasin.

[2] The Shallow Aquifer Zone has been impacted historically in localized areas and exhibits somewhat elevated concentrations of nitrate, chloride, and TDS.

[3] There are major data gaps related to surface water/groundwater interaction and historical stream depletion. However, based on numerical model runs and available data, it is possible there may have been surface water depletion that was sufficient to constitute undesirable results in the 1950s and early 1960s in the southern portion of the EBP Subbasin.

[4] In this context, "No" means that with GSP implementation, existing degraded water quality conditions will not become worse as a result of GSP projects and MA.

[5] There are major data gaps related to surface water/groundwater interaction and historical stream depletion. However, based on numerical model runs and available data, surface water depletion since 1990 is significantly less than model results for the 1950s and early 1960s in the southern portion of the EBP Subbasin.

3.1. Sustainability Goal

(California Code of Regulations [CCR] Title 23, Section 354.24)

3.1.1. Sustainability Goal

The sustainability goal for the Plan area is to manage and protect the East Bay Plain Subbasin in a manner that avoids UR while continuing to collect and analyze data to support science-based decision making to evaluate new opportunities for sustainable groundwater beneficial uses. The six sustainability indicators have been assigned minimum thresholds and measurable objectives (and interim milestones) as set forth in this GSP to avoid UR and ensure continued sustainable groundwater management of the EBP Subbasin over the planning and implementation horizon.

3.1.2. Explanation of How the Goal Will Be Achieved in 20 Years

The sustainability goal is already being achieved, which has been the case since at least the 1970s. Over the next 20 years of the GSP implementation period, the sustainability goal will continue to be achieved by prudent and incremental use of existing approved groundwater injection and extraction facilities. At this time, the GSAs have no plans to expand groundwater injection/extraction facilities, but the GSAs will continue data collection to provide current baseline conditions and evaluate potential impacts of incremental greater use of existing facilities and potential new facilities.

3.1.3. Description of Measures

Existing project facilities (e.g., EBMUD Bayside Well and Hayward Emergency Wells) are planned to continue operations in accordance with previous approval processes (e.g., Bayside 2005 FEIR) over the 20-year implementation period (2022 to 2042). The proposed projects and the MA will result in groundwater injection and net groundwater extractions consistent with existing permit conditions to maintain net groundwater pumping well below sustainable yield through and beyond 2042 and allow EBP Subbasin operations to remain sustainable over a 50-year period representing average hydrologic conditions. If actual hydrologic conditions differ from the 50-year average (plus accounting for anticipated climate change), then additional measures may be necessary. The implementation of only existing facilities/projects will maintain pumping well below the sustainable yield and allow for ongoing data collection and analysis to further evaluate the potential for increased groundwater pumping.

3.2. Undesirable Results

(CCR Title 23, Section 354.26)

The regulations define undesirable results as occurring when significant and unreasonable effects are caused by groundwater conditions occurring throughout the Subbasin for one or more sustainability indicators. This section provides a description of undesirable results for the relevant sustainability indicators, including:

- Causes of groundwater conditions that would lead to undesirable results.
- Criteria used to define undesirable results based on minimum thresholds.
- Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.

A summary of criteria used to define UR is provided below in **Table 3-2**, and detailed discussions of each sustainability indicator are provided in subsequent sections of this Chapter.

Locally defined significant and unreasonable conditions presented in **Table 3-2** were determined based on discussions with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives.

Table 3-2. Summary of MT, MOs, and Undesirable Results.

Sustainability Indicator	Interim Minimum Threshold	Interim Measurable Objective[1]	Undesirable Result UR
Chronic Lowering of Groundwater Levels	Shallow Aquifer Zone: Spring groundwater level of 50 feet below ground surface; Adjustment in GDE areas to allow only a 7.5-foot decline in Water Table Aquifer Zone groundwater levels Intermediate and Deep Aquifer Zones: Spring groundwater elevation of -50 feet MSL.	Average of recent observed high and low groundwater level measurements. Where recent observed data not available – average of recent modeled high and low groundwater levels.	25% or more RMS wells have levels below interim MT for two consecutive spring measurements.
Reduction of Groundwater Storage	Annual pumping volume of 12,500 AFY.	Annual pumping volume of 6,250 AFY.	Five-year moving average of annual pumping volumes greater than 12,500 AFY.
Seawater Intrusion	Five feet groundwater elevation contour line for Water Table Aquifer Zone moves inland by 25%.	Position of Water Table Aquifer Zone five feet contour line in Spring 2015.	Inland movement of Water Table Aquifer five feet contour line by at least 25% of existing 2015 land area (for northern

Table 3-2. Summary of MT, MOs, and Undesirable Results.			
Sustainability Indicator	Interim Minimum Threshold	Interim Measurable Objective[1]	Undesirable Result UR
			and/or southern areas) between Bay Margin and five feet contour line; and chloride concentration increases by 25% or more in sentinel wells.
Land Subsidence	Spring groundwater elevation of -50 feet MSL in Intermediate and Deep Aquifer Zones in southern EBP Subbasin; Spring groundwater elevation of -20 feet MSL in Intermediate and Deep Aquifer Zones in northern EBP Subbasin.	Same as Groundwater Level MO for Intermediate and Deep Aquifer Zones.	25% or more RMS wells below interim MT for two consecutive spring measurements (applies to Intermediate and Deep Aquifer Zones only; subsidence not expected in Shallow Aquifer).
Degraded Water Quality	Nitrate: 10 mg/L or existing baseline level plus 20% (whichever is greater); Arsenic: 10 µg/L or existing baseline level plus 20% (whichever is greater); Chloride: 250 mg/L or existing baseline level plus 20% (whichever is greater); TDS: 500 mg/L or existing baseline level plus 20% (whichever is greater).	Current concentrations (maximum of baseline sampling results) of nitrate, arsenic, chloride, and TDS.	25% or more RMS wells above the interim MT for the same constituent as a result of GSA projects or MA, based on average of most recent three-year period.
Depletion of Interconnected Surface Water	Two feet decline in Water Table Aquifer Zone groundwater levels beneath San Pablo or San Leandro Creeks.	Low end of range for recent observed high and low groundwater level measurements in Water Table Aquifer Zone beneath San Pablo and San Leandro Creeks. Where recent observed data not available –modeled groundwater levels were used.	50% or more RMS wells below interim MT for two consecutive spring measurements.

1 Interim Milestones are equal to Measurable Objectives.

3.2.1. Chronic Lowering of Groundwater Levels

Causes and Effects on Beneficial Users and Uses: The definition of UR for chronic lowering of groundwater levels is a significant and unreasonable decline in groundwater levels caused by excessive regional groundwater pumping over an extended period of time that results in existing water supply wells (drinking water, industrial, irrigation for large parcels) not being viable for intended beneficial uses due to reduction of pumping capacity, or groundwater levels exhibit ongoing lowering that significantly affects other beneficial uses (e.g., GDEs).

Minimum Threshold: The interim MT for Shallow Aquifer Zone groundwater levels is set at 50 feet below current ground surface. The interim MT for Intermediate and Deep Aquifer Zone groundwater levels is set at -50 feet mean sea level (MSL). Adjustments to the Shallow Aquifer Zone interim MT will be made at RMS wells located adjacent to GDEs that are solely dependent on groundwater levels (e.g., not located near stream or have roots extending below stream thalweg where stream is disconnected). In these areas, the initial interim MT for Shallow Aquifer Zone groundwater levels is set to 7.5 feet below existing/baseline conditions, and this will be updated (and potentially revised) pending additional hydrogeologic/biologic data collection and studies. The proposed interim MT requires construction of dedicated shallow wells within potential GDE areas that are planned for future installation to serve as RMS wells. Additional details on development of interim MT are provided in Section 3.3.

Criteria: An undesirable result is defined to occur when 25% or more RMS wells exceed the groundwater level minimum thresholds for the two consecutive Spring (March) readings. The technical justification for using 25% is reasonableness. If a very small percentage of wells was used (e.g., 10% or less), it would mean that a small number of wells falling below the interim MT (which may just be a very localized issue) would cause an undesirable result. Whereas, if a very high percentage of wells (e.g., 75%) was used, then a relatively large portion of the basin would already be impacted before an UR occur. Using a percentage in the 20 to 50% range is a reasonable balance between not letting a very localized problem drive the definition of undesirable results and not allowing most of the basin to be impacted before declaring an undesirable result has occurred. The selection of 25% is at the lower end of what is deemed a reasonable range.

3.2.2. Reduction of Groundwater Storage

Causes and Effects on Beneficial Users and Uses: The definition of UR for reduction of groundwater storage is excessive regional groundwater pumping that causes a significant and unreasonable decrease in groundwater storage over an extended period of time that results in significant reduction of pumping capacity to the extent that existing water supply wells (drinking water, industrial, irrigation for large parcels) are no longer viable for intended beneficial uses.

Minimum Threshold: The interim MT for reduction of groundwater storage is set at an annual pumping volume of 12,500 AFY, which is the estimated Subbasin sustainable yield. The interim MT will be updated (and possibly refined) as more data are collected and the sustainable yield is updated. This UR encourages total basin pumping to remain less than the estimated sustainable yield, including during average hydrologic conditions over the long-term and after full implementation of GSA projects and MA. Correspondingly, over the long-term, beneficial uses and users will have access to the groundwater in storage that exists in a balanced basin where inflows remain in balance with outflows. Increased pumping within the long-term sustainable yield during dry years may temporarily lower groundwater elevations and reduce the amount of groundwater in storage. Groundwater storage would then be replenished during wet years when pumping is decreased. Additional details on development of minimum thresholds are provided in Section 3.3.

Criteria: An UR is defined to occur when the five-year moving average of groundwater pumping exceeds 12,500 AFY. The technical justification is that a shorter time such as one or two years does not account for the potential need for short-term greater pumping that may occur due to very extreme water shortage due to natural disasters (e.g., earthquakes) and/or extreme drought conditions. However, a longer time frame for a moving average (e.g., 8 or 10 years) is excessive and unreasonable as a duration for extreme reliance on groundwater pumping for such conditions. The use of a five-year moving average provides a good balance between accounting for short-term extreme needs versus allowing for long-term overpumping of the basin. In addition, best available data indicate the EBP Subbasin was historically pumped at levels exceeding the current initial GSP sustainable yield estimate for more than five years. Thus, the selected interim MT based on the five-year moving average is likely to have been exceeded historically without major reported consequences in terms of UR (i.e., the MT duration represents a conservative/low value).

3.2.3. Seawater Intrusion

Causes and Effects on Beneficial Users and Uses: The definition of UR for seawater intrusion is excessive regional groundwater pumping that causes a significant and unreasonable inland migration of saline Bay water into existing freshwater aquifers that are or could be developed for water supply to the extent that increased groundwater salinity precludes beneficial use for drinking water.

Minimum Threshold: The interim MT is based on the position of the five-foot groundwater elevation contour for the Water Table Aquifer Zone. For the EBP Subbasin, the seawater intrusion UR is defined using groundwater levels as a proxy and maintaining the Water Table Aquifer Zone (i.e., Upper 50 feet of sediments) groundwater elevations above the MSL near the Bay margin.

Criteria: An UR is defined to occur when the five foot MSL groundwater elevation contour line for the Water Table Aquifer moves further inland from baseline conditions to the extent that the onshore area between the five feet MSL contour line and the Bay Margin increases by 25% or more in either the northern or southern portion of the EBP Subbasin, and chloride sentinel wells (i.e., N2S, N3S, others to be installed) show 25% or greater increases in chloride concentrations over baseline conditions. The technical justification for use of 25% is reasonableness. If a very small percentage such as a 10% increase in the area was used, it would be difficult to accurately quantify (the baseline area between 5 ft MSL and Bay Margin is relatively small portion of the Subbasin and 10% of that small area will be very small). If an increase in the area of greater than 50% was used, this would suggest a significant and unreasonable impact has already occurred. The proposed 25% increase in area represents a conservative percentage at the lower end of a reasonable range from 20 to 50%.

More refined baseline conditions will be established during the first two years of the GSP implementation. An initial interim estimate of the position of the five-foot MSL contour was developed as described in Section 3.3. However, available data will be reviewed, and additional water level measurements collected (e.g., new nested monitoring wells, possibly Port of Oakland wells) to better define the baseline conditions in 2022/2023. The proposed interim MT will benefit from ongoing and planned construction of additional shallow monitoring wells.

Shallow groundwater levels can serve as a good proxy for this sustainability indicator given that the Water Table Aquifer Zone is the only aquifer connected with the Bay bottom, and significant layers of clay separate the Water Table Aquifer Zone from the Intermediate and Deep Aquifer Zones. If the shallowest groundwater levels are maintained above MSL, there should be no significant incursion of saline water. This method of using shallow groundwater levels as a proxy for seawater intrusion is consistent with the DWR-approved Niles Cone Alternative (to a GSP). Supporting data related to chloride concentrations in monitoring network wells will be collected to complement the maintenance of shallow groundwater (GW) levels above MSL to prevent seawater intrusion.

3.2.4. Land Subsidence

Causes and Effects on Beneficial Users and Uses: The definition of UR for land subsidence is excessive regional groundwater pumping that leads to the occurrence of inelastic subsidence that results in significant and unreasonable damage at a regional scale to public infrastructure critical for public health and safety (i.e., levees, flood control channels, water supply aqueducts).

Minimum Threshold: The interim MT for land subsidence is set at -50 feet MSL in Intermediate and Deep Zone Aquifers in the southern portion of the EBP Subbasin and -20 feet MSL in Intermediate and Deep Zone Aquifers in the northern portion of the EBP Subbasin. These interim MT apply to Spring groundwater levels and were based on evaluation of historical low groundwater elevations in the Subbasin.

Criteria: An UR would occur if 25% or more RMS wells fall below the interim MT for two consecutive years. The technical justification for use of 25% is reasonableness. If a very small percentage of RMS wells (e.g., 10% or less) was used, then a small number of RMS wells falling below the interim MT (which may just be a very localized issue) would result in an UR. If a very high percentage (e.g., 75%) was used, then a relatively large portion the basin would be already impacted. Using a percentage in the 20 to 50% range is a reasonable balance between not letting a very localized problem drive the definition of UR and not allowing most of the basin to be impacted before declaring an UR has occurred. The selection of 25% is at the lower end of what is deemed a reasonable range. The UR definition also includes two consecutive years to ensure that an UR is not defined from a very temporary groundwater condition, but rather the UR represents a persistent undesirable groundwater condition.

Groundwater levels serve as a good proxy for this sustainability indicator because the minimum thresholds were based on an evaluation of historical low groundwater elevations. The historical low levels would generally need to be exceeded to trigger any potential for subsidence to occur. Therefore, historical low groundwater levels serve as a good proxy for the land subsidence sustainability indicator.

3.2.5. Degraded Water Quality

Causes and Effects on Beneficial Users and Uses: The definition of UR for degraded water quality is significant and unreasonable degradation of groundwater quality to the extent of interfering with beneficial uses/users of groundwater used as drinking water that is caused by GSA-related groundwater management activities or implementation of GSA projects and MA. Locally defined significant and unreasonable conditions were determined based on discussions with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives.

Minimum Threshold: The interim MT for key groundwater quality constituents are 500 mg/L for TDS, 250 mg/L for chloride, 10 mg/L for nitrate as N, and 10 µg /L for arsenic. In the case where the baseline concentration of a key constituent at an RMS well is close to (i.e., within 20%) or already exceeds the MCL, the interim MT is defined as a 20% increase in concentration from the baseline groundwater quality (for the applicable constituent(s)) for that RMS well.

Criteria: An UR occurs when 25% or more of RMS wells in the EBP Subbasin exceed the interim MT for a given key constituent, and this exceedance is a result of a GSA project or management action. The baseline concentration for each key constituent will be set as the maximum value from baseline sampling events. An exceedance of an interim MT at a given RMS well is defined based on the average concentration over a three-year monitoring period.

The technical justification for use of 25% is reasonableness. If a very small percentage of RMS wells (e.g., 10% or less) was used, then a small number of RMS wells exceeding the interim MT (which may just be a very localized issue) would result in an undesirable result. If a very high percentage of RMS wells (e.g., 75%) was used, then a relatively large portion the basin is already impacted before an UR occurs. Using a percentage in the 20 to 50% range is a reasonable balance between not letting a very localized problem drive the definition of UR and not allowing most of the basin to be impacted before declaring an UR has occurred. The selection of 25% is at the low end of what is deemed a reasonable range.

Establishing baseline concentrations for key constituents requires multiple sampling events during both the wet (winter/spring) and dry seasons (summer/fall). Additional baseline sampling is needed for key constituents in the RMS wells. In general, baseline concentrations for key constituents will be established based upon a minimum of two wet and two dry season sampling events. The baseline sampling events will occur within the initial four years of GSP implementation to provide the necessary data to establish the range of baseline concentrations for each RMS well key constituent by the 5-year Update Report. Annual sampling events will be conducted thereafter to compare against baseline concentrations for each key constituent.

3.2.6. Depletion of Surface Water

Causes and Effects on Beneficial Users and Uses: The definition of UR for depletion of interconnected surface water is excessive regional groundwater pumping that causes an increase in streamflow depletion rate that results in significant and unreasonable effects to potential beneficial uses/users (e.g., insufficient water for aquatic species, GDEs).

Minimum Threshold: The interim MT for shallow groundwater levels (as a proxy) is set at two feet below current baseline water levels in the Water Table Aquifer Zone beneath the major creeks. This is considered an interim MT, and the MT will be refined with collection of additional data to improve the understanding of stream-aquifer connectivity and potential for streamflow depletion related to groundwater pumping. The proposed MT requires future construction of dedicated shallow monitoring wells along major creeks that will serve as RMS wells. The interim MT are based on model-estimated groundwater levels and are subject to verification when the actual wells are installed and monitored for current baseline water levels.

Criteria: An UR will be defined to occur when 50% or more RMS levels measured in shallow RMS wells near major creeks fall below the interim MT for two consecutive years (e.g., three out of five wells). This is an initial interim percentage that is based on very limited data and a small number of planned RMS wells. The technical justification for the selected percentage is reasonableness. If a smaller percentage means 1 or 2 wells have levels that fall below the interim MT (which may be a very localized issue), then this would be an UR. While the selection of 50% may be at the higher end of what is deemed a reasonable range, this is an initial percentage based on a small number of RMS wells anticipated to be installed to monitor this sustainability indicator (up to 10 wells).

3.3. Minimum Thresholds

(CCR Title 23, Section 354.28)

The regulations define UR as occurring when significant and unreasonable effects are caused by groundwater conditions occurring throughout the Subbasin for a given sustainability indicator. Significant and unreasonable effects occur when MT are exceeded for one or more sustainability indicators. This section describes the following for each sustainability indicator relevant to the EBP Subbasin: the methodology used to set the MT and how selected MT avoid causing UR, relationships to other sustainability indicators, impact on adjacent subbasins, impacts on beneficial uses/users, comparison to relevant federal, state, and local standards, and the measurement method.

The approach used in this GSP is to establish MT for each sustainability indicator that solely reflect that one particular indicator and that consider protection of beneficial uses/users related to that one indicator. Based on this approach, the most constraining sustainability indicator becomes the driver for defining UR. For example, shallow groundwater levels near the Bay can be below sea level and still allow for adequate groundwater supply to be obtained from a shallow well (i.e., there is no UR for chronic lowering of groundwater levels); however, these shallow groundwater levels may not meet the seawater intrusion MT, which may then cause an UR for seawater intrusion (even though an UR for chronic groundwater level decline did not occur). This approach to establishing MT allows for clarity in identifying the cause(s) of UR should they ever occur in EBP Subbasin.

This GSP uses best available data to derive the MT, which includes using the model in some cases. Because data gaps exist for all six sustainability indicators, all the MT in this GSP are considered interim and will be confirmed or refined in the first five-year Update Report in January 2027 using additional data that will be collected. Development of the interim MT incorporated input received from GSA staff and technical representatives, interested stakeholders and the public through public meetings, individual stakeholder input to various GSA representatives, review of SGMA GSP regulations and DWR best management practices (BMPs), and review of DWR approval/consultation letters of four GSPs released in June 2021.

The future scenario with GSP projects and MA is described in detail in Chapter 4 of this GSP and in the groundwater model documentation included in **Appendix 6.E**. The future scenario includes injection (during wet years) and extraction (beginning with the third year of an extended drought) by the EBMUD Bayside Phase 1 Well, and operation of three of Hayward's emergency wells for short durations (two months) under assumed emergency conditions. This future scenario utilizes only the currently existing facilities for EBMUD and Hayward.

3.3.1. Chronic Lowering of Groundwater Levels

The GSP regulations provide that the "minimum thresholds for chronic lowering of groundwater levels shall be the groundwater level indicating a depletion of supply at a given location that may lead to UR." Chronic lowering of groundwater levels in the Subbasin would result in significant and unreasonable declines if they are sufficient in magnitude and duration to lower the rate of production of pre-existing groundwater wells below that necessary to meet the minimum required to support overlying beneficial use(s). In addition, groundwater levels will be managed with consideration of the interim MT to ensure the major aquifers in the Subbasin are not depleted in a manner to cause significant and unreasonable impacts to other sustainability indicators. At the same time, the GSAs recognize that groundwater levels may fall slightly below 2015 levels during the GSP implementation and sustainability periods because groundwater in the EBP Subbasin has been pumped at amounts significantly below the sustainable yield due to limited groundwater pumping since the 1960s. Thus, the interim MT have been designated with these considerations in mind.

The interim MT for groundwater levels and overall SMC program for this GSP are also intended to protect against significant and unreasonable impacts to groundwater storage volumes, seawater intrusion, land subsidence, groundwater quality, and surface water depletion. GDEs were also considered in setting of interim MT. The GDEs identified in the subbasin are dominated by terrestrial vegetation, which is susceptible to adverse impacts if groundwater levels in the underlying shallow aquifer experience chronic lowering. The development of the interim MT for chronic lowering of groundwater levels included review of the hydrogeologic conceptual model, climate, current and historical groundwater conditions including groundwater level trends and groundwater quality, seawater intrusion, land subsidence, surface water - groundwater interaction, and the water budget discussed in previous chapters.

The interim MT for chronic lowering of groundwater levels are based on selection of RMS wells from among existing and planned near-term future monitoring wells located throughout the Subbasin and screened in the Shallow, Intermediate, and Deep Aquifer Zones. The selected RMS wells are listed in **Table 3-3** and shown on **Figure 3-1**. Groundwater level hydrographs showing interim MT for each groundwater level RMS well are provided in **Appendix 3.A.**

The RMS wells described in **Table 3-3** and **Figure 3-1** are in locations that reflect available well locations to best represent groundwater conditions. These locations are representative of the overall Subbasin conditions because they are distributed throughout the Subbasin both vertically (in the Shallow, Intermediate, and Deep Aquifer Zones) and spatially throughout the Subbasin. Additional monitoring wells are currently being installed to fill data gaps and supplement the distribution of existing RMS wells. The GSAs have determined that use of the minimum groundwater elevation thresholds at each of the listed RMS wells will help avoid the UR of chronic lowering of groundwater levels by reducing the likelihood that access to adequate water resources for beneficial users within the Subbasin will be compromised.

Table 3-3. Summary of Groundwater Level Minimum Thresholds for RMS

Well I.D.	Reference Point Elevation (ft MSL)	Well Depth (ft bgs)	Screen Top-Bottom (ft bgs)	Model Layer(s)	Aquifer Designation	MT Depth[1] (ft bgs)	MT Elevation (ft bgs)	GSA[2]
MW-5S	13.88	210	200-210	3-4	Shallow and Intermediate	50	-36	EBMUD
MW-5I	13.88	325	315-325	6	Intermediate	64	-50	EBMUD
MW-5D	13.78	640	500-630	9-12	Deep	64	-50	EBMUD
MW-8D	14.76	490	420-480	7-9	Deep	65	-50	EBMUD
MW-9S	54.39	120	110-120	3	Shallow	50	4	EBMUD
MW-9I	54.39	210	200-210	5	Intermediate	104	-50	EBMUD
MW-9D	54.39	335	325-335	6	Intermediate	104	-50	EBMUD
MW-10S	11.76	120	100-120	3	Shallow	50	-38	EBMUD
MW-10I	11.76	360	340-360	7	Intermediate	62	-50	EBMUD
MW-10D	11.76	610	590-610	11	Deep	62	-50	EBMUD
S2-MWS1	6	85	50-80	2	Shallow	50	-44	EBMUD
S2-MWS2	6	205	140-180	3-4	Shallow	50	-44	EBMUD
S2-MWD1	6	555	480-500	7-8	Deep	56	-50	EBMUD
MW-N1S	73	TBD	TBD	TBD	Shallow	50	23	EBMUD
MW-N1I	73	TBD	TBD	TBD	TBD	123	-50	EBMUD
MW-N2S	19	TBD	TBD	TBD	Shallow	50	-31	EBMUD
MW-N2I	19	TBD	TBD	TBD	TBD	69	-50	EBMUD
MW-N3S	14	TBD	TBD	TBD	Shallow	50	-36	EBMUD
MW-N3I	14	TBD	TBD	TBD	Intermediate	64	-50	EBMUD
MW-S1S	27	TBD	TBD	TBD	Shallow	50	-23	Hayward
MW-S1I	27	TBD	TBD	TBD	Intermediate	77	-50	Hayward
MW-S1D	27	TBD	TBD	TBD	Deep	77	-50	Hayward
MW-S2S	18	TBD	TBD	TBD	Shallow	50	-32	Hayward
MW-S2I	18	TBD	TBD	TBD	Intermediate	68	-50	Hayward
MW-S2D	18	TBD	TBD	TBD	Deep	68	-50	Hayward
Well D	43	600	500-585	9-11	Deep	93	-50	Hayward
Mt. Eden Park	24	550	460-530	9-10	Deep	74	-50	Hayward

[1] The actual MT is based on the groundwater elevation, but the depth to water corresponding to the surface elevation in the project database is also provided.

[2] Each GSA is responsible for collecting groundwater levels for RMS within their GSA area.

3.3.1.1. Methodology

The methodology to develop the interim MT for chronic decline of groundwater levels involved the following steps:

1) Evaluate the DWR Well Completion Report (WCR) database for the location and construction details of wells (as described below).
2) Evaluate location of potential GDEs solely dependent on groundwater levels (as described below).
3) Review available existing and likely future RMS wells with regards to several variables/criteria (e.g., GSA ownership and/or access to well, known well construction details, preference for wells with several years of observed water levels, availability of recent water level data, good spatial distribution) and select appropriate RMS.
4) For each selected Shallow Aquifer Zone RMS hydrograph, plot a depth of 50 feet below land surface as the initial Shallow Aquifer Zone interim MT.
5) For each selected Shallow Aquifer Zone RMS well hydrograph, review/evaluate well location relative to potential GDEs. If the RMS well is within the designated GDE area, plot the depth of 7.5 feet below historical observed and/or baseline modeled groundwater elevations.
6) The shallowest MT at each Shallow Aquifer Zone RMS well location will serve as the interim Shallow Aquifer Zone MT for that RMS well.
7) For each selected Intermediate and Deep Aquifer Zone RMS hydrograph, plot an elevation of -50 feet MSL as the interim Intermediate/Deep Aquifer Zone MT.

DWR WCR Database Evaluation: The DWR WCR database was reviewed to evaluate the locations and construction details of various types of wells, including domestic, irrigation, industrial, and public water supply wells. Domestic wells represent the well type most likely to be impacted by declining groundwater levels, because they tend to be the shallowest wells. Additional evaluation and recategorization was needed with the DWR well log database, because the primary domestic well use in the EBP Subbasin has been for residential backyard irrigation and these wells are labeled as either domestic or irrigation wells. Labeling residential irrigation wells as irrigation instead of domestic wells causes some confusion with irrigation wells for larger non-residential parcels. Thus, domestic and irrigation wells were sorted by well diameter, with wells of 6-inch diameter or less considered to be domestic wells and wells of greater than 6-inch diameter considered to be irrigation wells. Maps were developed to show the general distribution and density of each well type (**Figures 2-2 through 2-5**) and to show minimum domestic well depth by township/range/section for all domestic wells drilled since 1970 and since 1990 (**Appendix 3.A**). These figures, combined with review of some of the associated WCRs, indicate that a relatively large number of very shallow residential backyard irrigation wells were installed in the 1970s during the 1976-1977 drought. Many of these wells appear to be hand dug (using an auger) to depths of 20 to 30 ft bgs with 4-inch PVC casing and well screen and a 10-foot sanitary seal.

A histogram for approximately 230 domestic wells installed since 1970 indicates about 45% of all wells were less than 50 feet deep and 65% were less than 100 feet deep (**Appendix 3.A**). Such shallow wells in the heavily urbanized EBP Subbasin could only reasonably be used for residential irrigation uses as opposed to drinking water, because the upper 50 to 100 feet of sediments are susceptible to contamination from fuel hydrocarbons, organic solvents, nitrate, and other contaminants. The histogram of 39 domestic wells installed since 1990 shows very few shallow wells (3 less than 50 feet and 10 less than 100 feet deep), suggesting that most of the shallow wells were installed over 30 years ago. It is not known if these very shallow backyard irrigation wells are still active.

Shallow Aquifer Zone MT Rationale: California well standards require a minimum 50-foot well seal for community water system and municipal water supply wells. Domestic and industrial wells have a 20-foot minimum well seal requirement. With respect to development of drinking water supply wells in the urban EBP Subbasin (including domestic wells that may serve as drinking water supply wells), it is reasonable to assume that drinking water supply wells of any type would have a well seal that is at least 50-feet or greater in depth (likely at least 100 feet deep) to protect the well from potential contaminants originating at ground surface (e.g., fuel hydrocarbons, solvents, nitrate) that are known to impact the upper 100 feet of sediments in the EBP Subbasin. Thus, a conservative assumption is that drinking water supply wells are a minimum of 60 feet deep to allow for a 50-foot well seal and some intake area; it is very likely that drinking water supply wells would need to be considerably deeper than 60 feet to obtain groundwater of suitable quality and to have some protection against the most likely potential contaminants. Based on the assessment of the DWR WCR database described above, the methodology for establishing interim MT for the shallow (water table) zone chronic lowering of groundwater levels is based in part on an assumed minimum well depth for drinking water supply wells of 60 feet.

GDEs (Shallow Aquifer Zone) MT Rationale: A second major consideration in establishing Water Table Aquifer Zone groundwater level interim MT is the occurrence of GDEs (aquatic or vegetation) that are either not associated with (located along) streams or are located along streams where GDE health is directly dependent on groundwater levels (i.e., vegetation with certain rooting depths). GDEs that are directly dependent on surface water flows are addressed under the surface water depletion criterion. GDEs directly dependent on groundwater levels would not necessarily be protected by an MT that is protective of drinking water supply wells. Therefore, areas of the EBP Subbasin coinciding with known GDEs will have adjustments to the groundwater level interim MT established to protect drinking water supply wells. Additional work is needed in the early stages of GSP implementation to conduct further evaluation of potential GDEs, rooting depths of various species, and how declines in groundwater levels may impact various potential GDE vegetative species.

Review of best available data for depth to water across the EBP Subbasin generally indicates depths to water of less than 20 feet in the Water Table Aquifer Zone, although some smaller areas may have depths to water greater than 20 feet. Review of the initial mapping of potential GDE areas (**Appendix 2.A.b**) indicates these potential GDE areas likely have depths to water of about 20 feet or less. Some GDE species are known to have rooting depths of as much as 30 feet; thus, it was considered that shallow water table (i.e., Water Table Aquifer Zone) groundwater level declines of up to 7.5 feet may not have significant effects on health of vegetative GDEs in the EBP Subbasin solely dependent on groundwater levels. Thus, an initial interim GDE MT adjustment has been established as a decline of 7.5 feet from baseline conditions. It is recognized that additional biological and hydrogeologic studies are needed to confirm or refine this initial GDE MT adjustment for the chronic lowering of groundwater levels sustainability indicator.

Intermediate/Deep Aquifer Zone MT Rationale: The Intermediate and Deep Aquifer Zones in EBP Subbasin are confined aquifers that require a separate analysis for setting groundwater level interim MT. In general, these aquifers would be comprised of wells that are deeper than 200 feet, and groundwater levels in these aquifers would not directly impact GDEs. Since the depth to top of well screens in Intermediate to Deep Aquifer Zone wells generally varies from 200 to 500 ft bgs and typical depths to water in these wells are less than 50 ft bgs, there is generally between 150 and 450 feet of available drawdown in these wells. With specific capacities in the range of 5 to 20 gallons per minute per foot (gpm/ft), a typical well might use up to 100 feet of available drawdown to achieve pumping rates in the range of 500 to 2,000 gpm for the Deep Aquifer Zone. Best available data for the Intermediate Aquifer Zone (which are more limited) suggest specific capacity values of 0.5 to 8 gpm/ft, which indicates pumping rates of 50 to 800 gpm. These results indicate confined groundwater level drawdowns of 100 to 200 feet are unlikely to significantly decrease the ability of Deep Aquifer Zone wells to obtain adequate well yields, because there would still be significantly more than 100 feet of available drawdown above the top of well screen. However, a relatively shallow Intermediate Zone well may have a top of well screen depth of 200 ft bgs. Since current Intermediate Aquifer Zone groundwater levels are typically within 50 feet of ground surface and at groundwater elevations near or above MSL, maintaining a static Spring groundwater elevation no lower than -50 feet MSL generally allows for maintaining 100 feet or more available drawdown above the shallowest Intermediate well screen, which would provide for maintaining close to current pumping capacities.

Example Hydrographs with MT: Example hydrographs showing interim MT are provided in **Figures 3-2** through **3-4**. The hydrograph for RMS MW-5D (**Figure 3-4**) and N1I (**Figure 3-3**) demonstrate the MT for the Deep and Intermediate Aquifer Zones, respectively. Recent observed data were available for comparison for MW-5D but not N1I, which was in the planning stages for installation in 2022. An example hydrograph illustrating MT for the Shallow Aquifer Zone is provided in **Figure 3-2**. This site (S1S) is also planned for installation in 2022. Hydrographs illustrating interim MT for all RMS wells are provided in **Appendix 3.A**.

3.3.1.2. Relationship to Other Sustainability Indicators

The interim groundwater level MT were set independently of other sustainability indicators to clearly distinguish the specific sustainability indicator(s) that would be causing UR, should they ever occur in EBP Subbasin. The relationships to other sustainability indicators are described below.

1. **Reduction of groundwater storage.** The interim MT for reduction of groundwater storage is based on the sustainable yield of EBP Subbasin. Pumping at or less than the sustainable yield will avoid long-term and ongoing reduction of both groundwater storage and groundwater elevations in the Subbasin. However, the groundwater level MT are not based on nor correlated to a specific amount of total groundwater pumping in the EBP Subbasin. Therefore, the groundwater level MT established for this GSP will be evaluated independently from reduction of groundwater storage that is based on pumping within the sustainable yield.
2. **Seawater Intrusion.** While MT for groundwater levels have been established for all three aquifer zones where present, it is the Shallow Aquifer Zone MT that is most important to seawater intrusion because this is the only zone that has a potential connection to the San Francisco Bay. The seawater intrusion MT is designed to maintain Water Table Aquifer Zone groundwater elevations at or above mean sea level. Therefore, while the Shallow Aquifer Zone groundwater level MT established for this

GSP are not necessarily set above mean sea level in some cases, groundwater level MT will not preclude finding of an undesirable result under the seawater intrusion indicator as described in Section 3.3.3.

3. **Land Subsidence.** A significant and unreasonable condition for land subsidence is measurable permanent (inelastic) subsidence that damages existing large scale public infrastructure. Inelastic subsidence is caused by reduction of pore pressure and compaction of clay-rich sediments in response to declining groundwater levels. There have not been historical reports of any significant subsidence in the EBP Subbasin, which includes during a period of much greater groundwater pumping in the 1950s and 1960s. Therefore, no land subsidence would be expected to occur if groundwater levels remain above historical low groundwater elevations that occurred in the 1950s/1960s. If groundwater levels were to exceed historical lows, it is unknown if or at what groundwater elevations significant inelastic subsidence may occur. The interim MT for land subsidence use Intermediate and Deep Aquifer Zone groundwater levels as a proxy and are set at historical low groundwater levels. Most of the groundwater level interim MT established for this GSP are at or above historical low levels (detailed in Section 3.3.4.1), which indicates UR for subsidence would not occur without UR for groundwater levels. There are a few RMS wells for which groundwater level MT are below subsidence MT; however, groundwater level and subsidence MT were set independently of one another to clearly indicate the sustainability indictor that may be causing future undesirable conditions should they occur.

4. **Degraded water quality.** GSP projects and MA include both groundwater extraction and injection projects. Overall, it is anticipated that there will likely be an overall net benefit to groundwater quality from GSP injection projects due to injection of high-quality surface water; however, the overall groundwater monitoring program developed for this GSP plus any additional project-specific monitoring determined to be needed will be utilized to evaluate the need for adaptive management related to groundwater quality issues that may arise due to GSP groundwater injection projects. It is also possible (although unlikely in most cases) that groundwater extraction projects from the Intermediate and Deep Aquifer Zones could draw shallow groundwater vertically downward in some areas where poorer water quality may be present in the shallow zone. There will be ongoing review of extraction well and nearby monitoring well water quality related to GSA projects to evaluate the need for adaptive management, as necessary.

5. **Depletion of interconnected surface waters.** The potential for impacts related to surface water depletion is a function of potential changes in shallow groundwater levels from implementation of GSA projects and MA. Most of these projects involve pumping from Intermediate and Deep Aquifer Zones, which are separated from shallow groundwater by significant thicknesses of clay layers that serve to impede vertical migration of groundwater. However, the potential for groundwater pumping from deeper zones to impact shallow groundwater levels is accounted for in establishing SMC for stream depletion. In general, groundwater level interim MT are lower than stream depletion interim MT for the Shallow Aquifer Zone adjacent to major creeks. Therefore, while the Shallow Aquifer Zone groundwater elevation MT established for this GSP are not necessarily set at or above stream depletion MT, groundwater level MT will not preclude occurrence of an UR under the stream depletion indicator as described in Section 3.3.6.

3.3.1.3. Impact of Selected Minimum Thresholds to Adjacent Basins

The interim groundwater level MT established for EBP Subbasin do not provide a good indication of anticipated impacts on adjacent subbasins from implementation of the GSP. This is because the GSAs' operational plans for future groundwater pumping represent a temporary groundwater level condition (drawdowns are expected to recover within a few months) since the planned pumping occurs only during short time frames. Ultimately, the potential for impacts on adjacent subbasins will be primarily a function of average water levels in EBP Subbasin. Therefore, the impact to adjacent subbasins is better described based on MO. Nonetheless, an evaluation of temporary low groundwater elevations in the EBP Subbasin and potential impacts on sustainability of Niles Cone Subbasin was conducted and is described below.

The Niles Cone Subbasin is being managed under SGMA with an Alternative (to a GSP) Plan, herein referred to as the Alternative or Niles Cone Alternative, that has been approved by DWR. The Below Hayward Fault portion of the Niles Cone Subbasin is the only area that would be potentially impacted by implementation of the EBP Subbasin GSP. The Below Hayward Fault portion of Niles Cone is separated from the southern EBP Subbasin by a transition zone described in detail in Chapter 2 of this GSP. In the transition zone area (see **Figure 3-5** for location), there are stratigraphic offsets of coarse-grained aquifer units that create a partial barrier that impedes horizontal groundwater flow through the transition zone. The presence and level of impedance through the transition zone is documented through a combination of geologic (e.g., stratigraphy and depositional environments), hydraulic (i.e., regional aquifer testing), and hydrochemical (i.e., isotope) data (**Appendix 2.A.b**) The EBP Subbasin Groundwater Model is calibrated to the available transition zone data (**Appendix 6.E**).

The Niles Cone Alternative measures sustainability by maintaining Shallow Aquifer Zone (Newark Aquifer) groundwater levels above sea level, and it allows for short-term declines below sea level during droughts (although the allowable duration of declines below sea level during droughts are not specified). A single sustainability indicator well (4S/1W-29A6) was selected to monitor sustainability in the Niles Cone Subbasin (see **Figure 3-5** for location of well). Management of Niles Cone Subbasin under the Alternative is based on maintaining shallow Newark Aquifer groundwater elevations above mean sea level to prevent seawater intrusion, and the Alternative states that this management approach also addresses the other sustainability criteria. The EBP GSP model scenario run for future proposed projects included inserting an observation point at the 4S/1W-29A6 location to measure estimated impacts (i.e., drawdown) from implementation of EBP Subbasin projects and MA. In addition, contour maps of drawdown were developed that extend into the Niles Cone Subbasin. Additional evaluation of potential impacts on the Niles Cone Subbasin is provided in **Appendix 6.E**.

Review of model-predicted impacts on Niles Cone Subbasin from implementation of proposed projects and MA in EBP Subbasin indicates that impacts to the Shallow Aquifer in Niles Cone Subbasin are expected to be less than 0.5 feet during years with GSA project extraction (and even less in other years). Based on how sustainability is defined for the Niles Cone Subbasin in the DWR-approved Niles Cone Alternative, the implementation of EBP Subbasin projects and MA outlined in the GSP will not impede the ability of Alameda County Water District (ACWD) to maintain sustainability in the Niles Cone Subbasin. If GSAs in the EBP Subbasin implement additional projects to increase net extraction, additional evaluation of potential impacts to neighboring subbasins will be conducted at that time.

3.3.1.4. Minimum Threshold Impacts on Beneficial Uses and Users

Groundwater level interim MT may have effects on beneficial uses, users, land use, and property owners. Those that may be impacted include other municipal users, industrial and irrigation water users, domestic water users, and ecological land uses and users. Other municipal, industrial, and irrigation water users may be impacted by temporary increases in pumping lifts/costs to pump groundwater, although benefits will be derived at other times with higher groundwater levels related to EBMUD Bayside well injection. Domestic well owners/users generally use small amounts of groundwater from the Shallow and possibly Intermediate Aquifer Zones. It is possible for the very shallow domestic irrigation wells, if they are still active, to experience temporary conditions of limited well saturation during droughts. In addition, there may be temporary increases in pumping lifts/costs to pump groundwater for domestic well owners/users, although impacts to the Shallow Aquifer Zone groundwater levels will be substantially less than in Intermediate/Deep Aquifer Zones.

Ecological impacts are possible in the potential GDE Units identified in the Subbasin. The potential GDE units are composed of vegetation, which may access shallow groundwater within approximately 30 feet of the surface. Modeled shallow water levels do not fluctuate very much in response to proposed groundwater pumping due to most pumping being derived from the Intermediate and Deep Aquifer Zones that are separated from the shallow Water Table Zone by multiple clay layers. If a 6-year drought and projected water level declines to interim MT levels were to occur, effects on potential GDEs could include short-term adverse impacts such as water stress and possibly longer-term impacts such as reduced growth and recruitment. Given the relatively low projected frequency and short duration of the shallow groundwater level declines, coupled with the inherent uncertainty in model projections and apparent resiliency of the potential GDEs to historical drought periods and times of pumping more than the sustainable yield, significant adverse impacts due to groundwater pumping are unlikely. Overall, sustainable groundwater management in the EBP Subbasin is expected to maintain the health and resiliency of the vegetation communities composing the potential GDE Units despite some potential temporary future impacts that may occur if the interim MT for groundwater levels are reached.

3.3.1.5. Comparison of Minimum Thresholds and Relevant State, Federal, or Local Standards

There are no Federal, State, or local standards that exist for chronic lowering of groundwater levels.

3.3.1.6. Minimum Thresholds Measurement Method

Groundwater levels for comparison to interim MT will be directly measured for existing and new monitoring wells. The groundwater level monitoring will be conducted in accordance with the monitoring plan and protocols outlined in Section 3.5. Furthermore, the groundwater level monitoring will meet the requirements of the technical and reporting standards included in the SGMA regulations. As noted in Section 3.5, the current groundwater level RMS monitoring network includes 10 wells in the Shallow Aquifer Zone, 9 wells in the Intermediate Aquifer Zone, and 8 wells in the Deep Aquifer Zone. EBMUD and Hayward are planning to install five new nested monitoring wells (with two or three separate wells at each site) in the Subbasin by early 2022, which are already incorporated into the RMS monitoring program. In addition, other data gaps for groundwater level monitoring are expected to be filled during the implementation period.

3.3.2. Reduction of Groundwater Storage

The GSP regulations state that the "…minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to UR. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield…and projected water use in the basin." Basin groundwater conditions that involve excessive regional groundwater pumping would result in a significant and unreasonable reduction of groundwater storage. Locally defined significant and unreasonable conditions were determined based on discussions with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives. Significant and unreasonable reduction of groundwater storage occurs when there is long-term reduction of groundwater storage during the sustainability period (i.e., after 2042). The interim MT for reduction of groundwater storage is an annual pumping volume no greater than 12,500 AFY (based on estimated sustainable yield) measured as a five-year moving average.

In evaluating this sustainable management criterion, it is noteworthy that groundwater storage as of the January 2015 SGMA benchmark reflects a groundwater basin that was experiencing substantially less groundwater pumping compared to its estimated sustainable yield. Thus, implementation of GSA projects and MA would be expected to result in some decline in groundwater storage from the 2015 SGMA baseline. However, the evaluation is based on significant and unreasonable reduction of groundwater storage, which would be reduction of storage beyond what would be expected with reasonable (i.e., within sustainable yield) additional development of groundwater supplies in EBP Subbasin.

3.3.2.1. Methodology

The selected methodology of annual groundwater pumping volumes involves developing a five-year moving average of annual groundwater pumping, which is to be maintained below the interim MT of 12,500 AFY (**Figure 3-6**). The five-year duration for the moving average is selected as a reasonable time frame, compared to a shorter or longer time frame. A shorter period such as one to two years does not account for the potential need for short-term greater pumping that may occur due to very extreme water shortages related to natural disasters (e.g., earthquakes) and/or extreme drought conditions. However, a longer time frame for a moving average (e.g., 8 or 10 years) is excessive and unreasonable as a duration for extreme reliance on groundwater pumping for such conditions. The use of a five-year moving average provides a good balance between accounting for short-term extreme needs, while not allowing for long-term over pumping of the subbasin. In addition, best available data indicates the EBP Subbasin was historically pumped at levels exceeding the current initial GSP sustainable yield estimate for more than five years. Thus, the selected interim MT based on the five-year moving average has been exceeded in the historical record without major reported consequences such as UR (i.e., the MT duration represents a conservative/low value).

As described in Chapter 2 of this GSP, there is estimated to be in excess of approximately two million acre-feet of groundwater storage in the EBP Subbasin. However, the usable storage is likely limited by maintaining a relatively full basin to prevent seawater intrusion, particularly in the Shallow Aquifer Zone. Derivation of the initial sustainable yield estimate included major constraints on pumping to ensure seawater intrusion does not occur. Therefore, pumping no more than an estimated sustainable yield that accounts for prevention of seawater intrusion is expected to maintain sufficient groundwater in storage.

One challenge in implementing this interim MT is the general lack of direct measurements of groundwater pumping in the basin (except for EBMUD and Hayward municipal wells). Most wells (except for municipal wells) are not metered, and indirect methods like estimating consumptive use would be primarily applicable to large, irrigated parcels known to be irrigated by groundwater. While the total water demand for residential irrigation has been (and can be) estimated, there is significant uncertainty in the total amount that may be supplied by groundwater. A portion of industrial water use is also supplied by groundwater, but industrial wells are not metered, and not all industrial well locations are known. The GSAs will be working to reduce uncertainty in groundwater pumping estimates in the future.

3.3.2.2. Relationship to Other Sustainability Indicators

The reduction of groundwater storage interim MT was set independently of other sustainability indicators to clearly distinguish the specific sustainability indicator(s) that are causing UR, should they ever occur in EBP Subbasin. The relationships to other sustainability indicators are described below.

1. **Chronic Lowering of Groundwater Levels.** Because the groundwater storage interim MT is based on the estimated sustainable yield and the sustainable yield is based in part on maintaining groundwater levels and groundwater outflow, it is expected that the reduction of groundwater storage MT will not cause UR for this sustainability indicator.
2. **Seawater Intrusion**. Similar to the discussion for groundwater levels above, the determination of sustainable yield, which is the basis for the reduction of groundwater storage interim MT, was based in part on maintaining shallow groundwater levels above sea level. Thus, use of the reduction of groundwater storage MT outlined above is not expected to have negative impacts related to seawater intrusion.
3. **Subsidence.** Because future groundwater levels in the Intermediate/Deep Zone Aquifers will be associated with groundwater pumping volumes no greater than 12,500 AFY, and historical pumping volumes in the 1950s and early 1960s were likely on the order of double the sustainable yield volume (see **Appendix 6.E**), it is expected that no subsidence will occur due to the reduction of groundwater storage interim MT because historical groundwater levels were lower than would occur at pumping volumes less than 12,500 AFY.
4. **Degraded Water Quality**. The interim MT pumping volume of 12,500 AFY for reduction of groundwater storage will not directly lead to a degradation of groundwater quality. Historical pumping volumes far greater than the reduction of groundwater storage MT have occurred, and apparently did not result in any reported groundwater quality impacts with the possible exception of local areas of elevated chloride/TDS in the Shallow Aquifer Zone along the Bay margin that are more related to the seawater intrusion sustainability indicator.
5. **Depletion of Interconnected Surface Waters**. As described above in Section 3.3.1 for groundwater levels, the potential for impacts related to surface water depletion for the reduction of groundwater storage interim MT is a function of potential changes in shallow groundwater

storage from implementation of GSA projects and MA. Most of these projects restrict pumping to the Deep or Intermediate/Deep Aquifer Zones, which are separated from Shallow Zone water levels by significant thicknesses of clay layers that serve to impede vertical migration of groundwater. While the selection of the reduction of groundwater storage MT is not expected to significantly influence depletion of interconnected surface waters, additional studies are planned to be conducted in the early years of GSP implementation to further address this criterion.

3.3.2.3. Impact of Selected Minimum Thresholds to Adjacent Basins

An interim MT for reduction of groundwater storage tied to EBP Subbasin sustainable yield over extended periods with average climatic conditions during the Sustainability Period should be protective of adjacent subbasins. Additional characterization of the potential interconnection between the EBP Subbasin and the Niles Cone Subbasin is planned in the near future. The results of that study and data collected from new wells in the southern part of the EBP Subbasin will be used to assess and potentially refine the interim MT of 12,500 AFY for reduction of groundwater storage. In addition, current plans for GSA groundwater development involve pumping no more than approximately 35% of the estimated sustainable yield. Future groundwater supply development to a greater proportion of sustainable yield would involve additional data collection, analyses, and further evaluation of adjacent basin impacts.

3.3.2.4. Minimum Thresholds Impact on Beneficial Uses and Users

The interim MT of 12,500 AFY of groundwater pumping allows for some small initial decline in groundwater elevations with implementation of projects and MA resulting in increased net groundwater pumping (while remaining within basin sustainable yield) followed by maintaining stable average groundwater elevations during the Sustainability Period. The overall initial reduction of groundwater storage is not expected to significantly impact beneficial uses and users of groundwater in the Subbasin. However, it is possible for localized pumping by GSAs or other third parties to impact other beneficial uses (e.g., environmental users, irrigation uses). Such impacts to other potential beneficial users are expected to be addressed through monitoring and adaptive management, as necessary.

3.3.2.5. Comparison Between Minimum Thresholds and Relevant State, Federal, or Local Standards

There are no Federal, State, or local standards that exist for reduction of groundwater storage.

3.3.2.6. Minimum Thresholds Measurement Method

The minimum thresholds for groundwater storage reduction are based on various methods of measuring or estimating groundwater pumping, such as meters, remote sensing, use of crop coefficients, and personal communication with well owners. Additional discussion of quantifying groundwater pumping is provided in Section 3.5.

3.3.3. Seawater Intrusion

The GSP regulations requires the use of chloride isocontour for the seawater intrusion MT, but they allow for use of groundwater levels as a proxy as long as a significant correlation exists between groundwater elevations and that indicator (CCR Title 23, Section 354.36(b)). Seawater intrusion in the Subbasin would become significant and unreasonable if excessive regional groundwater pumping causes migration of saline Bay water into existing freshwater aquifers that are or could be developed for water supply, to the extent that increased groundwater salinity precludes beneficial use of groundwater for drinking water supply.

The interim MT for seawater intrusion is based on the five-foot MSL groundwater elevation contour for the Water Table Aquifer Zone. Exceedance of the MT for seawater intrusion occur when the five foot above MSL groundwater elevation contour line for the Water Table Aquifer Zone migrates further inland from baseline conditions to the extent that the onshore area between the five foot MSL contour line and Bay Margin increases by 25% in the northern and/or southern areas of the Subbasin, and chloride sentinel wells (i.e., N2S, N3S, and others to be installed) show 25% or greater increases in chloride concentrations over baseline conditions.

3.3.3.1. Methodology

The selected methodology of using groundwater levels in the Water Table Aquifer Zone as a proxy involves use of groundwater level data from the GeoTracker website for environmental sites combined with field measurement of groundwater levels in the RMS monitoring well network to delineate the five feet groundwater elevation contour line, and comparison of the future position of the five feet groundwater elevation contour line to the interim MT. A key benefit of this approach is that it is the simplest and most direct approach using available wells to evaluate seawater intrusion conditions. The five feet groundwater elevation contour was selected because it is the lowest elevation contour (closest to mean sea level, which is one foot for the NAVD 88 datum used in this GSP) that can be reasonably defined using existing data. The five feet groundwater elevation contour is a low enough elevation to be impacted by a decline in Shallow Aquifer Zone groundwater levels below sea level.

The technical justification for selecting a 25% increase in the area west of the five-foot MSL contour line is reasonableness. It would be difficult to accurately quantify a smaller percentage increase (e.g., 10%) in the onshore area boundary by the five-foot MSL contour line. If a percentage greater than 50% increase in area were used, this suggests a significant and unreasonable impact has already occurred. The 25% criterion represents a conservative percentage at the lower end of a reasonable range from 20% to 50%.

Shallow groundwater levels can serve as a good proxy for this sustainability indicator given that the Water Table Aquifer Zone is the only aquifer connected with the Bay bottom, and significant layers of clay separate the Water Table Aquifer Zone from the Intermediate and Deep Aquifer Zones. If the shallowest groundwater levels are maintained above mean sea level, there should be no significant inland migration of saline Bay water. This method of using shallow groundwater levels as a proxy for seawater intrusion is consistent with the DWR-approved Niles Cone Alternative (to a GSP).

Chloride concentrations in RMS monitoring network wells will also be collected to supplement and confirm the use of the five feet MSL groundwater elevation contour to maintain shallow groundwater levels above mean sea level and avoid seawater intrusion. The technical justification for selecting a 25% increase in chloride concentration in sentinel wells to confirm a seawater intrusion exceedance is reasonableness. The selected percent increase is on the lower end of the reasonable range of 20 to 50% established for other SMC as described above and below.

Updated baseline conditions will be established during the first two years of GSP implementation. An initial estimate of the position of the five feet MSL contour was developed based on the Spring 2015 Water Table Aquifer Zone Contour map (**Figure 3-7**). However, available data will be reviewed, and additional water level measurements will be collected (e.g., new nested monitoring wells, possibly Port of Oakland monitoring wells) to better define the baseline conditions in future updates of the GSP.

3.3.3.2. Relationship to Other Sustainability Indicators

The interim seawater intrusion MT was set independently of other sustainability indicators to clearly distinguish the specific sustainability indicator(s) that are causing UR, should they ever occur in EBP Subbasin. The relationships to other sustainability indicators are described below.

1. **Chronic Lowering of Groundwater Levels.** Because the seawater intrusion interim MT will maintain Water Table Aquifer Zone groundwater levels above MSL, they are not expected to have any bearing on the UR for chronic lowering of groundwater levels.
2. **Groundwater Storage.** Because the seawater intrusion interim MT will maintain Shallow Aquifer Zone groundwater levels above MSL, they are not expected to have any bearing on the UR for reduction of groundwater storage.
3. **Subsidence.** Seawater intrusion interim MT are only associated with Shallow Aquifer Zone groundwater levels, whereas subsidence MT are only associated with Intermediate and Deep Aquifer Zone MT. Therefore, MT for seawater intrusion and subsidence are not directly related to each other.
4. **Degraded Water Quality.** The interim MT of shallow groundwater levels at/above mean sea level will not directly lead to a degradation of groundwater quality.
5. **Depletion of Interconnected Surface Waters.** The seawater intrusion interim MT is generally expected to maintain existing connections and groundwater recharge/discharge from/to major creeks in proximity to the Bay margin, where the seawater intrusion MT is most applicable.

3.3.3.3. Impact of Selected Minimum Thresholds to Adjacent Basins

A MT that does not allow for seawater intrusion during the sustainability period will not have negative impacts on adjacent basins and will be protective of adjacent subbasins. In particular, the EBP GSP interim seawater intrusion MT is very similar to and consistent with how ACWD manages the Niles Cone Subbasin, which should minimize any potential for adjacent basin impacts related to this key sustainability criterion.

3.3.3.4. Minimum Thresholds Impact on Beneficial Uses and Users

The seawater intrusion interim MT of maintaining shallow groundwater levels at/above mean sea level is not expected to significantly impact beneficial uses and users of groundwater in the Subbasin. However, it may result in some restrictions for users of shallow groundwater near the Bay margin.

3.3.3.5. Comparison Between Minimum Thresholds and Relevant State, Federal, or Local Standards

There are no Federal, State, and local standards for shallow aquifer groundwater levels for preventing sea water intrusion.

3.3.3.6. Minimum Thresholds Measurement Method

The interim MT for seawater intrusion are based on groundwater levels being measured in shallow (Water Table Aquifer Zone) wells in the GSP monitoring network and from GeoTracker groundwater level measurements.

3.3.4. Land Subsidence

The GSP regulations requires the use of a rate and extent of subsidence that, "substantially interferes with surface land uses…" for use as the MT, but they allow for use of groundwater levels as a proxy. Land subsidence in the Subbasin would become significant and unreasonable if excessive regional groundwater pumping causes significant and unreasonable damage on a regional scale to public infrastructure critical for public health and safety (i.e., levees, flood control channels, water supply aqueducts). Locally defined significant and unreasonable conditions were determined based on discussions with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives.

The interim MT for land subsidence are based on the Spring historical low groundwater elevations for the Intermediate and Deep Aquifer Zones: -50 feet MSL in the southern EBP Subbasin and -20 feet MSL in the northern EBP Subbasin. Documentation for historical low groundwater elevations is provided in **Appendix 3.D**. An UR for land subsidence is deemed to occur when 25% or more of RMS wells exceed the MT for two consecutive Spring measurements. Land subsidence generally does not occur in response to declines in shallow groundwater levels; therefore, no subsidence SMC are established for the Shallow Aquifer Zone.

3.3.4.1. Methodology

The methodology to develop the interim MT for land subsidence is based on historical low groundwater levels in the Intermediate and Deep Aquifer Zones. Measured/observed historical groundwater levels were described above in Chapter 2 and modeled historical groundwater levels are described in **Appendix 6.E**. Previous reports with groundwater elevation contour maps (from the 1950s to 1960s), previous reports with groundwater level data and narrative discussions, and hydrographs compiled for the GSP were used where available to establish historical low groundwater levels (**Appendix 3.D**). There was no reported subsidence in EBP Subbasin associated with these lower historical groundwater elevations. In addition, regardless of whether or not any subsidence occurred with lower historical groundwater elevations, the more important fact is that water levels were depressed for several years and any subsidence that could occur at those groundwater elevations would likely have occurred at that time (1950s through early 1960s). In order for subsidence to occur in the future, groundwater elevations would need to decline below historical low elevations. Therefore, historical low groundwater elevations provide any excellent proxy for land subsidence sustainable management criteria.

The selected methodology of using historical low groundwater elevations as a proxy involves field measurement of groundwater levels in the RMS monitoring well network and comparison to established land subsidence minimum thresholds. To the extent that groundwater levels are maintained above land subsidence interim MT and collectively (on average) maintained around MO, land subsidence would not exceed its MT or display significant and unreasonable inelastic land subsidence. The subsidence interim MT will be supported by periodic review of extensometer data from the USGS station near the existing Bayside Well, and additional subsidence surveys would be conducted as needed in the future (e.g., benchmark surveys, InSAR surveys, etc.) to ensure no significant inelastic subsidence has occurred.

Groundwater level data for historical lows in the southern EBP Subbasin includes groundwater elevation contour maps from previous reports and hydrographs prepared from groundwater level data compiled for the GSP (**Appendix 3.D**). The hydrograph data show a range of historical lows from -40 to -100 ft MSL for Spring highs for several wells throughout the southern EBP Subbasin. The groundwater elevation contour maps for Spring 1958 and Spring 1961 show large areas of the southern EBP Subbasin with Spring highs lower than -50 to -70 feet MSL. These data indicate a representative (and conservative) historical Spring low for most of the southern EBP Subbasin is -50 ft MSL.

Available data for the northern EBP Subbasin are more limited; however, the best available data includes one hydrograph for an Intermediate Aquifer Zone well in the Berkeley area that reached a low of -40 ft MSL. In addition, the report by Norfleet Consultants (1998) documents static and pumping water levels in the Richmond area and a 30-foot decline in water levels that occurred due to overpumping (3 to 4 MGD) between 1907 and 1911 (**Appendix 3.D**). These best available data indicate that use of Spring groundwater elevation MT of -20 ft MSL is a reasonably conservative value to assign for historical low levels in the northern EBP Subbasin.

The RMS wells for land subsidence listed in **Table 3-4** are in locations that reflect a wide cross section of Subbasin groundwater conditions (**Figure 3-8**). These locations are representative of the overall Subbasin conditions because they are spatially distributed throughout the EBP Subbasin. The GSAs have determined that use of groundwater level-based land subsidence interim MT at Intermediate/Deep Aquifer Zone wells will help avoid the UR for land subsidence because they will effectively prevent future inelastic subsidence (sufficient to impact infrastructure) that has not already occurred during the 1950s/1960s (if any). Example RMS well hydrographs with subsidence interim MT are provided in **Figures 3-9 and 3-10**.

Table 3-4. Summary of Land Subsidence Minimum Thresholds for RMS Wells

Well I.D.	Reference Point Elevation	Well Depth	Screen Top-Bottom	Aquifer Designation	MT Depth[1]	MT Elev	GSA[2]
MW-5S	13.88	210	200-210	Intermediate	64	-50	EBMUD
MW-5I	13.88	325	315-325	Intermediate	64	-50	EBMUD

Table 3-4. Summary of Land Subsidence Minimum Thresholds for RMS Wells

Well I.D.	Reference Point Elevation	Well Depth	Screen Top-Bottom	Aquifer Designation	MT Depth[1]	MT Elev	GSA[2]
MW-5D	13.78	640	500-630	Deep	64	-50	EBMUD
MW-8D	14.76	490	420-480	Deep	65	-50	EBMUD
MW-9I	54.39	210	200-210	Intermediate	104	-50	EBMUD
MW-9D	54.39	335	325-335	Intermediate	104	-50	EBMUD
MW-10I	11.76	360	340-360	Intermediate	62	-50	EBMUD
MW-10D	11.76	610	590-610	Deep	62	-50	EBMUD
S2-MWD1	6	555	480-500	Deep	56	-50	EBMUD
MW-N1I	73	TBD	TBD	Intermediate	93	-20	EBMUD
MW-N2I	19	TBD	TBD	TBD	39	-20	EBMUD
MW-N3I	14	TBD	TBD	TBD	34	-20	EBMUD
MW-S1I	27	TBD	TBD	Intermediate	77	-50	Hayward
MW-S1D	27	TBD	TBD	Deep	77	-50	Hayward
MW-S2I	18	TBD	TBD	Intermediate	68	-50	Hayward
MW-S2D	18	TBD	TBD	Deep	68	-50	Hayward
Well D	43	600	500-585	Deep	93	-50	Hayward
Mt. Eden Park	24	550	460-530	Deep	74	-50	Hayward

[1] The actual MT is based on the groundwater elevation, but the depth to water corresponding to the surface elevation in the project database is also provided.

[2] Each GSA is responsible for collecting groundwater levels for RMS wells within their GSA area.

3.3.4.2. Relationship to Other Sustainability Indicators

The interim land subsidence MT was set independently of other sustainability indicators to clearly distinguish the specific sustainability indicator(s) that are causing UR, should they ever occur in EBP Subbasin. The relationships to other sustainability indicators are described below.

1. **Chronic Lowering of Groundwater Levels.** The methodology to establish interim MT for groundwater levels in the southern EBP Subbasin does not result in MT lower than those being established for land subsidence. Thus, the MT established for subsidence in the southern EBP Subbasin are consistent with

the groundwater level MT. Groundwater level MT are lower than subsidence MT in the northern EBP Subbasin; however, they were set independently to demonstrate which sustainability indicator(s) would cause UR if they were to occur.

2. **Reduction of Groundwater Storage.** The reduction of groundwater storage interim MT is based on pumping volumes, whereas the land subsidence MT is based on historical low groundwater levels. Since the reduction of groundwater storage MT is based on a sustainable yield estimate of 12,500 AFY, and historical lows were generally associated with much higher pumping volumes, it is anticipated that the MT established for subsidence may be associated with an UR for reduction of groundwater storage. However, the intent of setting SMCs is to define an UR specific to each sustainability indicator independent of others.
3. **Seawater Intrusion.** The seawater intrusion interim MT is based on Water Table Aquifer Zone groundwater elevations, whereas the land subsidence MT is based on Intermediate and Deep Aquifer Zone groundwater elevations. Therefore, land subsidence MT do not relate to or conflict with seawater intrusion MT.
4. **Degraded Water Quality.** The land subsidence interim MT are consistent with historical groundwater level fluctuations in the EBP Subbasin, and they are not expected to result in a significant or unreasonable change in groundwater quality.
5. **Depletion of Interconnected Surface Waters.** The surface water depletion interim MT is based on Water Table Aquifer Zone groundwater elevations, whereas the land subsidence MT is based on Intermediate and Deep Aquifer Zone groundwater elevations. Therefore, land subsidence MT are not expected to conflict with surface water depletion MT.

3.3.4.3. Impact of Selected Minimum Thresholds to Adjacent Basins

Potential impacts of the interim MT established for land subsidence will be similar to those described in Section 3.3.1.3 for groundwater level MT for the southern portion of the EBP Subbasin. The northern portion of the EBP Subbasin is not adjacent to other groundwater basins.

3.3.4.4. Minimum Thresholds Impact on Beneficial Uses and Users

The land subsidence interim MT of maintaining groundwater levels at or above historical low groundwater elevations to prevent future subsidence is not expected to impact other municipal, industrial, or domestic groundwater pumpers except for the possibility of greater costs associated with increased pumping lifts. Land subsidence MT will not directly affect environmental uses/users because they are based on Intermediate and Deep Aquifer Zone groundwater levels, whereas environmental beneficial uses/users are dependent on shallow groundwater levels.

3.3.4.5. Comparison Between Minimum Thresholds and Relevant State, Federal, or Local Standards

There are no Federal, State, or local standards that exist for land subsidence.

3.3.4.6. Minimum Thresholds Measurement Method

The interim MT for land subsidence are based on groundwater levels measured in the RMS network for the groundwater level MT.

3.3.5. Degraded Water Quality

The GSP regulations state that the "…minimum thresholds for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies…" Degraded water quality in the Subbasin would become significant and unreasonable if SGMA-related groundwater management activities or implementation of GSA projects and MA cause degradation in water quality. Locally defined significant and unreasonable conditions were determined based on discussions with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives.

The interim MT for degraded water quality are based on the greater of MCLs for key constituents or the baseline concentration plus 20%. The MCLs are 10 mg/L for nitrate as N; 10 µg /L for arsenic; 250 mg/L for chloride, and 500 mg/L for TDS. If the baseline concentration already exceeds the MCL or is within 20% of the MCL, the MT is set at 20% higher than the baseline. An MT exceedance for a given constituent at a given RMS well occurs when the average concentration over a 3-year period exceeds the MT. UR occur when the MT of a key constituent are exceeded at 25% or more RMS wells in the EBP Subbasin. A 3-year average is used to help ensure that a one-time concentration fluctuation does not automatically cause a MT exceedance, and allows for confirmation sampling to be conducted in subsequent sampling rounds to confirm that an MT exceedance has occurred. Groundwater quality MT were not established for contaminant plumes because water supply pumping impacts (primarily from Intermediate and Deep Zones) were deemed very unlikely to impact contaminant plumes that would tend to occur in the upper portion of the Shallow Zone. However, potential impacts to contaminant plumes will be evaluated on a GSA project-specific basis.

In addition to setting interim MT for degraded water quality, Action Levels were established at 50% and 75% of the MT for key constituents with primary MCLs (i.e., nitrate and arsenic) at RMS wells where the baseline concentration is well below the MT. The purpose of setting these Action Levels is to require certain GSA actions. At the 50% Action Level the cause of key constituent concentration increases is evaluated along with whether or not the cause is tied to GSA projects or management actions. If the 75% Action Level is exceeded, the GSA will with take action to avoid a MT exceedance (if increase in concentrations is determined to be caused by GSA projects or management actions) or report results to the appropriate agencies (if not caused by GSA projects or management actions). Action levels were not set for key constituents with secondary MCLs (i.e., TDS and chloride) because: 1) unlike primary MCLs, secondary MCLs are aesthetic-based and not health-based standards, and 2) the MTs for constituents with secondary MCLs are already based on the lowest (recommended) secondary MCL (e.g., the recommended secondary MCL for chloride is 250 mg/L whereas the maximum secondary MCL for chloride is 500 mg/L).

The interim MT for degraded water quality apply to RMS wells selected from among existing and proposed future wells located throughout the Subbasin and screened in the Shallow, Intermediate, and Deep Aquifers. The RMS wells for groundwater quality include monitoring wells to be sampled and analyzed by the Subbasin GSAs. The selected RMS wells for groundwater quality are listed in **Table 3-5** and locations are shown on **Figure 3-11**. An example groundwater quality RMS wells time series for selection of SMC is provided in **Figure 3-12**.

Table 3-5. Summary of Groundwater Quality Minimum Thresholds for RMS Wells

Well ID	Well Depth	Screen Top-Bottom	Aquifer Designation	MT Arsenic Concentration (µg/L)[2]	MT Nitrate Concentration (mg/L)[2]	MT Chloride Concentration (mg/L)[2]	MT TDS Concentration (mg/L)[2]
MW-5S	210	200-210	Intermediate	10	10	250	551
MW-5I	325	315-325	Intermediate	23[3]	10	250	545
MW-5D	640	500-630	Deep	10	10	250	556
MW-8D	490	420-480	Deep	18	10	250	500
MW-9S	120	110-120	Shallow	10	10	250	737
MW-9I	210	200-210	Intermediate	10	10	250	514
MW-9D	335	325-335	Intermediate	10	10	250	569
MW-10S	120	100-120	Shallow	10	10	250	500
MW-10I	360	340-360	Intermediate	10	10	250	558
MW-10D	610	590-610	Deep	10	10	250	634
S2-MWS1	85	50-80	Shallow	10	10	18,000	32,400
S2-MWS2	205	140-180	Shallow	10	10	4,200	7,320
S2-MWD1	555	480-500	Deep	10	10	250	500
MW-N1S*	TBD[1]	TBD	Shallow	10	10	250	500
MW-N1I*	TBD	TBD	TBD	10	10	250	500
MW-N2S*	TBD	TBD	Shallow	10	10	250	500
MW-N2I*	TBD	TBD	TBD	10	10	250	500
MW-N3S*	TBD	TBD	Shallow	10	10	250	500
MW-N3I*	TBD	TBD	Intermediate	10	10	250	500
MW-S1S*	TBD	TBD	Shallow	10	10	250	500
MW-S1I*	TBD	TBD	Intermediate	10	10	250	500
MW-S1D*	TBD	TBD	Deep	10	10	250	500
MW-S2S*	TBD	TBD	Shallow	10	10	250	500
MW-S2I*	TBD	TBD	Intermediate	10	10	250	500
MW-S2D*	TBD	TBD	Deep	10	10	250	500
Well D	600	500-585	Deep	10	10	250	500

1 To Be Determined (TBD); information will be updated upon completion of well construction in late 2022.

2 Values will be confirmed and/or adjusted as needed based on results from initial sampling for constituents.

3 MT greater than MCLs are due to baseline concentrations being greater than 80% of the MCL.

3.3.5.1. Methodology

The methodology to develop interim MT for groundwater quality is based on the objective of protecting beneficial uses from significant and unreasonable adverse impacts from SGMA-related groundwater management activities and implementation of GSP projects and management actions. In accordance with the Basin Plan (California Regional Water Quality Control Board, San Francisco Bay Region, 2019), groundwater in the Subbasin is considered suitable or potentially suitable for municipal and domestic water supply (MUN), agricultural supply (AGR), industrial service supply (IND), and industrial process supply (PRO) beneficial uses. From a groundwater quality standpoint, the municipal and domestic supply beneficial use is the most restrictive with Basin Plan water quality objectives linked to drinking water MCLs. As a result, the MT for groundwater quality set for each of the four identified key water quality constituents (nitrate, arsenic, chloride, TDS) are the respective MCL values, except for cases where existing or historical concentrations for these constituents already exceed the MCL. When baseline concentrations for the key constituents exceed 80% of the MCL, the MT is set at the current concentration plus 20 percent. When current or historical water quality for the key constituents has not been measured, the MT will be set as the MCL and adjusted as needed after water quality monitoring commences. The applicable MT for groundwater quality in the GSP apply to degraded groundwater quality as a direct result of impacts from SGMA-related groundwater management activities and implementation of projects and MA under the GSP that cause an exceedance to occur. Future exceedances of the MT may occur due to activities or conditions unrelated to implementation of the GSP, in which case they would not constitute an MT exceedance that contributes to an UR.

While GSA causation will need to be evaluated on a case-by-case basis, general procedures to be followed and considerations to be made in evaluating GSA causation for groundwater quality degradation include: review of monitoring data collected for the GSP, review work by others in/near area of concern with respect to key constituent monitoring, evaluation of whether contaminant concentration change is related to vertical or horizontal groundwater movement, evaluation of changes in groundwater levels (rise or fall) in causing increased concentrations of the key constituent, evaluation of available baseline/historical data for the key constituent in area of concern where groundwater quality degradation is occurring with respect to timing of GSA project (or management action) implementation, recommend additional monitoring steps as necessary (e.g., confirmation sampling, and review of existing wells nearby that could be added to monitoring network). Based on the assessment steps described above, a tentative conclusion regarding GSA causation will be made and supporting evidence outlined. The analysis will be presented in the Annual Report or Five-Year Update Report for DWR review.

Establishing baseline concentrations for key constituents requires multiple sampling events during both the wet (winter/spring) and dry seasons (summer/fall). Additional baseline sampling is needed for key constituents in the RMS wells. In general, baseline concentrations for key constituents will be established based upon a minimum of two wet and two dry season sampling events. The baseline sampling events will occur within the initial four years of GSP implementation to provide the necessary data to establish the range of baseline concentrations for each RMS well's key constituent(s) by the 5-year Update Report. Annual sampling events will be conducted to compare against baseline concentrations for each key constituent.

The technical justification for using a 20% increase from baseline concentrations to set the interim MT for RMS wells that already exceed the MCL for a key constituent is based on evaluation of three potential sources of fluctuations in key constituent concentrations from a series of sampling events at a given well:

1) Variability/uncertainty related to analytical lab methods/analysis;
2) Variability/uncertainty caused by slight differences in sampling methods or purge rates (this will be addressed to some extent with GSP sampling protocols, but some variability can still occur between different sampling personnel or from one sampling event to another plus existing data that may have been collected using slightly different protocols), and
3) Fluctuations/variability in constituent concentrations in the groundwater system due to the rise/fall of groundwater levels, changes in local groundwater flow directions, fluctuations in recharge rates, water year type, and other natural conditions affecting the groundwater system.

Consultation with the EBMUD analytical laboratory indicated that the margin of error associated with analytical lab measurements within a method may be set as:

a. The method reference used in the analysis.
b. Statistically calculated based on historical data of laboratory fortified blank samples or fortified matrix spikes.
c. Estimating the uncertainty of measurement by taking into consideration all sources contributing to the uncertainty, including, but not limited to standard references, reference materials, equipment used, environmental conditions, properties and conditions of the samples being tested or calibrated, and the operator.
d. Based on The National Environmental Laboratory Accreditation Program Institute (TNI) acceptable criteria of performance testing (PT) study; these may be set by EPA or statistically calculated for the study.

Table 3-6. Analytical Laboratory Error of Measurement for Key Constituents

Analyte	Method Reference	Method Reference or Laboratory Statistically Calculated Precision (% RPD[1])	Method Acceptance Criteria for Accuracy (% Recovery)	TNI Acceptance Criteria of Performance Testing Study (% Recovery)
TDS	SM2540C	10%	±15%	±20%
Nitrate	EPA 300.1	At ≥ 10xMRL[2]xMRL[2]: ±10% RPD At < 10xMRL: ±20% RPD	±15%	±10%
Chloride	EPA 300.1	At ≥ 10xMRL: ±10% RPD At < 10xMRL: ±20% RPD	±15%	±15%
Arsenic	EPA 200.8	20%	±15%	±30%

1 Relative percent difference (RPD).

2 Minimum reporting limit (MRL) typically set by a lab as 3 x Method Detection Limit ≈ 3 x Standard Deviation.

Based on the laboratory input summarized above, the error based on the "Method Acceptance Criteria for Accuracy" may be the best reference to use since it is 15% for all the constituents and takes into consideration sources that contribute to the uncertainty.

Work being conducted for other programs, such as the Central Valley Irrigated Lands Regulatory Program (ILRP), requires extensive review of QA/QC procedures for field sampling and analytical lab analyses for various constituents of concern (including nitrate and TDS), along with quantification of the expected Relative Percent Difference (RPD) that may occur with key constituent concentrations from groundwater quality sampling events. An RPD of up to 25% constitutes the acceptance criteria for field duplicate samples, which accounts for analytical laboratory plus field sampling methods/procedures but not natural factors influencing the groundwater system. The groundwater system fluctuations/variability factor would add greater uncertainty beyond the 25% from laboratory and field sampling methods/procedures factors. Based on prior experience, the potential constituent fluctuations from various natural factors influencing the groundwater system likely exceed 5% and result in a total expected range of fluctuations from all three factors of greater than 30%. Therefore, use of a 20% increase over baseline conditions is likely a conservative (i.e., low) value relative to the reasonably expected range of fluctuations in constituent concentrations that could be expected to occur during a series of sampling events.

3.3.5.2. Relationship to Other Sustainability Indicators

Although there are potential relationships between groundwater quality and other sustainability indicators, setting of interim MT for groundwater quality does not conflict with other sustainability indicators and associated interim MT. Management of groundwater for other sustainability indicators and associated Interim MT may not ensure that impacts on groundwater quality are avoided.

3.3.5.3. Impact of Selected Minimum Thresholds to Adjacent Basins

The interim MT for groundwater quality established for the Subbasin are intended to protect all beneficial uses within the Subbasin, including municipal and domestic water supply uses, from groundwater quality degradation caused by projects or MA included in the GSP. Therefore, the interim MT to avoid degradation of water quality are not likely to impact adjacent subbasins or their ability to achieve sustainability.

3.3.5.4. Minimum Thresholds Impact on Beneficial Uses and Users

Municipal and domestic supplies are the most restrictive beneficial uses for groundwater quality with water quality objectives equal to drinking water MCLs. Setting the groundwater quality interim MT for key constituent concentrations at respective drinking water MCLs, or within a tolerance of no more than a 20% increase above existing concentrations, is intended to limit degradation of groundwater quality caused by SGMA-related groundwater management activities, GSP projects and MA, to protect municipal and domestic supply beneficial uses. Protection of municipal and domestic beneficial uses is also protective of other groundwater beneficial uses.

3.3.5.5. Comparison Between Minimum Thresholds and Relevant State, Federal, or Local Standards

The Federal and State drinking water quality standards are represented through MCLs that are applicable to public drinking water supplies and provide reasonable guidance on water quality for safe drinking water in non-public supplies. As described above, the State of California drinking water MCLs for arsenic, nitrate, chloride, and TDS are being used to define interim MT for groundwater quality degradation caused by GSP projects and MA, except in cases where existing baseline concentrations already exceed these levels or are already within 20% of the MCL (in which case, the interim MT will be baseline concentration plus 20%).

3.3.5.6. Minimum Thresholds Measurement Method

Groundwater quality will be monitored on an annual basis at identified representative groundwater quality monitoring indicator wells presented in **Table 3-5** and **Figure 3-11**. Monitoring will be conducted through sampling of groundwater quality conducted for the GSP monitoring. All groundwater quality sampling and analysis will be conducted in accordance with the monitoring protocols and procedures described in the GSP. The monitoring network and monitoring protocols for groundwater quality are described in Section 3.5 (Monitoring Network and Monitoring Protocols for Data Collection).

3.3.6. Depletion of Surface Water

The GSP regulations requires use of a rate or volume of surface water depletions, “caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results” to define the MT, but allows for use of groundwater levels as a proxy. Surface water depletion in the Subbasin would become significant and unreasonable if excessive regional groundwater pumping causes insufficient water to be available to support potential beneficial uses/users (e.g., aquatic species, GDEs). Locally defined significant and unreasonable conditions were determined based on discussions with GSA staff and technical representatives, input received from interested stakeholders and the public through public meetings, and through individual stakeholder input to various GSA representatives.

The interim MT for surface water depletion are average shallow groundwater levels (as a proxy) set at two feet below current baseline average water levels. This interim MT will be refined with collection of additional data to improve the understanding of stream-aquifer connectivity and potential for streamflow depletion related to groundwater pumping. The proposed MT requires use of shallow wells along major creeks, which are planned to be installed for use as RMS wells. The interim MT are based on model estimated groundwater levels. Documentation for surface water depletion interim MT are provided in **Appendix 3.F**. Undesirable results for surface water depletion are deemed to occur when more than 50% of RMS wells exceed the interim MT for two consecutive Spring measurements.

As described in the HCM in Chapter 2, data are extremely limited for evaluation of streamflow depletion. Regional groundwater levels are generally expected to potentially be below stream thalwegs in the eastern portion of the Subbasin, and above stream thalwegs in the western portion of the Subbasin. There is very limited existing information to define gaining and losing reaches of Subbasin streams and the extent of connection between groundwater and surface water under various seasonal and water year type climatic conditions. Thus, a significant data gap exists related to depletion of surface water that will be addressed during the GSP implementation period (see Chapter 5).

Given the general lack of available data relating to streamflow, gaining, and losing reaches, and overall spatial/temporal connections between surface water and groundwater, initial interim MT are based on results from the EBP Subbasin groundwater model. Additional data to be collected early in GSP implementation to fill data gaps related to surface water depletion will be reviewed during the five-year Update Report, and interim MT for surface water depletion will be revisited at that time. The initial interim stream depletion MT are summarized in **Table 3-7** for locations shown on **Figure 3-13**. An example RMS well hydrograph with SMC is provided in **Figure 3-14**.

Table 3-7. Summary of Surface Water Depletion Minimum Thresholds for RMS

Well I.D.	Reference Point Elevation	Screen Top-Bottom	Model Baseline GW Elevation (ft MSL)	Observed Baseline GW Elevation (ft MSL)	MT Depth	MT Elev	GSA
SPC-1	30	TBD[1]	27-29	NA[2]	5	25	EBMUD
SPC-2	70	TBD	59-60	NA	13	57	EBMUD
SPC-3	76	TBD	48-51	NA	30	46	EBMUD
SLC-1	9	TBD	6-7	NA	5	4	EBMUD
SLC-2	70	TBD	35-46	NA	37	33	EBMUD

1 To Be Determined (TBD); information will be updated upon completion of construction planned for 2022.

2 Not Available (NA), RMS well not yet installed.

3.3.6.1. Methodology

There are very limited to no data to characterize streamflow and stream-aquifer interconnections for the largest streams in the EBP Subbasin, which include San Pablo Creek, Wildcat Creek, San Leandro Creek, and San Lorenzo Creek. San Pablo Creek and San Leandro Creek are the streams that have been assigned initial interim MT. San Lorenzo Creek was not assigned interim MT because it is lined through most of the EBP Subbasin, and the unlined portion is near San Francisco Bay where the river stage is controlled by tide levels. Wildcat Creek was not assigned an interim MT because it flows very close to San Pablo Creek, which should also be representative of conditions along Wildcat Creek. Additional information is currently being developed for San Pablo and San Leandro Creeks under a DWR Proposition 68 grant (e.g., isotope sampling; synoptic streamflow measurements), and additional data collection to characterize potential for streamflow depletion is planned for the early years (initial ten years) of GSP implementation. Therefore, due to the current lack of field data, the technical analysis to evaluate UR, using MT and MO, is based on steady-state groundwater model runs from the 1960s, the sustainability model run, and the current conditions model run. The model results related to stream depletion are summarized in **Appendix 3.F**.

Use of groundwater levels as a proxy is based on the analysis/justification using model results as summarized below. The groundwater model runs for baseline conditions (3,600 AFY), sustainability (12,500 AFY), and 1960s (23,000 AFY) pumping conditions were compared for changes in stream-aquifer connectivity, changes in average streamflow, and changes in shallow groundwater levels. The change in connectivity along each major stream reach between current baseline and sustainability model runs included no change for San Pablo, San Leandro and San Lorenzo Creeks, and a decline of 7% in connectivity for Wildcat Creek. The change in average streamflow from baseline to sustainability run conditions ranged from 0 cubic feet per second (cfs) (San Lorenzo Creek) to between 0.3 (Wildcat Creek) and 0.6 cfs (San Pablo Creek) for the other three major creeks. Changes in shallow groundwater levels along San Pablo and San Leandro Creeks ranged from 0.0 to 1.8 feet.

The change in connectivity along each major stream reach between current baseline and the 1960s run resulted in no change for San Pablo Creek, and declines ranging from 4% (Wildcat Creek) to 29% and 37% for San Leandro and San Lorenzo Creeks, respectively. However, it should be noted that the change in connectivity along San Lorenzo Creek has no significant effect on stream – aquifer interaction because the channel is lined. The decrease in average streamflow from baseline to the 1960s run conditions ranged from 0.1 to 0.3 cfs (Wildcat and San Pablo Creeks) to between 0.6 (San Lorenzo Creek) and 1.5 cfs (San Leandro Creek). The change in average streamflow for San Lorenzo Creek only occurs along the unlined reach of the creek within 0.75 miles of San Francisco Bay where the stream stage is primarily controlled by tidal fluctuations. Changes in shallow groundwater levels along the creeks ranged from 0.1 feet (San Pablo Creek) to 6 feet (San Leandro Creek). A decrease in shallow groundwater levels beneath/adjacent to creek channels will tend to cause a reduction of connectivity (in cases where shallow groundwater levels fall below the creek bed) and a decrease in streamflow due to either decreased groundwater flow into the creeks (stream discharge) or increased seepage of streamflow into the aquifer (stream recharge). The groundwater model helps demonstrate and quantify this relationship between shallow groundwater levels and changes in connectivity and streamflow.

Steady-state model results indicate that surface water depletion impacts were considerably greater for San Leandro Creek in the 1960s (by a factor of 3 to 4 times) compared to what would occur with pumping at sustainable yield levels, whereas impacts along San Pablo Creek are slightly less for the 1960s model run. The reason for these impact differences is because pumping in the 1960s was concentrated in the southern EBP Subbasin with very limited pumping in the northern EBP Subbasin, whereas the sustainability run included evenly distributed pumping (in proportion to transmissivity) from north to south.

Overall, this analysis suggests use of an average groundwater level decline of two feet in shallow wells along major creeks (San Pablo and San Leandro Creeks) as the basis for an interim MT, which is based primarily on model results for shallow groundwater level differences between the baseline and sustainable yield model runs. This analysis does not specifically address the issue that summer baseflow periods are the most critical; such an analysis requires additional field data collection to characterize current baseflow conditions followed by model updates and revision to these interim streamflow depletion MT.

3.3.6.2. Relationship to Other Sustainability Indicators

The surface water depletion interim MT was set independently of other sustainability indicators to clearly distinguish the specific sustainability indicator(s) that are causing UR, should they ever occur in EBP Subbasin. The relationships to other sustainability indicators are described below.

1. **Chronic Lowering of Groundwater Levels.** The methodology to establish interim MT for groundwater levels does not account for stream depletion. Thus, circumstances may occur where declines in Water Table Aquifer Zone groundwater levels would not constitute an MT exceedance under the chronic decline in groundwater levels sustainability criteria but would be an MT exceedance under the surface water depletion sustainability indicator. The independent establishment of interim MT under this GSP intends to distinguish which sustainability indicator is not being met for a given set of groundwater conditions that may occur.
2. **Reduction of groundwater storage.** The reduction of groundwater storage interim MT is based on pumping volumes, whereas the surface water depletion interim MT is based on changes in shallow groundwater levels. Since most groundwater pumping is from wells screened in the Intermediate/Deep Aquifer Zones (greater than 200 ft bgs) that are separated from the Water Table Aquifer Zone (upper 50 feet) by extensive clay layers, the relationship between a specific set of pumping conditions/volumes is not necessarily known. Collection of additional data and ongoing monitoring during GSP implementation and associated with future groundwater model refinements/improvements along with additional model scenario runs will improve the understanding of the relationships between various potential future pumping scenarios, shallow groundwater levels, and surface water depletion.
3. **Seawater Intrusion.** The seawater intrusion and surface water depletion interim MT are both based on Water Table Aquifer Zone groundwater elevations. In general, seawater intrusion interim MT are likely more consistent with surface water depletion interim MT near the Bay margin than they are further inland. However, as described above for groundwater level interim MT, the intent of this GSP is to establish independent interim MT for each sustainability indicator to distinguish which sustainability indicator may be violated if undesirable conditions were to occur in the future.
4. **Land Subsidence.** The surface water depletion interim MT is based on Water Table Aquifer Zone groundwater elevations, whereas the land subsidence interim MT is based on Intermediate and Deep Aquifer Zone groundwater elevations. Therefore, land subsidence interim MT do not directly relate to or conflict with surface water depletion interim MT.
5. **Degraded water quality.** The surface water depletion interim MT are not expected to result in a significant or unreasonable change in groundwater quality.

3.3.6.3. Impact of Selected Minimum Thresholds to Adjacent Basins and

The selected minimum thresholds for surface water depletion to adjacent basins will not impact the ability of adjacent basins to be sustainable.

3.3.6.4. Minimum Thresholds Impact on Beneficial Uses and Users

The selected interim MT for surface water depletion will help protect beneficial uses/users that are dependent on streamflow, which may include potential GDEs along particular reaches of some creeks.

However, beneficial users (i.e., well owners) pumping shallow groundwater near creeks may potentially be impacted by having their pumping restricted (if the GSAs decided to implement policies to restrict pumping) due to the interim MT for surface water depletion established under this GSP.

3.3.6.5. Comparison between Minimum Thresholds and Relevant State, Federal or Local Standards

There are no Federal, State, or local standards that exist for surface water depletion.

3.3.6.6. Minimum Threshold Measurement Method

The interim MT for surface water depletion will be based on measured groundwater levels in shallow wells to be installed early in GSP implementation.

3.3.7. Management Area Minimum Thresholds

No management areas were designated for the EBP Subbasin.

3.4. Measurable Objectives

(CCR Title 23, Section 354.30)

As detailed below, the MO represent the expected operating conditions for the EBP Subbasin during the sustainability period. If the GSAs successfully operate to the MO described, the Subbasin will be operating sustainably. MO and interim milestones are detailed below. As with the interim MT, the MO developed for this GSP are also considered interim due to the data gaps that exist for the six sustainability indicators. The MO will be confirmed or refined in the first five-year Update Report in 2027.

A description of the interim MO and how they were established are provided, along with recognition of the anticipated fluctuations in basin conditions around the established interim MO. This section describes how the GSP helps to meet each MO, how each measurable objective is intended to achieve the sustainability goal for the Plan area for the long-term beneficial uses, and how the interim milestones are intended to reflect the anticipated progress toward the MO during the 2022 to 2042 implementation period.

The GSP regulations define MO as specific, quantifiable criteria for the maintenance or improvement of specific groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin.

Per GSP Regulations (354.30):

1. Measurable objectives shall be established, "…including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon." (354.30.a)
2. "Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metric and monitoring sites as are used to define the minimum thresholds." (354.30.b)

3. "Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions, which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty." (354.30.c)
4. "…a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators…" may be established where "…the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence." (354.30.d)
5. "Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years." (354.30.e)

The interim MO developed for each applicable sustainability indicator in this GSP are based on the current understanding of the Plan Area and Basin Setting as discussed in detail in Chapter 2. RMS wells are identified for monitoring of MO and interim milestones for each sustainability indicator.

3.4.1. Chronic Lowering of Groundwater Levels

Measurable objectives and interim milestones for chronic lowering of groundwater levels are described below.

3.4.1.1. Measurable Objectives

Interim measurable objectives for groundwater levels were established in accordance with the sustainability goal through review and evaluation of measured groundwater level data and future projected fluctuations in groundwater levels utilizing the numerical groundwater flow model (**Appendix 6.E**), which simulated implementation of projects (with existing facilities) and MA with representative long-term hydrology. This analysis provides estimates of the expected groundwater level variability due to climatic and operational variability. Both annual (year to year) and seasonal (winter/spring to summer/fall) variability were considered. Measurable objectives for groundwater levels were determined based on recent groundwater level measurements and/or model-derived groundwater levels. MO were established based on the average of recent (i.e., last ten years) observed measurements if sufficient data were available, otherwise the average (of high and low) of model-simulated groundwater elevations were used to determine the MO. Measurable objectives for groundwater levels for each sustainability indicator well or RMS are summarized in **Table 3-8**, and locations of groundwater level sustainability indicator wells are shown in **Figure 3-1**. Groundwater level hydrographs showing MO for each groundwater level sustainability indicator well are provided in **Appendix 3.A**, and examples are provided in **Figures 3-2 through 3-4.**

3.4.1.2. Interim Milestones

Interim milestones for chronic lowering of groundwater levels were established at five-year intervals over the Implementation Period from 2022 to 2042, at years 2027, 2032, and 2037. Since the MO effectively represent current conditions under which the Subbasin is already sustainable, interim milestones were set equal to the MO. Interim milestones for groundwater levels for each sustainability indicator well are summarized in **Table 3-9**, and locations of groundwater level RMS wells are shown in **Figure 3-1**.

Table 3-8. Summary of Groundwater Level Measurable Objectives for RMS

Well I.D.	Reference Point Elevation	Well Depth	Screen Top-Bottom	Model Layer(s)	Aquifer Designation	MO Depth	MO Elev[1]	GSA[2]
MW-5S	13.88	210	200-210	3-4	Shallow/Int	6	8	EBMUD
MW-5I	13.88	325	315-325	6	Intermediate	7	7	EBMUD
MW-5D	13.78	640	500-630	9-12	Deep	19	-5	EBMUD
MW-8D	14.76	490	420-480	7-9	Deep	23	-8	EBMUD
MW-9S	54.39	120	110-120	3	Shallow	21	33	EBMUD
MW-9I	54.39	210	200-210	5	Intermediate	34	20	EBMUD
MW-9D	54.39	335	325-335	6	Intermediate	48	6	EBMUD
MW-10S	11.76	120	100-120	3	Shallow	4	8	EBMUD
MW-10I	11.76	360	340-360	7	Intermediate	8	4	EBMUD
MW-10D	11.76	610	590-610	11	Deep	17	-5	EBMUD
S2-MWS1	6	85	50-80	2	Shallow	3	3	EBMUD
S2-MWS2	6	205	140-180	3-4	Shallow	3	3	EBMUD
S2-MWD1	9	555	480-500	7-8	Deep	12	-3	EBMUD
MW-N1S	73	TBD[3]	TBD	TBD	Shallow	20	53	EBMUD
MW-N1I	73	TBD	TBD	TBD	TBD	23	50	EBMUD
MW-N2S	19	TBD	TBD	TBD	Shallow	14	5	EBMUD
MW-N2I	19	TBD	TBD	TBD	TBD	14	5	EBMUD
MW-N3S	14	TBD	TBD	TBD	Shallow	7	7	EBMUD
MW-N3I	14	TBD	TBD	TBD	Intermediate	7	7	EBMUD
MW-S1S	27	TBD	TBD	TBD	Shallow	11	16	Hayward
MW-S1I	27	TBD	TBD	TBD	Intermediate	20	7	Hayward
MW-S1D	27	TBD	TBD	TBD	Deep	30	-3	Hayward
MW-S2S	18	TBD	TBD	TBD	Shallow	9	9	Hayward
MW-S2I	18	TBD	TBD	TBD	Intermediate	12	6	Hayward
MW-S2D	18	TBD	TBD	TBD	Deep	22	-4	Hayward
Well D	43	600	500-585	9-11	Deep	45	-2	Hayward
Mt. Eden Park	24	550	460-530	9-10	Deep	41	-17	Hayward

[1] The actual MO is based on the groundwater elevation, but the depth to water corresponding to the surface elevation in the project database is also provided.

[2] Each GSA is responsible for collecting groundwater levels for the RMS wells within their GSA area.

[3] TBD = To Be Determined; information will be updated upon completion of construction planned for 2022.

Table 3-9. Summary of Groundwater Level Interim Milestones for RMS										
Well I.D.	Model Layer(s)	2027 DTW	2032 DTW	2037 DTW	2042 DTW	2027 Elev	2032 Elev	2037 Elev	2042 Elev	GSA
MW-5S	3-4	6	6	6	6	8	8	8	8	EBMUD
MW-5I	6	7	7	7	7	7	7	7	7	EBMUD
MW-5D	9-12	19	19	19	19	-5	-5	-5	-5	EBMUD
MW-8D	7-9	23	23	23	23	-8	-8	-8	-8	EBMUD
MW-9S	3	21	21	21	21	33	33	33	33	EBMUD
MW-9I	5	34	34	34	34	20	20	20	20	EBMUD
MW-9D	6	48	48	48	48	6	6	6	6	EBMUD
MW-10S	3	4	4	4	4	8	8	8	8	EBMUD
MW-10I	7	8	8	8	8	4	4	4	4	EBMUD
MW-10D	11	17	17	17	17	-5	-5	-5	-5	EBMUD
S2-MWS1	2	3	3	3	3	3	3	3	3	EBMUD
S2-MWS2	3-4	3	3	3	3	3	3	3	3	EBMUD
S2-MWD1	7-8	12	12	12	12	-3	-3	-3	-3	EBMUD
MW-N1S	TBD	20	20	20	20	53	53	53	53	EBMUD
MW-N1I	TBD	23	23	23	23	50	50	50	50	EBMUD
MW-N2S	TBD	14	14	14	14	5	5	5	5	EBMUD
MW-N2I	TBD	14	14	14	14	5	5	5	5	EBMUD
MW-N3S	TBD	7	7	7	7	7	7	7	7	EBMUD
MW-N3I	TBD	7	7	7	7	7	7	7	7	EBMUD
MW-S1S	TBD	11	11	11	11	16	16	16	16	Hayward
MW-S1I	TBD	20	20	20	20	7	7	7	7	Hayward
MW-S1D	TBD	30	30	30	30	-3	-3	-3	-3	Hayward
MW-S2S	TBD	9	9	9	9	9	9	9	9	Hayward
MW-S2I	TBD	12	12	12	12	6	6	6	6	Hayward
MW-S2D	TBD	22	22	22	22	-4	-4	-4	-4	Hayward
Well D	9-11	45	45	45	45	-2	-2	-2	-2	Hayward
Mt. Eden Park	9-10	41	41	41	41	-17	-17	-17	-17	Hayward

[1] To Be Determined (TBD); information will be updated upon completion of construction planned for 2022.

3.4.1.3. Achieving and Maintaining Sustainability

The combination of interim milestones and MO reflects how the basin anticipates maintaining sustainability with continued use of existing groundwater injection/extraction facilities. Future projections will require assumptions about future hydrologic conditions, including the sequence of wet, average, and dry climatic years. The future climatic assumptions for the implementation and sustainability periods used in this GSP incorporate sequences of wet, average, and dry years that represent overall long-term average historical climatic conditions over the implementation and sustainability periods, including one prolonged period of dry years. This overall pattern of anticipated fluctuations in groundwater levels reflects a slight decrease in average groundwater elevations associated with a very modest increase in overall groundwater extraction using existing facilities.

3.4.1.4. Impact of Selected Measurable Objectives on Adjacent Basins

The interim MO established for the EBP Subbasin Plan area provide a good basis for evaluation of anticipated impacts on adjacent subbasins from implementation of the GSP. This is because MO are set to reflect the average groundwater levels to be maintained during the sustainability period. Ultimately, the potential for impacts on adjacent subbasins will be primarily a function of average water levels in the Plan area during the sustainability period, average water levels in adjacent subbasins during the sustainability period, and natural groundwater flow conditions that would be expected to occur at Plan area boundaries. The average groundwater levels expected for the Plan area are reflected in the MO. Groundwater model results indicate that the average groundwater levels reflected in the MO will result in similar groundwater elevations as in the historical period from 1990 to 2015. Therefore, the projects and MA implemented for this GSP are expected to have no significant impacts on adjacent subbasins (compared to historical conditions) and will not hinder the ability of adjacent subbasins to be sustainable.

3.4.2. Reduction of Groundwater Storage

MO and interim milestones for reduction of groundwater storage are described below.

3.4.2.1. Measurable Objective

The interim MO for reduction of groundwater storage is based on the volume of annual groundwater pumping and is half of the estimated sustainable yield or 6,250 AFY, measured as a five-year rolling average. Available data for current groundwater pumping amounts are provided in **Appendix 3.B**.

3.4.2.2. Interim Milestones

The interim milestones for reduction of groundwater storage are the same as the MO.

3.4.2.3. Achieving and Maintaining Sustainability

The combination of interim milestones and MO reflects how the basin will maintain sustainability. Annual pumping volumes can exceed the MO while the EBP Subbasin still remains sustainable. However, additional work is needed during the early years of GSP implementation to further evaluate the sustainable yield. The initial interim MO was set at a lower level until further analysis of the sustainable yield is conducted.

3.4.2.4. Impact of Selected Measurable Objectives on Adjacent Basins

Groundwater model results indicate that the average annual groundwater pumping volumes reflected in the MO will result in no significant impacts on groundwater storage in adjacent basins. Therefore, the projects and MA implemented for this GSP will not hinder the ability of adjacent basins to be sustainable with regards to groundwater storage.

3.4.3. Seawater Intrusion

Information on historical seawater intrusion in the Subbasin is presented in the HCM (Chapter 2). The EBP Subbasin has not experienced significant seawater intrusion in the past, even when groundwater levels in the Intermediate and Deep Aquifer Zones were substantially lower in the 1950s and 1960s. A minor amount of seawater intrusion in the Shallow Aquifer Zone near the San Francisco Bay Margin (e.g., San Pablo Wellfield in Richmond, Alameda Island) reportedly occurred in some areas of the EBP Subbasin prior to the 1930s. Due to the potential to draw Intermediate and Deep Aquifer groundwater elevations below sea level in the future, there is at least the potential for seawater intrusion to occur. MO and interim milestones for seawater intrusion were established and are described below.

Since the San Francisco Bay is only connected to the shallow Water Table Aquifer Zone (upper 50 feet of sediments) with multiple thick clay layers between the Water Table Aquifer Zone and deeper aquifer units, shallow groundwater levels serve as a good proxy for seawater intrusion. Maintaining shallow groundwater levels above Mean Sea Level is expected to prevent seawater intrusion.

3.4.3.1. Measurable Objective

The interim MO for seawater intrusion is maintaining the five feet MSL groundwater elevation contour for the Water Table Aquifer Zone in its current or baseline position (or maintaining an equivalent total area between the shoreline and five-foot groundwater elevation contour). An initial interim baseline for the five feet groundwater elevation contour is provided in **Figure 3-7**. Currently available data supporting proposed seawater intrusion SMC are provided in **Appendix 3.C**.

3.4.3.2. Interim Milestones

The Interim Milestones for seawater intrusion are the same as the MO.

3.4.3.3. Achieving and Maintaining Sustainability

The combination of interim milestones and MO reflects how the basin will maintain sustainability through 2042 and beyond. Since groundwater levels serve as a practical proxy for evaluating potential for seawater intrusion, achieving and maintaining sustainability relative to this indicator is expected to occur with maintenance of existing conditions.

3.4.3.4. Impact of Selected Measurable Objectives on Adjacent Basins

The Niles Cone Subbasin is managed on the same premise as applied in this GSP for seawater intrusion: shallow groundwater levels maintained above MSL will prevent seawater intrusion. Therefore, the MO will have no impacts on adjacent subbasins.

3.4.4. Land Subsidence

Information on historical subsidence in the Subbasin is presented in the HCM (Chapter 2). The EBP Subbasin has not experienced significant subsidence or damage to infrastructure in the past, even when groundwater levels in the Intermediate and Deep Aquifer Zones were substantially lower in the 1950s and 1960s. However, due to the predominance of clay sediments and at least the potential for subsidence to occur in the future, MO and interim milestones for land subsidence were established and are described below.

3.4.4.1. Measurable Objective

There is a relationship between the potential for land subsidence to occur and groundwater levels; this allows groundwater levels to serve as a proxy for the land subsidence sustainability indicator in this GSP. Therefore, the interim MO for land subsidence is based on the MO for chronic lowering of groundwater levels. Since groundwater levels in the Intermediate and Deep Aquifers were tens to hundreds of feet below sea level in the 1950s and 1960s without any apparent significant subsidence impacts, historical low groundwater levels represent a decline in groundwater levels that did not incur any significant inelastic subsidence. Even if some amount of subsidence occurred and went unreported in the 1950s and 1960s, no additional significant subsidence would be expected to occur until historical low water levels are exceeded. The interim MO for land subsidence are the same as the MO for groundwater levels in the Intermediate and Deep Aquifers. The locations of land subsidence RMS wells are provided in **Figure 3-8** Supporting data for development of land subsidence SMC are provided in **Appendix 3.D**.

3.4.4.2. Interim Milestones

Groundwater levels are being used as a proxy for land subsidence; therefore, the interim milestones for land subsidence are the same as the interim milestones for chronic lowering of groundwater levels in Intermediate and Deep RMS wells.

3.4.4.3. Achieving and Maintaining Sustainability

The combination of interim milestones and MO reflects how the basin will maintain sustainability through 2042 and beyond. Since groundwater levels serve as a practical proxy for evaluating potential for land subsidence, achieving and maintaining sustainability relative to this indicator is similar to that described above in the groundwater level Section 3.4.1.3.

3.4.4.4. Impact of Selected Measurable Objectives on Adjacent Basins

Groundwater model results indicate that the average groundwater levels reflected in the MO will result in groundwater levels similar to recent groundwater levels. Therefore, the projects and MA implemented for this GSP will not hinder the ability of adjacent basins to be sustainable with regards to land subsidence.

3.4.5. Degraded Water Quality

Varied levels of key constituents in groundwater affect water quality considerations throughout the Subbasin (see Chapter 2). Elevated concentrations of naturally occurring and existing constituent concentrations resulting from historical land use practices are present in certain areas and aquifer depth zones of the basin. As noted in Chapter 2 (HCM), elevated concentrations of nitrate and TDS are present in some Shallow Aquifer Zone wells in the Subbasin. It is possible that increases in these concentrations may occur due to historical nitrogen and salt loading in the unsaturated zone independent of any GSP activities. The planned projects and MA are not intended to remediate these existing concentrations; however, they also are not anticipated to exacerbate these trends and conditions. Municipal and domestic supply (MUN) is a designated beneficial use for groundwater in the Subbasin; therefore, groundwater quality degradation would become significant and unreasonable based on adverse impacts to this beneficial use. This GSP intends to implement planned projects and MA in ways that do not cause or exacerbate groundwater quality impacts to beneficial uses.

3.4.5.1. Measurable Objective

The interim MO for groundwater quality are established to not exacerbate adverse impacts on all beneficial uses of groundwater resulting from implementation of GSP projects or MA. MO for the groundwater quality sustainability indicator are intended to assure that GSP projects and MA do not cause groundwater quality conditions to become unsuitable for any beneficial use, especially municipal and domestic supply uses since these are the most restrictive from a water quality standpoint. The groundwater quality MO are defined for individual RMS wells for key water quality constituents, including: arsenic, nitrate, chloride, and TDS. As discussed in Chapter 2 of this GSP, nitrate is a water quality constituent of concern, occurring at elevated concentrations in shallow groundwater in some areas, likely as a result of historical land use practices. The MO for arsenic, chloride, and TDS are intended to address additional potential groundwater quality impacts associated with GSP projects and MA that may result from lowered groundwater levels in some areas or altered groundwater flow dynamics.

The RMS wells represent groundwater quality conditions across the Subbasin and will be monitored by the GSAs. For all groundwater quality RMS wells, the interim MO concentrations for arsenic, nitrate, chloride, and TDS are or will be set at levels representative of recent/current baseline concentrations observed in the well with the intent to ensure that activities related to GSP projects or MA do not adversely impact groundwater quality conditions. Recent concentrations over the past 10 to 15 years (or baseline concentrations to be established from groundwater sampling early in the GSP implementation period) are used as the basis for setting the MO concentrations. The interim MO concentrations are an average (of high and low) of the recent (i.e., last 10 to 15 years) concentrations from baseline sampling for each of the key constituents. MO concentrations for groundwater quality for each sustainability indicator well are summarized in **Table 3-10**, and locations of groundwater quality sustainability indicator RMS wells are shown in **Figure 3-11**. Tables and graphs of historical results for key water quality constituents in the groundwater quality RMS wells are presented in **Appendix 3.E.** It should be noted that many RMS wells have no or one measured value for a given constituent, and additional groundwater quality sampling is needed early in the GSP Implementation Period to establish a reliable baseline concentration.

3.4.5.2. Interim Milestones

The interim milestones for the groundwater quality sustainability indicator are the same as the MO and include ensuring that during the Implementation Period, GSP projects and MA do not cause degradation of existing groundwater quality that would make groundwater unsuitable for the most restrictive beneficial use of municipal and domestic supply. The groundwater quality interim milestones are maintaining existing groundwater quality concentrations for arsenic, nitrate, chloride, and TDS at each RMS well over the Implementation Period as summarized in **Table 3-11**. Consistent with the MOs, groundwater quality interim milestones also include maintaining existing or historical groundwater quality conditions over the Implementation Period for wells in which the existing or historical conditions already exceed the MCL. The GSP does not include any plan or milestones specifically intended to improve groundwater quality conditions in wells with existing or historical MCL exceedances.

Table 3-10. Summary of Groundwater Quality Measurable Objectives for RMS

Well ID	Well Depth	Screen Top-Bottom	Aquifer Designation	MO Arsenic Concentration (µg/L)[1]	MO Nitrate Concentration (mg/L)[1]	MO Chloride Concentration (mg/L)[1]	MO TDS Concentration (mg/L)[1]	GSA Location	Measurement Frequency
MW-5S	210	200-210	Intermediate	3	8	56	459	EBMUD	Annual
MW-5I	325	315-325	Intermediate	19	8	63	454	EBMUD	Annual
MW-5D	640	500-630	Deep	0.5	0.06	85	463	EBMUD	Annual
MW-8D	490	420-480	Deep	15	0.006	50	420	EBMUD	Annual
MW-9S	120	110-120	Shallow	2	8	52	614	EBMUD	Annual
MW-9I	210	200-210	Intermediate	2	8	47	428	EBMUD	Annual
MW-9D	335	325-335	Intermediate	3	8	53	474	EBMUD	Annual
MW-10S	120	100-120	Shallow	6	8	43	390	EBMUD	Annual
MW-10I	360	340-360	Intermediate	6	8	53	465	EBMUD	Annual
MW-10D	610	590-610	Deep	2	8	123	528	EBMUD	Annual
S2-MWS1	85	50-80	Shallow	8	8	15,000	27,000	EBMUD	Annual
S2-MWS2	205	140-180	Shallow	8	8	3,500	6,100	EBMUD	Annual
S2-MWD1	555	480-500	Deep	8	8	200	420	EBMUD	Annual
MW-N1S	TBD[2]	TBD	Shallow	8	8	200	420	EBMUD	Annual
MW-N1I	TBD	TBD	TBD	8	8	200	420	EBMUD	Annual
MW-N2S	TBD	TBD	Shallow	8	8	200	420	EBMUD	Annual
MW-N2I	TBD	TBD	TBD	8	8	200	420	EBMUD	Annual
MW-N3S	TBD	TBD	Shallow	8	8	200	420	EBMUD	Annual
MW-N3I	TBD	TBD	Intermediate	8	8	200	420	EBMUD	Annual
MW-S1S	TBD	TBD	Shallow	8	8	200	420	Hayward	Annual

Table 3-10. Summary of Groundwater Quality Measurable Objectives for RMS

Well ID	Well Depth	Screen Top-Bottom	Aquifer Designation	MO Arsenic Concentration (µg/L)[1]	MO Nitrate Concentration (mg/L)[1]	MO Chloride Concentration (mg/L)[1]	MO TDS Concentration (mg/L)[1]	GSA Location	Measurement Frequency
MW-S1I	TBD	TBD	Intermediate	8	8	200	420	Hayward	Annual
MW-S1D	TBD	TBD	Deep	8	8	200	420	Hayward	Annual
MW-S2S	TBD	TBD	Shallow	8	8	200	420	Hayward	Annual
MW-S2I	TBD	TBD	Intermediate	8	8	200	420	Hayward	Annual
MW-S2D	TBD	TBD	Deep	8	8	200	420	Hayward	Annual
Well D	600	500-585	Deep	1	8	56	414	Hayward	Annual

[1] Values will be confirmed and/or adjusted as needed based on results from initial sampling for constituents.

[2] To Be Determined (TBD); these RMS wells have not been drilled yet but are planned for installation in late 2022.

Table 3-11. Summary of Groundwater Quality Interim Milestones for RMS

Well ID	2027 As (µg/L)[1]	2032 As (µg/L)[1]	2037 As (µg/L)[1]	2042 As (µg/L)[1]	2027 Nitrate (mg/L)[1]	2032 Nitrate (mg/L)[1]	2037 Nitrate (mg/L)[1]	2042 Nitrate (mg/L)[1]	2027 Cl (mg/L)[1]	2032 Cl (mg/L)[1]	2037 Cl (mg/L)[1]	2042 Cl (mg/L)[1]	2027 TDS (mg/L)[1]	2032 TDS (mg/L)[1]	2037 TDS (mg/L)[1]	2042 TDS (mg/L)[1]	GSA Location
MW-5S	3	3	3	3	8	8	8	8	56	56	56	56	459	459	459	459	EBMUD
MW-5I	19	19	19	19	8[†]	8	8	8	63	63	63	63	454	454	454	454	EBMUD
MW-5D	0.5	0.5	0.5	0.5	0.06	0.06	0.06	0.06	85	85	85	85	463	463	463	463	EBMUD
MW-8D	15	15	15	15	0.006	0.006	0.006	0.006	50	50	50	50	420	420	420	420	EBMUD
MW-9S	2		2	2	0.003	0.003	0.003	0.003	52	52	52	52	614	614	614	614	EBMUD
MW-9I	2	2	2	2	8	8	8	8	47	47	47	47	428	428	428	428	EBMUD
MW-9D	3	3	3	3	8	8	8	8	53	53	53	53	474	474	474	474	EBMUD
MW-10S	6	6	6	6	8	8	8	8	43	43	43	43	390	390	390	390	EBMUD
MW-10I	6	6	6	6	8	8	8	8	53	53	53	53	465	465	465	465	EBMUD
MW-10D	2	2	2	2	8	8	8	8	123	123	123	123	528	528	528	528	EBMUD
S2-MWS1	8	8	8	8	8	8	8	8	15,000	15,000	15,000	15,000	27,000	27,000	27,000	27,000	EBMUD
S2-MWS2	8	8	8	8	8	8	8	8	3,500	3,500	3,500	3,500	6,100	6,100	6,100	6,100	EBMUD
S2-MWD1	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	EBMUD
MW-N1S	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	EBMUD
MW-N1I	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	EBMUD
MW-N2I	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	EBMUD
MW-N3S	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	EBMUD
MW-N3I	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	EBMUD
MW-S1S	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	Hayward
MW-S1I	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	Hayward
MW-S1D	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	Hayward
MW-S2S	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	Hayward
MW-S2I	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	Hayward
MW-S2D	8	8	8	8	8	8	8	8	200	200	200	200	420	420	420	420	Hayward
Well D	1	1	1	1	8	8	8	8	56	56	56	56	414	414	414	414	Hayward

[1] Values will be confirmed and/or adjusted as needed based on results from initial sampling for constituents.

3.4.5.3. Achieving and Maintaining Sustainability

The combination of interim milestones and MO reflects how the basin will maintain sustainability by ensuring that GSP projects and MA do not significantly and unreasonably degrade groundwater quality conditions or exacerbate already degraded conditions. The network of groundwater quality RMS wells will enable tracking of groundwater quality conditions as they relate to GSP-related activities and activities unrelated to GSP actions. If evaluation of groundwater quality monitoring suggests that GSP projects and MA are having adverse impacts on groundwater quality affecting beneficial uses, modifications to the GSP projects and MA may be required.

3.4.5.4. Impact of Selected Measurable Objectives on Adjacent Basins

Groundwater quality MO are set to protect and maintain groundwater quality conditions suitable for all beneficial uses in the Subbasin, including municipal and drinking water supply, and are not anticipated to impact beneficial uses for groundwater in adjacent subbasins.

3.4.6. Depletion of Surface Water

As described in the HCM in Chapter 2, regional groundwater levels are generally expected to be below stream thalwegs in the eastern portion of the Subbasin, and above stream thalwegs in the western portion of the Subbasin. There is very limited existing information to define gaining and losing reaches of Subbasin streams and the extent of connection between groundwater and surface water under various seasonal and water year type climatic conditions. Thus, a significant data gap exists related to depletion of surface water that will be addressed during the GSP Implementation Period (see Section 3.5). Supporting data available for establishing initial interim SMC for surface water depletion are provided in **Appendix 3.F**.

3.4.6.1. Measurable Objective

There is a general lack of available data relating to streamflow, gaining and losing reaches, and overall spatial/temporal connections between surface water and groundwater; accordingly, MO are established to maintain current conditions in the EBP Subbasin relative to shallow groundwater levels that serve as a proxy for stream depletion (see discussion in Section 3.3). New wells will be installed at representative locations along major creeks to establish baseline conditions and for future monitoring. Initial interim MO have been established at five potential shallow monitoring well sites along two major creeks: San Pablo Creek and San Leandro Creek (**Table 3-12 and Figure 3-13**). Additional data to be collected early in GSP implementation to fill data gaps related to surface water depletion will be reviewed during the five-year Update Report, and MO for surface water depletion will be updated then.

Table 3-12. Summary of Surface Water Depletion Measurable Objectives for RMS							
Well I.D.	Reference Point Elevation	Screen Top-Bottom	Model Baseline GW Elevation (ft MSL)	Observed Baseline GW Elevation (ft MSL)	MO Depth	MO Elevation	GSA
SPC-1	30	TBD[1]	27-29	NA[2]	3	27	EBMUD
SPC-2	70	TBD	59-60	NA	11	59	EBMUD
SPC-3	76	TBD	48-51	NA	28	48	EBMUD
SLC-1	9	TBD	6-7	NA	3	6	EBMUD
SLC-2	70	TBD	35-46	NA	35	35	EBMUD

1 To Be Determined (TBD); RMS Wells not drilled yet.

2 Not Available (NA); RMS Well not drilled yet.

3.4.6.2. Interim Milestones

Initial interim milestones for surface water depletion (**Table 3-13**) are the same as the MO. Additional data to be collected early in GSP implementation to fill data gaps related to surface water depletion will be reviewed during the five-year Update Report, and interim milestones for surface water depletion will be updated.

Table 3-13. Summary of Surface Water Depletion Interim Milestones for RMS										
Well I.D.	Reference Point Elevation	2027 DTW[1]	2032 DTW	2037 DTW	2042 DTW	2027 Elev[2]	2032 Elev	2037 Elev	2042 Elev	GSA
SPC-1	30	3	3	3	3	27	27	27	27	EBMUD
SPC-2	70	11	11	11	11	59	59	59	59	EBMUD
SPC-3	76	28	28	28	28	48	48	48	48	EBMUD
SLC-1	9	3	3	3	3	6	6	6	6	EBMUD
SLC-2	70	35	35	35	35	35	35	35	35	EBMUD

1 Depth to water.

2 Elevation.

3.4.6.3. Achieving and Maintaining Sustainability

The EBP Subbasin is currently operated in a sustainable manner. The establishment of interim milestones and MO will reflect how the basin will maintain sustainability. Adhering to these interim milestones and MO will allow the EBP Subbasin to continue operating in a sustainable manner.

3.4.6.4. Impact of Selected Measurable Objectives on Adjacent Basins

The MO set for the EBP Subbasin will serve to maintain sustainability of the EBP Subbasin, which would also serve to maintain sustainability in adjacent subbasins. Therefore, the projects and MA implemented for this GSP are not expected to hinder the ability of adjacent basins to be sustainable. The MO set for stream depletion in EBP Subbasin will not impact adjacent basins.

3.5. Monitoring Network

This section describes the monitoring network and includes the following subsections:

- Description of Monitoring Network
- Monitoring Protocols for Data Collection and Monitoring
- Representative Monitoring
- Assessment and Improvement of Monitoring Network

3.5.1. Description of Monitoring Network

(CCR Title 23, Section 354.34)

This subsection on the monitoring network is intended to:

- Describe how the monitoring network will be used to collect sufficient data about groundwater conditions to evaluate Plan implementation
- Describe monitoring network objectives
- Describe how the monitoring network will be used to demonstrate progress towards achieving MO, monitor impacts to beneficial uses/users, monitor changes in groundwater conditions, and quantify annual changes in water budget components
- Describe how the monitoring network allows documentation of groundwater occurrence, flow, and hydraulic gradients, calculation of annual groundwater storage change, rate and extent of subsidence, and groundwater quality trends
- Describe how the monitoring network provides adequate coverage of sustainability indicators
- Describe monitoring network density and measurement frequency
- Describe monitoring network site selection rationale
- Describe data and reporting standards
- Provide map(s) with location and types of monitoring sites.

The GSP groundwater level monitoring network was initially developed using existing wells in the Subbasin and new nested monitoring wells being installed in late 2022. Plans are being developed for additional monitoring wells to fill data gaps; these recommended wells will likely be installed during the initial five years of the Implementation Period. The database for existing wells was reviewed with the following criteria in mind:

- Wells owned by GSAs are preferred;
- Wells with known construction (screen intervals, depth) are preferred;
- Wells with several years of water level data history (including recent data) are preferred;
- Wells that are spatially distributed are preferred;
- Wells that provide representation of Shallow, Intermediate, and Deep Aquifer Zones (Intermediate and Deep Zones are not present in all areas of EBP Subbasin) are preferred.

To the extent possible, the network was composed of wells known to represent a specific aquifer depth zone and not screened across multiple zones. The network will enable the collection of data to assess sustainability indicators, the effectiveness of MA and projects that maintain sustainability, and to evaluate the MO and MT of each applicable sustainability indicator. In some cases (e.g., depletion of interconnected surface waters), available field data are insufficient to characterize groundwater conditions relative to that sustainability indicator, and additional data collection and installation of RMS wells are proposed early in the GSP Implementation Period. Therefore, this GSP uses best available data (e.g., model results only in some cases) to derive initial interim MT, which will be updated in the first five-year Update Report in January 2027.

As described above, for the purposes of the GSP monitoring program, a subset of existing wells was identified that best meets certain criteria. Not all the criteria were satisfied for each well, but this effort resulted in 27 wells to represent the Subbasin, with ten wells in the Shallow Aquifer Zone, nine wells in the Intermediate Aquifer Zone, and eight wells in the Deep Aquifer Zone – referred to as the RMS wells.

These RMS wells are distributed throughout the Subbasin to provide coverage of the entire area to the extent possible. This initial RMS coverage combined with the planned overall monitoring network generally allows for the collection of data to evaluate groundwater level fluctuations over time and to calculate the annual change in storage over a significant portion of the Subbasin. The spatial coverage is currently limited primarily to the southern portion of the Subbasin due to availability of existing wells (installation of nested monitoring wells in late 2022 is expected to expand the area of coverage for the northern Subbasin). Furthermore, the monitoring frequency of the RMS wells will allow for the monitoring of seasonal highs and lows. For wells that have sufficient historical data records, future groundwater data will be compared to historical data. The monitoring network is expected to evolve as new wells are drilled and water level data histories are developed. The monitoring network will be periodically reviewed, and improvements made where possible.

3.5.1.1. Groundwater Level Monitoring Program

The interim MT and MO for the chronic lowering of groundwater levels sustainability indicator are evaluated by monitoring groundwater levels. The SGMA regulations require a network of monitoring wells sufficient to demonstrate groundwater occurrence, flow direction, and hydraulic gradients between principal aquifers and surface water features. The overall monitoring network for groundwater levels is comprised of the RMS Wells and the potential supplemental wells (**Appendix 3.G)**.

The objectives of the groundwater level monitoring program include:

- Improve the understanding of the occurrence and movement of groundwater; monitor local and regional groundwater levels including seasonal and long-term trends; and identify vertical hydraulic head differences in the aquifer system and aquifer-specific groundwater conditions, especially in areas where potential development of additional groundwater resources may be considered in the future;
- Detect the occurrence of, and factors attributable to, natural (e.g., direct infiltration of precipitation), irrigation, and surface water seepage to groundwater or projects and MA (e.g., injection and extraction wells) that affect groundwater levels and trends;
- Establish a monitoring network to aid in the assessment of changes in groundwater storage; and
- Generate data to better understand groundwater basin conditions and assess current and future local water supply availability and reliability; update analyses as additional data become available.

A map of the Subbasin showing the potential supplemental monitoring network wells is provided in **Appendix 3.G**, along with a table listing each well. The current status of these wells and potential access arrangements for these supplemental wells is unknown at this time and will require further investigation. Updates on the supplemental monitoring network will be provided in future Annual Reports. **Figures 3-15** through **3-17** illustrate the locations of the wells selected as representative monitoring sites for monitoring of groundwater levels in the Shallow, Intermediate, and Deep Zone Aquifers, respectively. **Tables 3-14** through **3-16** list the well identification, location, monitoring frequency, well construction data, and measurement years, and number of measurements for the Shallow, Intermediate, and Deep Zone Aquifers, respectively.

DWR has released a series of best management practices to assist GSAs with the preparation of their GSPs. The best management practices document for monitoring networks provides guidance on determining an appropriate number of monitoring wells for a given area. The method developed by Hopkins (1984) was applied to the Subbasin. This methodology states that, for areas pumping more than 10,000 AFY per 100 square miles (note: EBP Subbasin pumping is considerably less than this threshold), they should have four monitoring wells for every 100 square miles. The Subbasin occupies an area of approximately 111 square miles, yielding 4 monitoring wells for this minimum density requirement. This number was taken to be the minimum number of monitoring wells for each aquifer in the Subbasin and several additional wells were added based on informational needs resulting from MA and historical trends in groundwater levels. This GSP includes 27 existing (plus planned to be installed in late 2022) RMS wells with a potential for additional monitoring wells to be added to the program. The selection rationale for all water level monitoring wells is summarized in **Tables 3-14 through 3-16.**

Table 3-14. Summary of Shallow Aquifer Zone Groundwater Level RMS Monitoring Network Wells								
Well I.D.	Latitude	Longitude	Minimum Frequency	First Year Data	Last Year Data	Years Measured	Number of Measurements	Selection Rationale
MW-5S	37.67622	-122.152	Spring/Fall	2009	2021	12	39,897	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-9S	37.68652	-122.113	Spring/Fall	2014	2021	7	6,362	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-10S	37.68861	-122.162	Spring/Fall	2012	2021	9	7,042	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
S2-MWS1	37.75669	-122.21369	Spring/Fall	2000	2000	1	1	EBMUD well; known well construction; spatial/vertical distribution
S2-MWS2	37.75669	-122.21369	Spring/Fall	2000	2000	1	1	EBMUD well; known well construction; spatial/vertical distribution
MW-N1S	NA[1]	NA	Spring/Fall	Expected inlate 2022	NA	NA	NA	Not yet installed; but will be/have: EBMUD well; known well construction; spatial/vertical distribution
MW-N2S	NA	NA	Spring/Fall	Expected in late 2022	NA	NA	NA	Not yet installed; but will be/have: EBMUD well; known well construction; spatial/vertical distribution
MW-N3S	NA	NA	Spring/Fall	Expected in late 2022	NA	NA	NA	Not yet installed; but will be/have: EBMUD well; known well construction; spatial/vertical distribution
MW-S1S	NA	NA	Spring/Fall	Expected in late 2022	NA	NA	NA	Not yet installed; but will be/have: Hayward well; known well construction; spatial/vertical distribution
MW-S2S	NA	NA	Spring/Fall	Expected in late 2022	NA	NA	NA	Not yet installed; but will be/have: Hayward well; known well construction; spatial/vertical distribution

[1] Not Available (NA); RMS planned for installation in 2022.

Table 3-15. Summary of Intermediate Aquifer Zone Groundwater Level RMS Monitoring Network Wells

Well I.D.	Latitude	Longitude	Minimum Frequency	First Year Data	Last Year Data	Years Measured	Number of Measurements	Selection Rationale
MW-5I	37.67622	-122.152	Spring/Fall	2009	2021	12	42,303	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-9I	37.68652	-122.113	Spring/Fall	2014	2021	7	5,002	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-9D	37.68652	-122.113	Spring/Fall	2009	2021	12	42,281	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-10I	37.68861	-122.162	Spring/Fall	2011	2021	10	42,263	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-N1I	NA[1]	NA	Spring/Fall	Expected in late 2022	NA	NA	NA	Not yet installed; but will be/have: EBMUD well; known well construction; spatial/vertical distribution
MW-2NI	NA	NA	Spring/Fall	Expected in late 2022	NA	NA	NA	Not yet installed; but will be/have: EBMUD well; known well construction; spatial/vertical distribution
MW-N3I	NA	NA	Spring/Fall	Expected in late 2022	NA	NA	NA	Not yet installed; but will be/have: EBMUD well; known well construction; spatial/vertical distribution
MW-S1I	NA	NA	Spring/Fall	Expected in late 2022	NA	NA	NA	Not yet installed; but will be/have: Hayward well; known well construction; spatial/vertical distribution
MW-S2I	NA	NA	Spring/Fall	Expected in late 2022	NA	NA	NA	Not yet installed; but will be/have: Hayward well; known well construction; spatial/vertical distribution

[1] Not Available (NA); RMS wells planned for installation in 2022.

Table 3-16. Summary of Deep Aquifer Zone Groundwater Level RMS Monitoring Network Wells								
Well I.D.	Latitude	Longitude	Minimum Frequency	First Year Data	Last Year Data	Years Measured	Number Measurements	Selection Rationale
MW-5D	37.67622	-122.152	Spring/Fall	2009	2021	12	42,429	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-8D	37.71761	-122.183	Spring/Fall	2012	2021	9	6,995	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-10D	37.68861	-122.162	Spring/Fall	2009	2021	12	40,390	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
S2-MWD1	37.75688	-122.21354	Spring/Fall	2000	2000	1	1	EBMUD well; known well construction; spatial/vertical distribution
MW-S1D	NA[1]	NA	Spring/Fall	Expected in late 2022	NA	NA	NA	Not yet installed; but will be/have: Hayward well; known well construction; spatial/vertical distribution
MW-S2D	NA	NA	Spring/Fall	Expected in late 2022	NA	NA	NA	Not yet installed; but will be/have: Hayward well; known well construction; spatial/vertical distribution
Well D	37.65332	-122.114	Spring/Fall	1996	2003	7	4	Hayward well; known well construction; spatial/vertical distribution
Mt. Eden Park	37.63144	-122.099	Spring/Fall	NA	NA	0	0	Hayward Area Recreation District well; known well construction; spatial/vertical distribution

[1] Not Available (NA); RMS wells planned for installation in 2022.

3.5.1.2. Reduction of Groundwater Storage Monitoring Program

The objectives of the monitoring program to calculate changes in groundwater storage based on annual groundwater pumping in the EBP Subbasin include:

- Improve the understanding of applied water rates for large, irrigated parcels (e.g., parks, golf courses, cemeteries) using groundwater as a source of supply;
- Improve the understanding of industrial water user locations and amount of groundwater use;
- Improve the understanding of groundwater use for residential irrigation; and
- Continue metering of groundwater extraction (and injection) by the GSAs.

Because changes in groundwater storage are dependent on changes in the amount of groundwater pumping, this GSP evaluates groundwater storage reduction based on total annual groundwater pumping, as described previously in this section. Due to the potential for seawater intrusion in a coastal margin aquifer like the EBP Subbasin, evaluation of total annual pumping will be used to assess when an undesirable result may occur due to GSA projects and MA. The RMS wells and regional monitoring networks will also be used for monitoring changes in groundwater levels and storage in accordance with Annual Report requirements.

The GSAs will follow up on previous outreach work with well owners asking about wells and the amount of groundwater pumping they do for irrigation, industrial, and domestic uses. This outreach may include talking with selected well owners to potentially install meters to confirm existing estimates of applied water use for large irrigated parcels and industrial facilities. Other methods (e.g., remote sensing) may also be considered for estimation of pumping volumes and consumptive use to further refine the overall understanding of current and future pumping in the EBP Subbasin. The GSAs may consider a mailer insert or other outreach to residents asking for information on backyard irrigation wells and water use; possibly followed up by some outreach/interviews with residents in areas of known dense clusters of historical domestic well use (e.g., San Leandro). In addition, future GSP meetings could include discussions of this topic and requests for input from attendees on their groundwater use.

3.5.1.3. Seawater Intrusion Monitoring Program

The objectives of the monitoring program to calculate changes in seawater intrusion include:

- Use available GeoTracker contaminant site wells and monitor RMS and other monitoring network wells screened in the Water Table Aquifer Zone (upper 50 feet of sediments) to develop a refined baseline groundwater elevation contour map; and
- Use available wells described above to produce annual Water Table Aquifer Zone groundwater elevation contour maps to compare against the baseline map.

The connection to San Francisco Bay is limited to the Water Table Aquifer Zone; consequently, water table elevations maintained above MSL will prevent seawater intrusion into the Subbasin. This GSP adopts groundwater levels as a proxy for assessing seawater intrusion, as described previously in this GSP. The wells selected for monitoring seawater intrusion will be a combination of GeoTracker contaminant site wells, RMS monitoring wells screened in the upper 50 feet, and other monitoring network wells screened in the upper 50 feet.

3.5.1.4. Land Subsidence Monitoring Program

The objectives of the monitoring program to calculate changes in land subsidence include:

- Monitor groundwater levels and review extensometer data collected by the USGS at a station near the EBMUD Bayside well to improve the understanding of the relationship between groundwater levels in the Intermediate and Deep Aquifers and the potential occurrence of subsidence;
- Review periodic subsidence surveys that may be conducted by others;
- Review local groundwater levels in the Subbasin to ensure groundwater levels remain above minimum thresholds for subsidence.

Because of the dependence of land subsidence on groundwater levels (as well as soil properties), this GSP adopts groundwater levels as a proxy for assessing land subsidence (in combination with periodic review of extensometer data and subsidence surveys that may be conducted by others), as described previously in this section. The wells selected for monitoring land subsidence will be the Intermediate and Deep Aquifer wells used for groundwater level monitoring. **Figure 3-8** illustrates the locations of the wells selected for monitoring of groundwater levels to assess the potential for subsidence. **Table 3-17** lists the well identification, location, monitoring frequency, well construction data, and measurement years, and number of measurements for the subsidence RMS wells. Because the same wells for water level monitoring are being used for land subsidence monitoring, the selection process and rationale for selection are also the same (**Table 3-17**).

The land subsidence sustainability indicator will also be evaluated by annual review of extensometer data and other subsidence surveys that may be conducted. These extensometer data/subsidence surveys will be compared to groundwater level data collected in the Subbasin to verify that maintaining groundwater levels above the interim MT does not result in significant inelastic subsidence.

Table 3-17. Summary of Land Subsidence RMS Monitoring Network Wells								
Well I.D.	Latitude	Longitude	Minimum Frequency	Aquifer Designation	First and Last Year Data	Years Measured	Number Measurements	Selection Rationale
MW-5I	37.67622	-122.152	Spring/Fall	Intermediate	2009/2021	12	42,303	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-9I	37.68652	-122.113	Spring/Fall	Intermediate	2014/2021	7	5,002	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-9D	37.68652	-122.113	Spring/Fall	Intermediate	2009/2021	12	42,281	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-10I	37.68861	-122.162	Spring/Fall	Intermediate	2011/2021	10	42,263	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-N3I	NA[1]	NA	Spring/Fall	Intermediate	NA	NA	NA	Not yet installed; but will be/have: EBMUD well; known well construction; spatial/vertical distribution
MW-S1I	NA	NA	Spring/Fall	Intermediate	NA	NA	NA	Not yet installed; but will be/have: Hayward well; known well construction; spatial/vertical distribution
MW-S2I	NA	NA	Spring/Fall	Intermediate	NA	NA	NA	Not yet installed; but will be/have: Hayward well; known well construction; spatial/vertical distribution
MW-5D	37.67622	-122.152	Spring/Fall	Deep	2009/2021	12	42,429	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution

Table 3-17. Summary of Land Subsidence RMS Monitoring Network Wells								
Well I.D.	Latitude	Longitude	Minimum Frequency	Aquifer Designation	First and Last Year Data	Years Measured	Number Measurements	Selection Rationale
MW-8D	37.71761	-122.183	Spring/Fall	Deep	2012/2021	9	6,995	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
MW-10D	37.68861	-122.162	Spring/Fall	Deep	2009/2021	12	40,390	EBMUD well; known well construction; recent history of WL data; spatial/vertical distribution
S2-MWD1	37.75688	-122.21354	Spring/Fall	Deep	2000/2000	1	1	EBMUD well; known well construction; spatial/vertical distribution
MW-S1D	NA	NA	Spring/Fall	Deep	NA	NA	NA	Not yet installed; but will be/have: Hayward well; known well construction; spatial/vertical distribution
MW-S2D	NA	NA	Spring/Fall	Deep	NA	NA	NA	Not yet installed; but will be/have: Hayward well; known well construction; spatial/vertical distribution
Well D	37.65332	-122.114	Spring/Fall	Deep	1996/2003	7	4	Hayward well; known well construction; spatial/vertical distribution
Mt. Eden Park	37.63144	-122.099	Spring/Fall	Deep	NA	0	0	Hayward/HARD well; known well construction; spatial/vertical distribution

[1] Not Available (NA); RMS wells planned for installation in late 2022.

3.5.1.5. Groundwater Quality Monitoring Program

The sustainability indicator for degraded water quality is evaluated by monitoring groundwater quality at a network of RMS wells. The objectives of the groundwater quality monitoring program for the EBP Subbasin include the following as they relate to the implementation of GSP projects and MA:

- Evaluate baseline groundwater quality conditions in the various areas of the Subbasin, and identify spatial differences in water quality between areas and vertically in the aquifer system;
- Ongoing monitoring of concentrations of key constituents of interest as represented by nitrate, arsenic, chloride, and TDS;
- Assess the changes and trends in groundwater quality; and
- Identify the natural and anthropogenic factors that lead to changes in water quality.

For monitoring groundwater quality conditions and potential impacts from GSP projects and MA, a network of RMS wells has been selected from among existing and proposed future monitoring wells located throughout the Subbasin and screened in the various aquifer zones. The RMS wells for groundwater quality monitoring will be sampled and analyzed by the Subbasin GSAs. The selected RMS wells for groundwater quality are listed in **Table 3-18** and shown on **Figure 3-11**. Information on historical groundwater quality monitoring for each of these wells is included in **Appendix 3.E**.

Organic chemical (e.g., solvents such as TCE and PCE; fuel hydrocarbons) contaminant plumes tend to occur in the upper portion of the Shallow Aquifer Zone in EBP Subbasin. It is not anticipated that these contaminant plumes will interact with or be affected by GSA Projects that utilize the Intermediate and Deep Aquifer Zones due to impedance of vertical flow through intervening clay layers between the Shallow Aquifer Zone and deeper zones. However, development of new GSA Projects will include evaluation of potential contaminant plumes that may be near the project site as part of the overall project feasibility study.

The network of groundwater quality RMS wells includes 26 existing and new wells to be installed in late 2022 that are also part of the water level monitoring indicator well network and will be sampled for groundwater quality by the Subbasin GSAs. As details of GSP projects and MA are refined, the groundwater quality monitoring network will be reviewed and modified if needed to ensure that the network is sufficient to monitor groundwater quality conditions and avoid impacts (or plume migration) that may potentially be caused by GSP projects and MA. Groundwater quality impacts from activities unrelated to specific GSP projects and MA are subject to oversight by other regulatory programs overseeing waste discharges to groundwater and groundwater contamination sites.

Table 3-18. Summary of Groundwater Quality RMS Monitoring Network Wells, Constituents, and Measurement Frequency

Well ID	Aquifer Zone	Monitoring Entity	Field Measurements					Laboratory Measurements											
			Specific Conductance	pH	Dissolved Oxygen	Oxygen Reduction Potential	Temperature	Nitrate (as nitrogen)	Arsenic	Total dissolved solids (TDS)	Carbonate	Bicarbonate	Chloride	Sulfate	Calcium	Sodium	Magnesium	Potassium
MW-5S	Shallow and Intermediate	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-5I	Intermediate	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-5D	Deep	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-8D	Deep	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-9S	Shallow	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-9I	Intermediate	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-9D	Intermediate	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-10S	Shallow	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-10I	Intermediate	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-10D	Deep	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
S2-MWS1	Shallow	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
S2-MWS2	Shallow	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
S2-MWD1	Deep	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-N1S	Shallow	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-N1I	Intermediate	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-N2S	Shallow	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-N2I	Shallow/Int	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-N3S	Shallow	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-N3I	Shallow/Int	EBMUD	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-S1S	Shallow	Hayward	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-S1I	Intermediate	Hayward	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-S1D	Deep	Hayward	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-S2S	Shallow	Hayward	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-S2I	Intermediate	Hayward	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
MW-S3D	Deep	Hayward	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year
Well D	Deep	Hayward	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	5-Year	5-Year	Annual	5-Year	5-Year	5-Year	5-Year	5-Year

3.5.1.6. Surface Water Depletion Monitoring Program

The objectives of the monitoring program to evaluate surface water depletion include:

- Install wells and monitor groundwater levels in the Water Table Aquifer Zone near major creeks;
- Collect additional streamflow data under different flow conditions using a combination of synoptic stream surveys (i.e., collection of streamflow measurements at multiple locations along a creek on the same day) and stream gauges;
- Review shallow groundwater levels and streamflow data to characterize stream-aquifer connection along major creeks;
- Monitor shallow groundwater levels along streams to ensure groundwater levels remain above the interim MT for surface water depletion.

Because of the dependence of surface water depletion on shallow groundwater levels and the difficulty of accurately quantifying surface water depletion from streamflow data (due to variability in streamflow caused by variable climatic conditions, reservoir releases, and other factors), this GSP adopts shallow groundwater levels along major creeks as a proxy for assessing surface water depletion, as described previously in this GSP. The wells selected for monitoring surface water depletion will be the Water Table Aquifer Zone (i.e., upper 50 feet of sediments) wells to be installed early in GSP implementation to fill data gaps. **Figure 3-13** illustrates the approximate locations of the shallow wells being considered for monitoring of groundwater levels for surface water depletion. Final well locations may vary due to site logistics and further study regarding optimum well locations. These proposed shallow wells are expected to be up to 50 feet deep, but they could be significantly shallower depending on lithology and groundwater levels encountered during drilling at each location. The selection process and rationale for selection is based on better characterizing the primary creeks in the EBP Subbasin with priority assigned to San Pablo Creek and San Leandro Creek, which have two of the largest contributing watersheds to EBP Subbasin. Secondary creeks being considered are Wildcat Creek, Codornices Creek, and San Lorenzo Creek. Wildcat Creek flows very close to San Pablo Creek in the main part of the EBP Subbasin in the Richmond area and is likely well represented by overall conditions along San Pablo Creek. Codornices Creek has one of the smaller watersheds tributary to the EBP Subbasin, but it is representative of a creek that has been targeted for restoration activities. San Lorenzo Creek is mostly concrete-lined from the eastern EBP Subbasin boundary until it reaches about 0.75 miles from the Bay margin; therefore, it was deemed secondary in importance for stream-aquifer connection compared to San Leandro Creek (which is unlined over a greater length) even though the San Lorenzo Creek watershed is one of the major watersheds tributary to the EBP Subbasin.

3.5.2. Monitoring Protocols for Data Collection and Monitoring
(CCR Title 23, Section 352.2)

This section provides a description of technical standards, methods, and procedures/protocols to ensure comparable data and methodologies for data collection and monitoring. All field monitoring activities will follow established monitoring protocols for the Subbasin that reflect the standards, methods, and procedures described below.

3.5.2.1. Groundwater Level Monitoring Program

The interim MT and MO for the chronic lowering of groundwater levels sustainability indicator are evaluated by monitoring groundwater levels. The SGMA regulations require a network of monitoring wells sufficient to demonstrate groundwater occurrence, flow direction and hydraulic gradients between principal aquifers and surface water features. The overall monitoring network for groundwater levels is provided in **Appendix 3.G**.

The protocols for measuring groundwater levels include:

- Measure depth to water in the well using procedures appropriate for the measuring device. Equipment must be operated and maintained in accordance with manufacturer's instructions. Groundwater levels should be measured to the nearest 0.01 foot (or at least to the nearest 0.1 foot at a minimum) relative to the Reference Point (RP). Measurements and RPs should not be recorded in feet and inches.
- For measuring wells that are under pressure, allow a period of time for the groundwater levels to stabilize. In these cases, multiple measurements should be collected to ensure the well has reached equilibrium such that no significant changes in water level are observed. Every effort should be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value should be appropriately qualified as a questionable measurement. If a well is artesian, site-specific procedures should be developed to collect accurate information and be protective of safety conditions associated with a pressurized well. In many cases, an extension pipe may be adequate to stabilize head in the well. Record the dimension of the extension and document measurements and configuration.
- The groundwater elevation should be calculated using the following equation.

  GWE= RPE−DTW
  Where:
  GWE = Groundwater Elevation in NAVD88 datum
  RPE = Reference Point Elevation in NAVD88 datum
  DTW = Depth to Water

- The well caps or plugs should be secured following a depth to water measurement.
- Groundwater level measurements are to be made on a semi-annual basis at a minimum during periods that will capture seasonal highs and lows.
- The sampler should record the well identifier, date, time (24-hour format), RPE, height of RP above or below ground surface, DTW, GWE, and comments regarding any factors that may influence the depth to water readings such as weather, nearby pumping, flooding, or well condition. Of particular concern may be pumping of nearby supply wells or time since pumping stopped in the well being monitored (if it is a production well); such conditions should be specifically identified and noted to the extent possible. If there is a questionable measurement or the measurement cannot be obtained, it should be noted. Standardized field forms will be used for all data collection.
- Wells containing groundwater with high salinity may occur in the shallow sediments (i.e., upper 50 to 80 feet) along the San Francisco Bay margin. Certain water level measurement devices (e.g.,

electronic sounder) may provide anomalous readings, and levels should be measured multiple times to ensure a consistent depth to water is recorded. After each measurement attempt, the probe should be retrieved and rinsed with fresh water and then reinserted into the well to confirm the measurement. It is recommended that at least three attempts occur, and the same reading should be recorded to ensure accurate measurement in saline groundwater conditions.

- The sampler should have a record of previous measurements in the field for each well to compare with the current measurements being recorded. If a current measurement appears anomalous compared to previous measurements, it should be re-checked and verified.
- All data should be entered into the GSP data management system (DMS) as soon as possible. Care should be taken to avoid data entry mistakes and the entries should be checked by a second person.

3.5.2.2. Installing Pressure Transducers and Downloading Data

The procedures below should be followed for the installation of a pressure transducer and periodic data downloads:

- The sampler must use an electronic sounder or chalked steel tape and follow the protocols listed above to measure the groundwater level and calculate the groundwater elevation in the monitoring well to properly program and reference the installation. It is recommended that transducers record measured groundwater level to conserve data capacity; groundwater elevations can be calculated later after downloading.
- The sampler must note the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.
- Transducers must be able to record groundwater levels with an accuracy of at least 0.1 foot. Professional judgment will be exercised to ensure that the data being collected is meeting the data quality objectives (DQO) and that the instrument is capable of meeting DQO. Battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers should be included in the evaluation.
- The sampler must note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. Non-vented units are preferred (generally less expensive, require less maintenance than vented units, and are less prone to failure) and provide accurate data if properly corrected for natural barometric pressure changes. This requires the consistent logging of barometric pressures by GSAs to coincide with measurement intervals.
    - Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that DQOs are being met for the GSP.
    - Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or an indelible marker. This will allow estimates of future cable slippage.

The transducer data should be periodically checked against hand measured groundwater levels to monitor electronic drift or cable movement. This should happen during routine site visits, at least annually to maintain data integrity. The data should be downloaded as necessary to ensure no data are lost and entered into the DMS following the QA/QC program established for the GSP. Data collected with non-vented data logger cables should be corrected for atmospheric barometric pressure changes, as appropriate. After the sampler is confident that the transducer data have been safely downloaded and stored, the data should be deleted from the data logger to ensure that adequate data logger memory remains.

3.5.2.3. Groundwater Storage Reduction Monitoring Program

The monitoring protocols for evaluating change in groundwater storage are related to quantification of groundwater pumping. To the extent that flow meters may be used on representative irrigation or industrial wells (in addition to GSA municipal production wells) to quantify groundwater pumping volumes from a well, the following procedures should be followed for the installation of a meter and reporting of meter reads:

- The person collecting meter reads must note the well identifier, the meter brand and model number, and meter location relative to bends in piping both up- and downstream of the meter location.
- Meters should be able to record groundwater volumes to a precision of at least 100 gallons. Professional judgment will be exercised to ensure that the data being collected meet the data quality objectives (DQO) and that the instrument is capable of meeting DQO.
- Follow manufacturer specifications for installation, calibration, recording data, correction procedure (if meter is found to be insufficiently calibrated) to assure that DQOs are being met for the GSP.

3.5.2.4. Seawater Intrusion Monitoring Program

The monitoring protocols for evaluating seawater intrusion are similar to the protocols described above for groundwater levels for monitoring wells being used to supplement the GeoTracker well database. While each contaminant site with monitoring wells in the GeoTracker well database may have slightly different monitoring protocols developed by the responsible parties at each site, it is expected that those protocols will be very similar to the groundwater measurement protocols developed for this GSP.

3.5.2.5. Land Subsidence Monitoring Program

Subsidence monitoring will include the following protocols:

- Obtain and review extensometer subsidence data collected by the USGS. This data will be input into the DMS following QA/QC.
- Obtain and review subsidence survey data that may be collected by others. This data will be input into the DMS following QA/QC.
- Groundwater level data collected as part of the subsidence monitoring program will follow the same protocols as described above for groundwater level monitoring.

3.5.2.6. Groundwater Quality Monitoring Program

Annual monitoring of groundwater quality will include sampling and laboratory analysis of key parameters of interest as indicated on **Table 3-18** to be conducted by GSAs as presented in **Tables 3-5, 3-10, and 3-11**. Water quality parameters may be added to the groundwater quality monitoring program in the future, if appropriate. During sampling events, measurement of select water quality parameters will take place in the field. These field parameters should be measured at an annual frequency and include electrical conductivity (EC) in µS/cm, pH, temperature (in °C), redox, and dissolved oxygen (DO) in mg/L. The annual testing is summarized in **Table 3-18.**

The GSP monitoring program will utilize the following protocols for collecting groundwater quality samples.

- Prior to sampling, the analytical laboratory will be contacted to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.
- Each well used for groundwater quality monitoring will have a unique identifier. This identifier will appear on the well housing or the well casing to verify well identification.
- In the case of wells with dedicated pumps, samples should be collected at or near the wellhead following purging.
- Prior to sampling, the sampling port and sampling equipment will be cleaned of any contaminants. The equipment will be decontaminated after purging and collection of water samples at each site to avoid any cross-contamination between wells.
- The groundwater elevation in the well should be measured following appropriate protocols described above in the groundwater level measuring protocols.
- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water should be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally considered adequate. Professional judgment should be used to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), document the condition and allow well to recover to within 90% of original level prior to sampling.
- Field parameters of pH, electrical conductivity, temperature, and turbidity should be collected periodically during purging and prior to the collection of each sample. Field parameters should be evaluated during the purging of the well and should stabilize prior to collection of the water sampling. Measurements of pH values should occur in the field since the short hold times for laboratory pH analysis are typically unachievable. Other parameters, such as oxidation-reduction potential (ORP), dissolved oxygen (DO) (in situ measurements preferable), or turbidity, may also be useful for assessing purge conditions. All field instruments should be calibrated daily and evaluated for drift throughout the day.
- Sample containers should be labeled prior to sample collection. The sample label must include sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used (if any), and analytes and analytical method(s).
- Samples should be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection. Alternatively, the flow rate from the sampling tap should correspond to laminar flow conditions when possible.

- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. Ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolved analytes. Specifically, samples to be analyzed for metals should be field filtered prior to preservation; do not collect an unfiltered sample in a preserved container.
- Samples should be chilled and maintained at 4 °C to prevent degradation of the sample. The laboratory's Quality Assurance Management Plan should detail appropriate chilling and shipping requirements.
- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.
- Ensure the laboratory uses appropriate reporting limits that are at or below levels needed for the objectives of the monitoring.
- Groundwater quality samples are to be collected annually for key constituents and every five years for all other constituents.
- For wells monitored by other entities, obtain results and associated information on sampling activities through coordination and communication directly with the monitoring entity or through public databases such as SWRCB GeoTracker where these data are available.

All groundwater quality data and other information from sampling activities should be entered into the DMS as soon as possible and in accordance with established QA/QC procedures. Care should be taken during any data entry to avoid mistakes and data entered into the database should be checked for accuracy and completeness.

3.5.2.7. Surface Water Depletion Monitoring Program

Stream depletion monitoring will include the following protocols:

- Obtain and review stream discharge data collected by various parties (e.g., USGS, Alameda County, EBMUD reservoir releases). This data will be input into the DMS following QA/QC.
- Obtain and review stream discharge data from synoptic studies and/or stream gauges conducted/installed by GSAs for GSP implementation. This data will be input into the DMS following QA/QC.
- Groundwater level data collected as part of the stream depletion monitoring program will follow the same protocols as described above for groundwater level monitoring.

3.5.2.8. GDE Monitoring Program

The GDE monitoring program will include monitoring of groundwater levels and biological monitoring. Groundwater level monitoring being conducted for the overall GSP will include new shallow monitoring wells adjacent to selected potential GDE units. Baseline biological monitoring will be conducted within the initial five years of GSP implementation and will be conducted every five years thereafter to document ecological condition of the potential GDE units. Biological data will be analyzed in conjunction with hydrological data to assess potential ecological effects related to changes in groundwater levels and the relative degree of influence on GDE conditions exerted by streamflow (if the potential GDE unit is adjacent to a creek) and groundwater levels associated with the GDE.

3.5.3. Representative Monitoring

(CCR Title 23, Section 354.36)

This section is intended to provide the following:

- Description of representative sites
- Demonstration of adequacy of using groundwater elevations as proxy for other sustainability indicators
- Adequate evidence demonstrating representative monitoring sites reflect general conditions in the area

Groundwater level data are collected from a large network of EBMUD and Hayward wells (**Appendix 3.G**). Representative monitoring sites are defined in the SGMA regulations as a subset of monitoring sites that are representative of conditions in the Subbasin. Existing wells available for use as RMS sites are primarily located in the southern EBP Subbasin due to a greater thickness of unconsolidated alluvium (and presence of all three aquifer zones) and greater well capacity production potential in this area compared to the northern EBP Subbasin (Deep Aquifer Zone generally not present, and Intermediate Aquifer Zone also not present in many areas). Additional nested monitoring wells are already in planning stages for drilling/installation at three locations (two monitoring wells at each site to different depths) in the northern EBP Subbasin to fill data gaps and provide initial RMS coverage in this area. Overall, the initial RMS network provided in this GSP makes best use of existing wells combined with using additional monitoring wells planned for installation in late 2022. Data gaps in the RMS and overall monitoring network will continue to be evaluated during early years of GSP implementation and additional RMS wells may be added. Groundwater level monitoring will be used to assist in monitoring seawater intrusion, subsidence, and stream depletion.

In terms of subsidence, significant impacts to infrastructure are not known to have occurred during a time of much greater pumping in the EBP Subbasin and associated historical low groundwater levels in the 1950s and 1960s. Thus, representative Intermediate and Deep Aquifer Zone monitoring wells are included in the RMS network with interim MT tied to historical low groundwater levels, which greatly reduces the potential for any significant and unreasonable future inelastic subsidence. There is also ongoing extensometer monitoring near the EBMUD Bayside well to further evaluate the relationship between groundwater levels and subsidence.

San Francisco Bay is relatively shallow and only connected to the upper portion of the Shallow Aquifer Zone, which is referred to as the Water Table Aquifer Zone (i.e., upper 50 feet of sediments) in this GSP. There are thick and laterally extensive clay layers throughout the Shallow Aquifer Zone, as well as the Intermediate and Deep Aquifer Zones. Therefore, saline water from the Bay is limited to migrating horizontally inland within the shallowest sediments of the EBP Subbasin. If Water Table Aquifer Zone groundwater elevations are maintained above mean sea level, seawater intrusion would not be expected to occur in the EBP Subbasin. A very similar approach of using shallow aquifer groundwater levels to manage seawater intrusion is being followed in the Niles Cone Subbasin Alternative (to a GSP), which has been approved by DWR.

Field data (e.g., stream discharge, shallow groundwater levels near streams) are very limited for the EBP Subbasin. However, it is apparent that there is some connectivity between creeks and shallow groundwater, especially in the western to central portion of the EBP Subbasin. Significant additional work is planned to better characterize the major creeks (e.g., San Pablo Creek, San Leandro Creek) in terms of stream-aquifer connectivity, gaining and losing reaches, and typical baseflows. Even if a good historical record of streamflow were available, it is very difficult to determine if streamflow depletion is occurring related to groundwater pumping. However, establishing the relationship between shallow groundwater levels and surface water depletion using a combination of field data (shallow monitoring wells, stream discharge data) and groundwater modeling can allow for the relationship between shallow groundwater levels and surface water depletion to be established. In this manner, the change in shallow groundwater levels from baseline conditions can provide a reasonable proxy for measurement of surface water depletion.

The initial RMS wells included in this GSP, combined with additional wells in the proposed monitoring network along with shallow wells from GeoTracker, will provide adequate monitoring to reflect general conditions in the EBP Subbasin. As noted above, work to fill data gaps in the monitoring network is already underway in 2021 with a target completion date of mid-2022. In addition, an initial plan to further address data gaps identified during GSP development is provided in this GSP. The intent is to develop robust monitoring networks for the sustainability indicators for the initial five-year Update Report in 2027. Data collected and scientific analyses conducted during this period and subsequent years will be used to inform and guide plans for any additional groundwater development by the GSAs. This allows time to improve data gaps in monitoring networks and collect sufficient background/baseline data under current basin conditions and for future evaluation of potential impacts should additional development of groundwater resources in EBP Subbasin occur.

3.5.4 *Review and Evaluation of the Monitoring Network*
(CCR Title 23, 354.38)

Per Section 354.38 of the GSP Regulations, this section of the GSP is intended to provide the following:

- Review and evaluation of the monitoring network
- Identification and description of data gaps
- Description of steps to fill data gaps
- Description of monitoring frequency and density of sites

Development of this GSP included extensive review and documentation of historical data, evaluation of currently available monitoring facilities, and identification of data gaps for various data types (**Appendix 2.A**). This data gaps analysis demonstrated that historical data and currently available monitoring facilities are very limited in the northern EBP Subbasin. The southern EBP Subbasin has significantly more historical data and available monitoring facilities, but significant data gaps still remain. The results of this study were used as the basis for the DWR Proposition 68 grant application that was approved/awarded to begin filling these data gaps. The Proposition 68 grant includes drilling/installation of nested monitoring wells in both the north (three sites and six wells) and south (two sites and six wells), regional aquifer testing in both the north and south, and evaluation of streamflow and stream chemistry (isotopes) along San Pablo and San Leandro Creeks. This work is underway with a target completion date of late 2022.

A major data gap area throughout the EBP Subbasin is the understanding of stream-aquifer interconnection and potential for stream depletion from groundwater pumping. The Proposition 68 grant cited above provides some additional information, but more work has been identified to address this data gap.

The monitoring networks described above for each of the applicable sustainability indicators will be evaluated on a yearly basis. This evaluation will involve a review of the described interim MT and MO and their comparison to observed trends in the networks. Furthermore, a more comprehensive review of the monitoring networks will be conducted every five years. During this review, MA and projects will be evaluated and the monitoring networks will be assessed for their efficacy in tracking progress based on the actions and projects. These evaluations and assessments will also highlight any additional data gaps and recommended changes to the monitoring networks.

3.5.4.1. Identification and Description of Data Gaps

Identification and description of data gaps for the monitoring networks described above for each of the applicable sustainability indicators are summarized below.

3.5.4.2. Groundwater Elevation

Groundwater elevation data have been collected within the Subbasin over the past several decades from various sources including DWR, Alameda County, EBMUD, Hayward, USGS, and others. However, despite these data collection efforts, data gaps still exist. Specifically, the northern portion of the Subbasin and portions of the southern EBP Subbasin are lacking in historical data and existing monitoring wells. These gaps are evident in the designed monitoring network. In addition to these spatial gaps, temporal data collection gaps also exist at the monitoring network sites. Historical data are available from the early 1960s to 2000 for several wells previously monitored by Alameda County and DWR. Some groundwater elevation data from the 1990s to more recent years are available from Hayward wells. The Bayside Well monitoring network provides significant data since 2010 in the southern EBP Subbasin. Some of the spatial data gaps will be filled with installation of the nested monitoring wells by 2022, particularly for the northern EBP Subbasin where data gaps are most extensive. Temporal data gaps will begin to be filled by more regular collection of data as part of the GSP together with the installation of transducers in new nested monitoring wells.

Data gaps relative to GDEs can be characterized as a combination of groundwater levels and biological monitoring. Data gaps related to shallow groundwater levels occur in areas identified as potential GDEs in this GSP, and these will be addressed as cited above with installation of additional monitoring wells. Biological monitoring, recommended every five years, will be used to evaluate potential beneficial or adverse effects on GDEs that may be related to changes in future groundwater conditions during the Implementation and Sustainability Periods. Baseline biological monitoring will be conducted in the initial five years of GSP implementation followed by regular biological monitoring at five-year intervals.

3.5.4.3. Groundwater Storage

Resolving groundwater storage data gaps primarily entails developing better estimates of groundwater pumping throughout the Subbasin. The approach to improve groundwater pumping estimates will be further developed during the initial years of GSP implementation, but this may include: metering of selected production wells to better understand applied water rates for irrigation of large parcels and/or industrial sites; use of remote sensing or other technologies/methods to refine estimates of applied water for irrigation; and continued outreach and communication with basin stakeholders and well owners about groundwater use.

3.5.4.4. Seawater Intrusion

As described in previous sections, hydrogeologic conditions pertaining to seawater intrusion indicate that it can best be managed by maintaining shallow Water Table Aquifer Zone groundwater elevations above mean sea level. A fairly extensive network of shallow monitoring wells with water level observations serving as a proxy and representative of the shallowest sediments are available from data collected for contaminant sites in GeoTracker. These data will be supplemented by nested monitoring wells currently under construction for a DWR Proposition 68 grant and scheduled to be completed in early 2022. Additional shallow monitoring wells planned for installation near creeks in the early years of GSP implementation will provide additional data points for use in mapping groundwater elevations in the upper 50 feet of sediments (i.e., Water Table Aquifer Zone).

3.5.4.5. Subsidence

There has been no significant subsidence impacting infrastructure in the EBP Subbasin despite extensive and much greater groundwater pumping in the 1950s and 1960s. A key component of monitoring for subsidence is the extensometer station installed by USGS near the EBMUD Bayside Well. Subsidence data have been collected from this station for over 10 years to help establish background conditions, and data will continue to be collected in the future. If the Bayside Well is used more extensively in the future, the extensometer will provide a detailed record of any elastic and inelastic subsidence that may occur. In addition, extensive monitoring of groundwater levels in and around the extensometer will allow for further understanding of the relationship between groundwater levels and subsidence.

Given that groundwater levels are being used as a proxy for subsidence, the data gaps described above for groundwater levels apply for subsidence as well. However, the key areas for potential subsidence (western half of the southern EBP Subbasin) have a relatively good network of existing monitoring wells in the Intermediate and Deep Aquifers that are key to subsidence monitoring.

3.5.4.6. Groundwater Quality

Considerable historical groundwater quality data exist for the Subbasin although the spatial distribution and well construction details present limitations. Several of the wells in the groundwater quality sustainability indicator monitoring network have not been historically monitored for groundwater quality or have only one measurement for a given constituent. The combination of these existing wells and the monitoring wells currently being constructed provide a sufficient initial network for monitoring of groundwater quality and impacts from GSP projects and managements actions. As GSP projects and MA are implemented and the planned locations for these activities are better known, the groundwater quality monitoring network will be reviewed and modified as needed to provide sufficient groundwater quality monitoring to meet the stated objectives.

3.5.4.7. Surface Water Depletion

The surface water depletion sustainability indicator has the most limited data of all the sustainability indicators in the EBP Subbasin. Data for shallow groundwater levels adjacent to/beneath creeks are generally lacking, as are detailed survey data on creek thalweg elevations along the lengths of major creeks traversing the EBP Subbasin. In addition, stream discharge data are generally lacking for the major creeks. Therefore, a preliminary plan has been developed to fill these data gaps in the initial five years of GSP implementation. Additional details of the overall plan to fill data gaps are described below in more detail and include installation of shallow monitoring wells along major creeks and potential GDE areas, conducting synoptic/hydrometric surveys, additional isotope sampling, and collection of additional stream discharge data.

Additional work during the first five years of GSP implementation will include drilling/installation of ten shallow monitoring wells up to 50 feet deep to be located along major creeks and GDEs, further synoptic surveys to collect stream discharge data and delineate gaining and losing stream reaches, and installation of stream gauges to provide for ongoing collection of stream discharge measurements.

3.5.4.8. Description of Steps to Fill Data Gaps

Data gaps have been presented above for the six sustainability indicators, along with details of steps to fill data gaps that are both currently in progress and planned to be conducted during the initial five years of GSP implementation. The following steps are currently in progress to address these data gaps:

- Implementation of a DWR Proposition 68 grant to drill/install nested monitoring wells at three locations (two wells at each site for a total of six new monitoring wells) in the northern EBP Subbasin, and at two locations (three wells at each site for a total of six new monitoring wells) in the southern EBP Subbasin. These new monitoring wells will allow for collection of water level and water quality data in the Water Table, Shallow, and Intermediate Aquifer Zones in the northern EBP Subbasin, and in the Shallow, Intermediate, and Deep Aquifer Zones in the southern EBP Subbasin. These new monitoring wells will help fill data gaps for the following sustainability indicators: groundwater levels, seawater intrusion, subsidence, and groundwater quality. The new wells will also provide key data points for annual calculations of groundwater storage change. All of the new wells being drilled under the DWR Proposition 68 grant are included in the list of groundwater level RMS wells.
- Implementation of the DWR Proposition 68 grant to conduct long-term (up to two weeks) aquifer tests in both the northern and southern EBP Subbasins. Regional aquifer testing will help improve the HCM in terms of developing better estimates of aquifer parameters (especially in the northern EBP Subbasin where such data are very limited), connection between deeper aquifer zones (where pumping wells are screened) and shallow groundwater levels from pumping, and in the southern EBP Subbasin will enhance current understanding of connection between the EBP and Niles Cone Subbasins.

- Implementation of the DWR Proposition 68 grant to conduct synoptic stream surveys and collect stream isotope data in two major creeks (San Pablo and San Leandro) to better characterize stream-aquifer connectivity and interaction. This information will improve overall understanding of key hydrogeologic factors related to the surface water depletion sustainability indicator and relationship between groundwater levels and potential GDEs that may occur along these creeks.

In addition to these ongoing studies to fill data gaps, several additional steps to fill data gaps have been identified and outlined above and are planned to be conducted in the initial five years of GSP implementation. These additional steps include:

- Drilling and installation of ten shallow monitoring wells along major creeks and in potential GDE areas;
- Conducting periodic synoptic (hydrometric) stream surveys;
- Installing additional stream gauges;
- Better characterization of overall basin groundwater pumping;
- Biological surveys to better characterize species and rooting depths in potential GDE areas and to provide baseline ecosystem health data.

In addition to these ongoing studies to fill data gaps, the monitoring networks will be evaluated on a yearly and five-year basis. If additional data gaps arise, the GSAs will consider the implications of these gaps, associated costs, and importance to the continued implementation of the GSP and take appropriate actions to address the gaps.

3.5.4.9. Description of Monitoring Frequency and Density of Sites

Monitoring frequency and density of sites for all sustainability indicators are described in previous sections of this report.

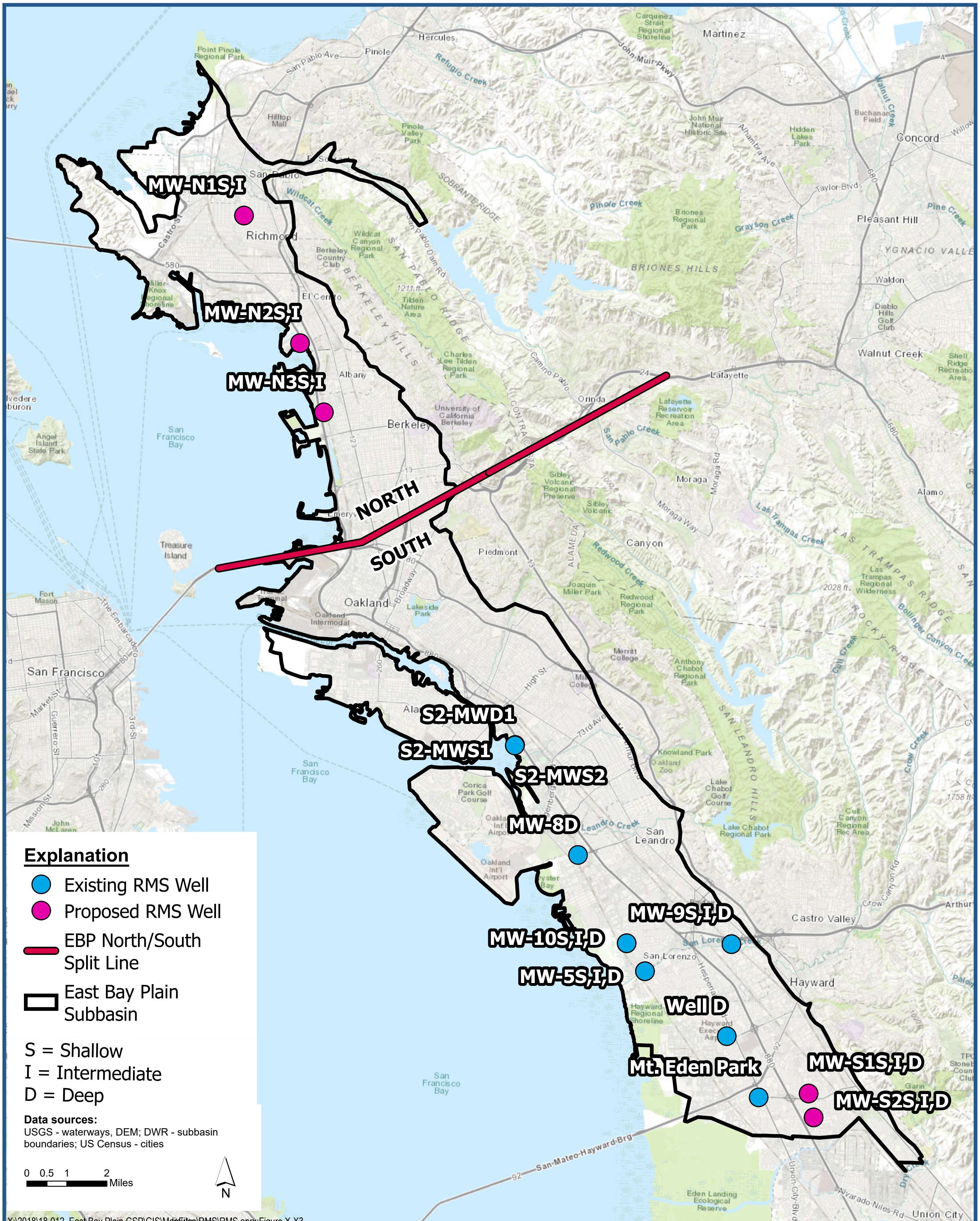
3.6. References

California Regional Water Quality Control Board, San Francisco Bay Region. 2019. *San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan).*

Norfleet Consultants. 1998. *Groundwater Study and Water Supply History of the East Bay Plain, Alameda and Contra Costa Counties, California*. Prepared for The Friends of the San Francisco Estuary.

FIGURES

Figures 3-1 through 3-17

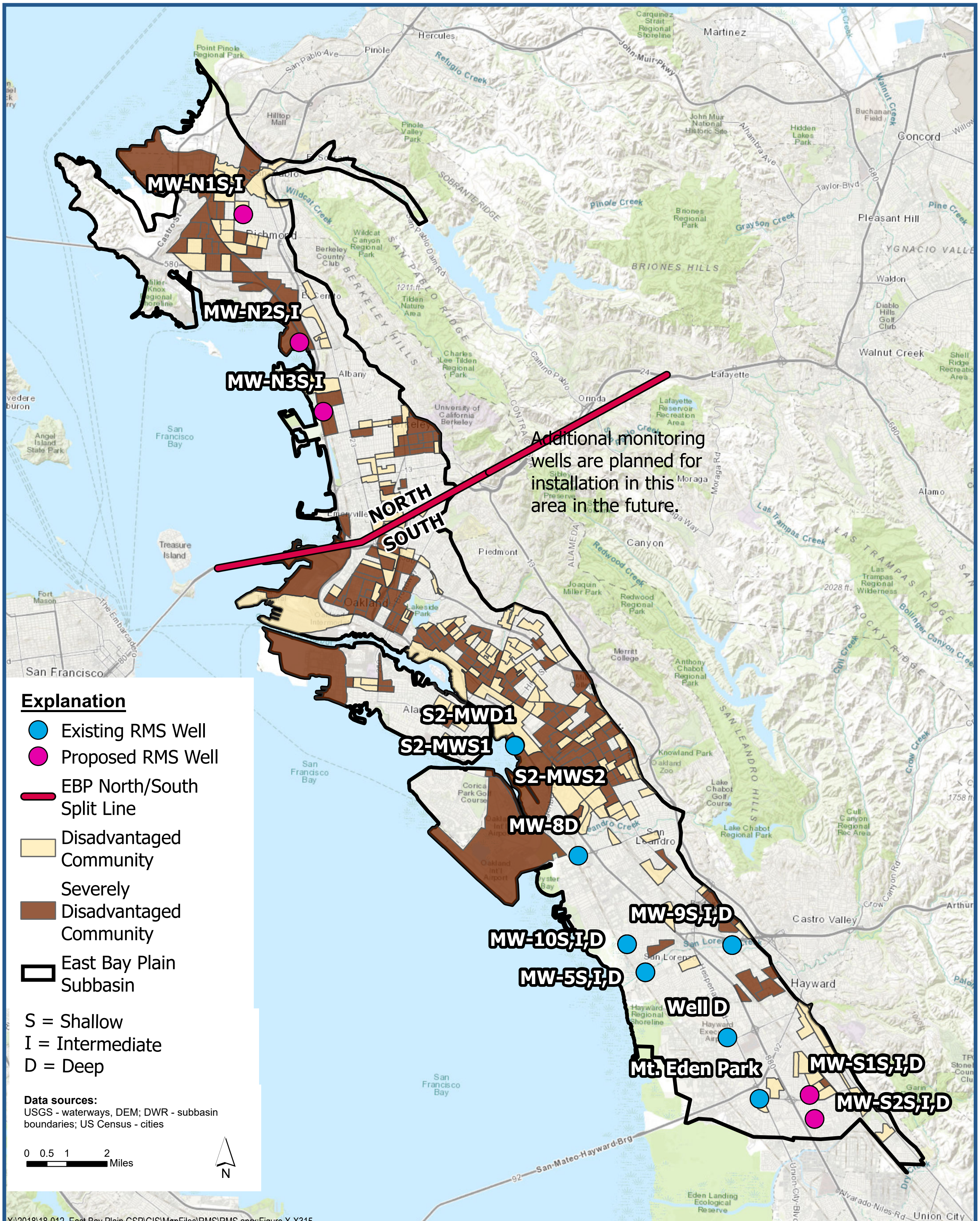


LSCE TEAM

Groundwater Level RMS Wells

Figure 3-1a

East Bay Plain Subbasin
Groundwater Sustainability Plan



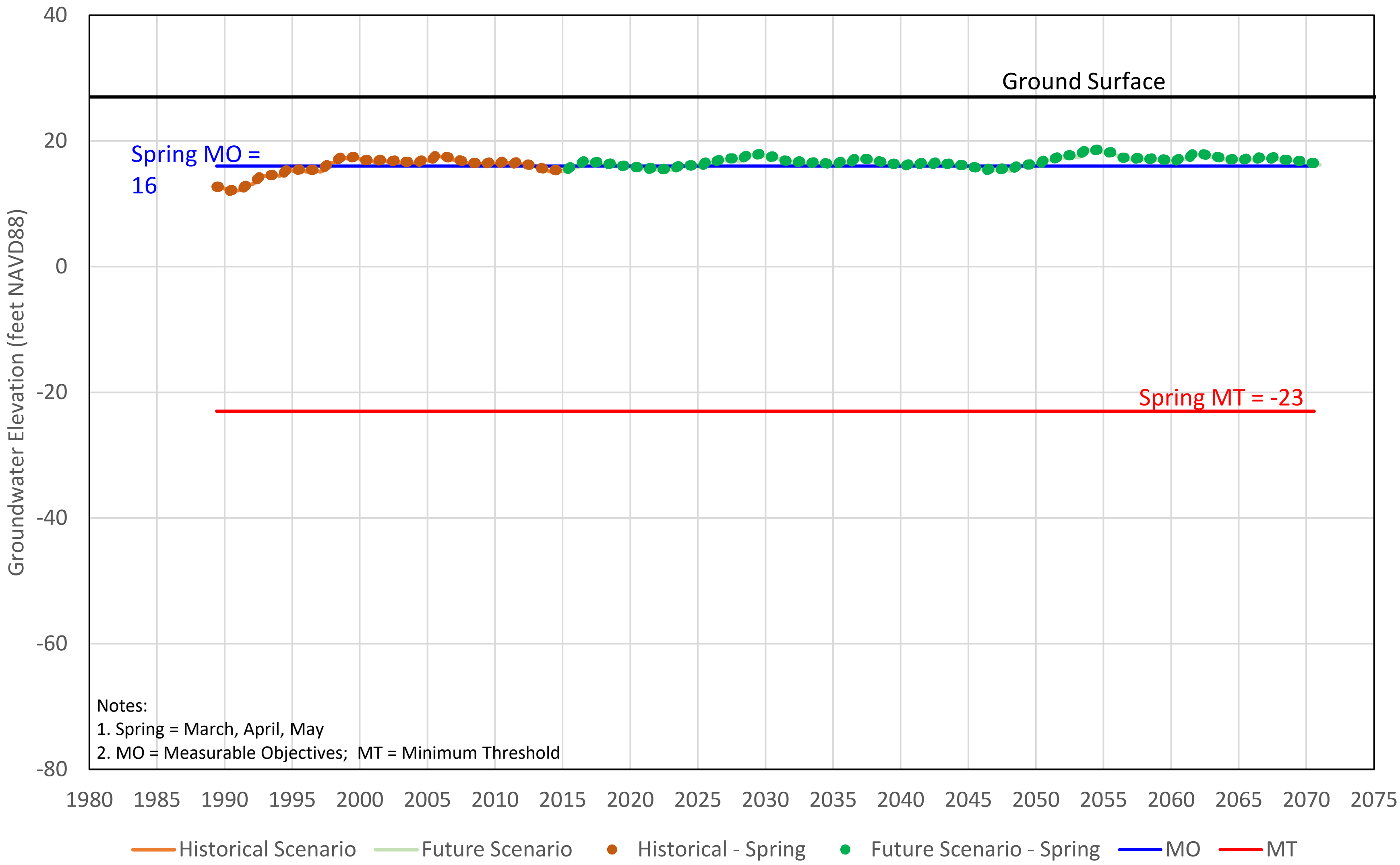
X:\2018\18-012 East Bay Plain GSP\GIS\MapFiles\RMS\RMS.aprx Figure X-X315

LSCE TEAM

Groundwater Level RMS Wells and SDACs/DACs

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-1b

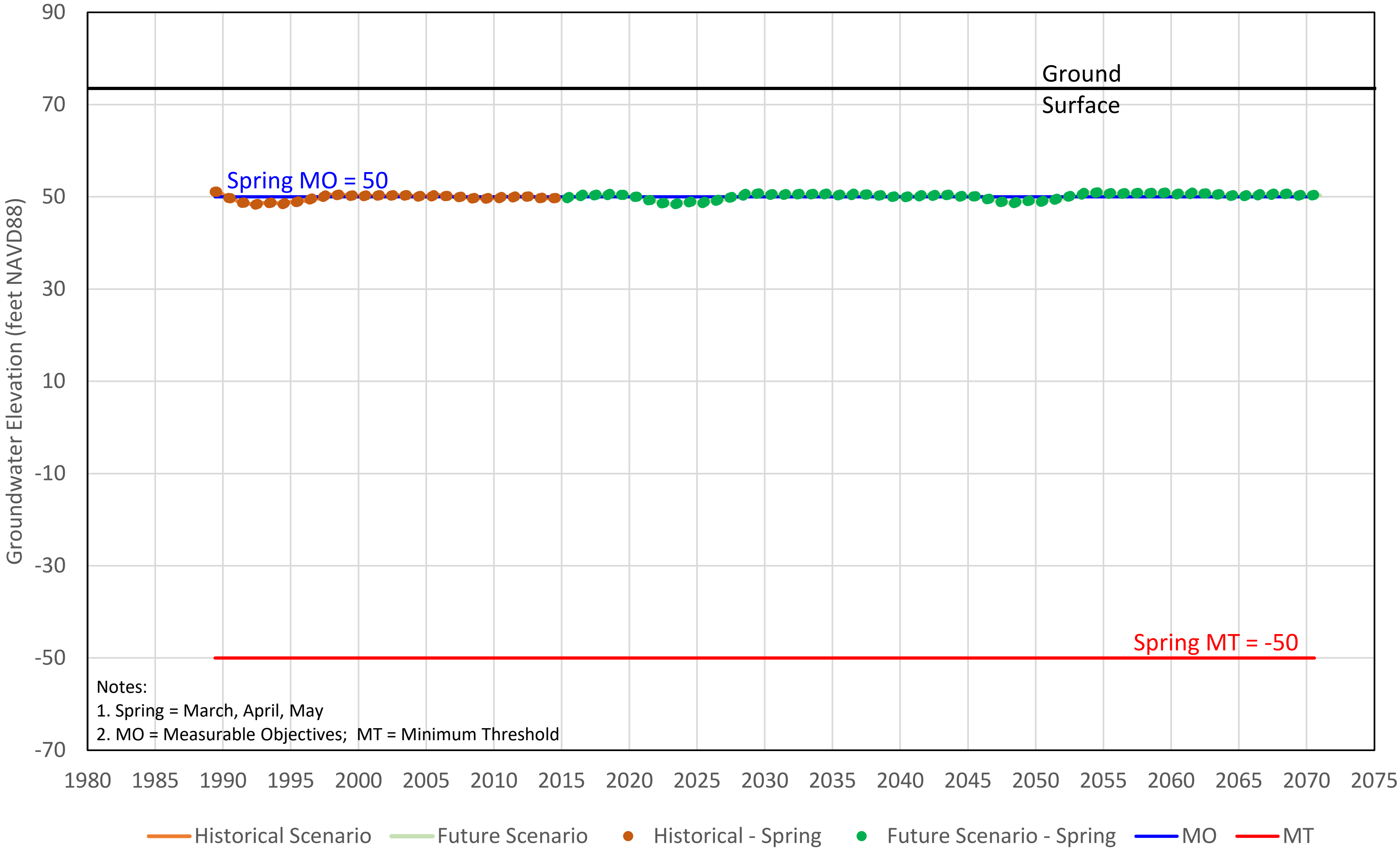


LSCE TEAM

MW-S1S Groundwater Level SMC Hydrograph

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-2

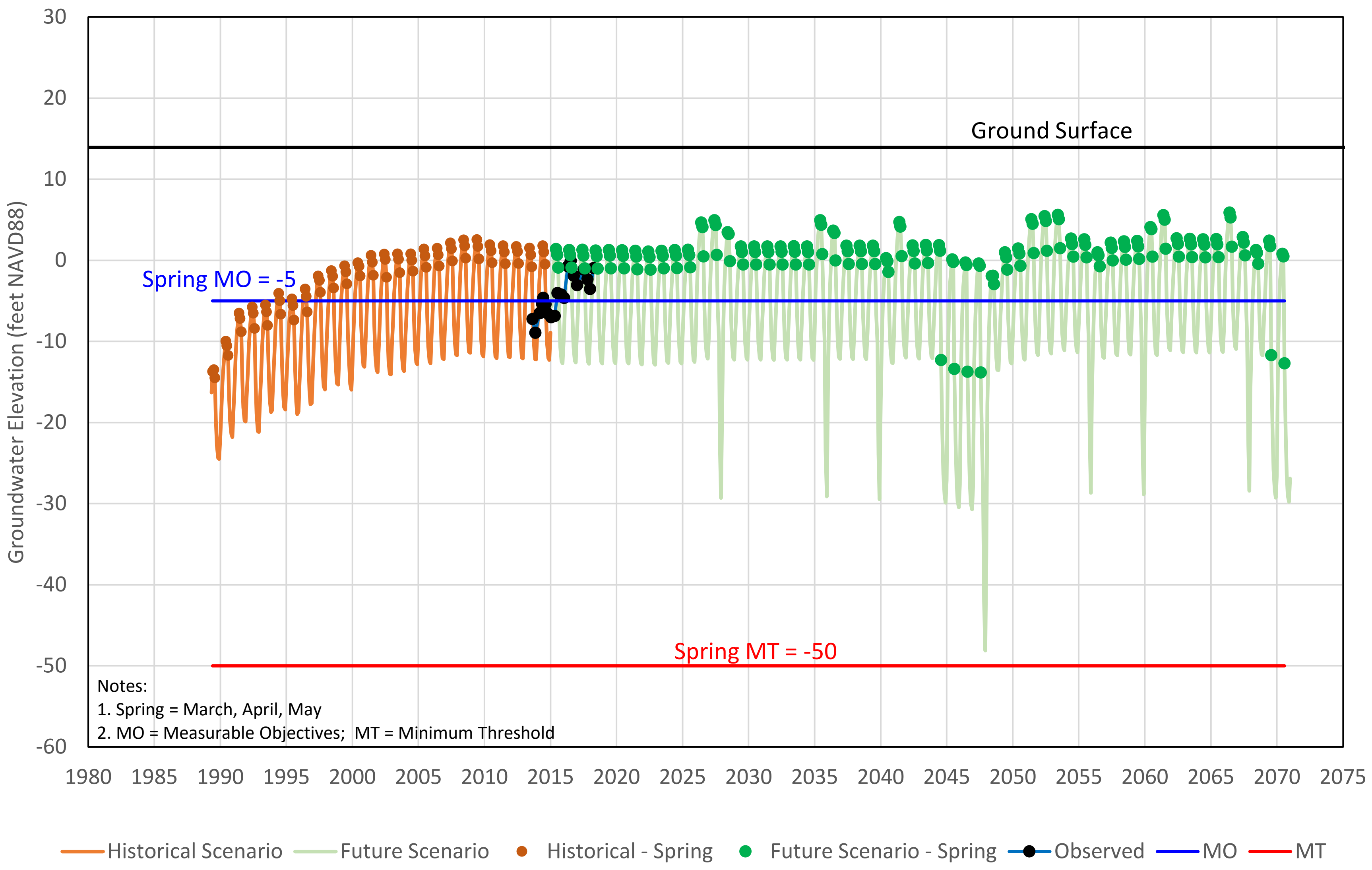


LSCE TEAM

MW-N1I Groundwater Level SMC Hydrograph

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-3

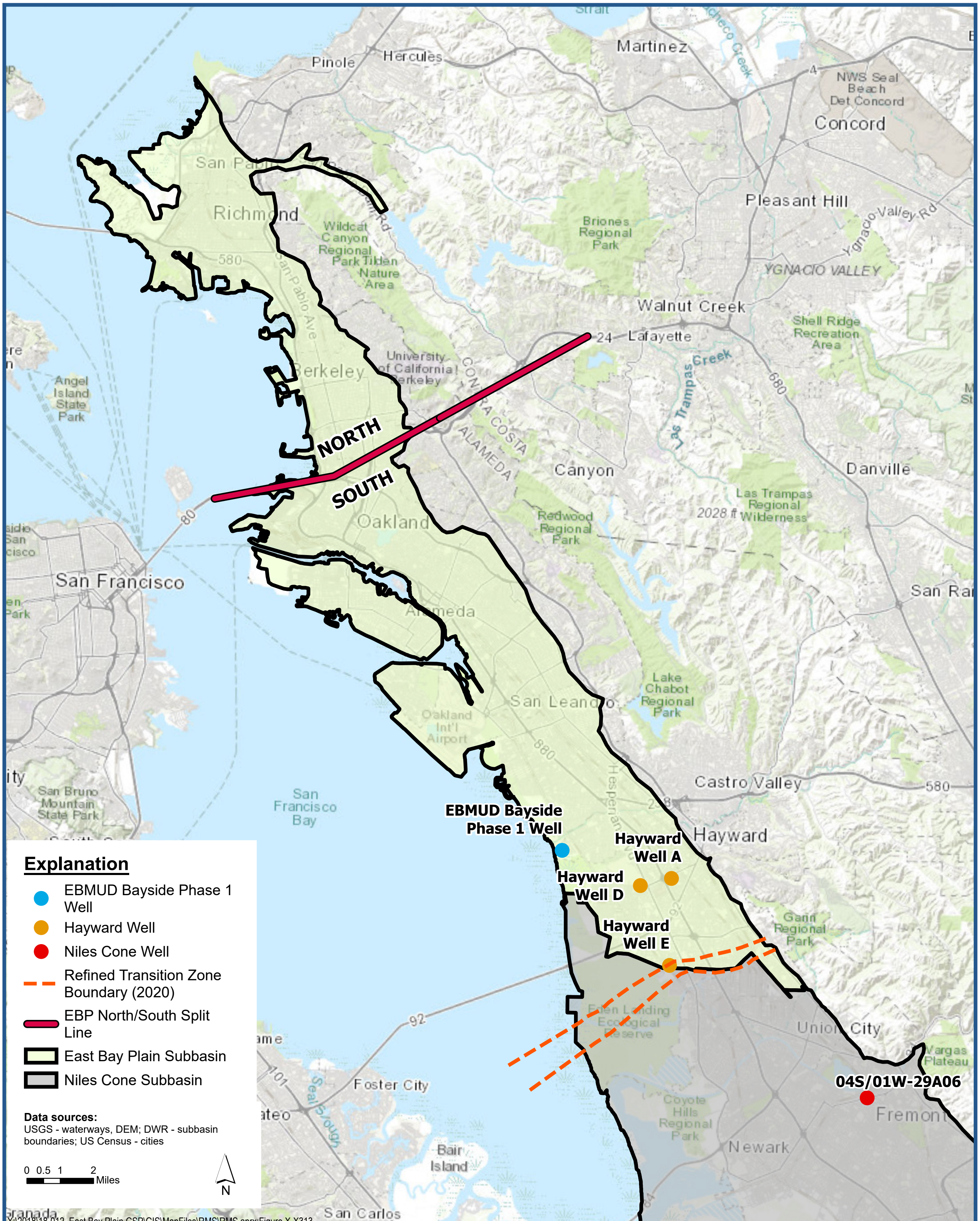


LSCE TEAM

MW-5D Groundwater Level SMC Hydrograph

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-4

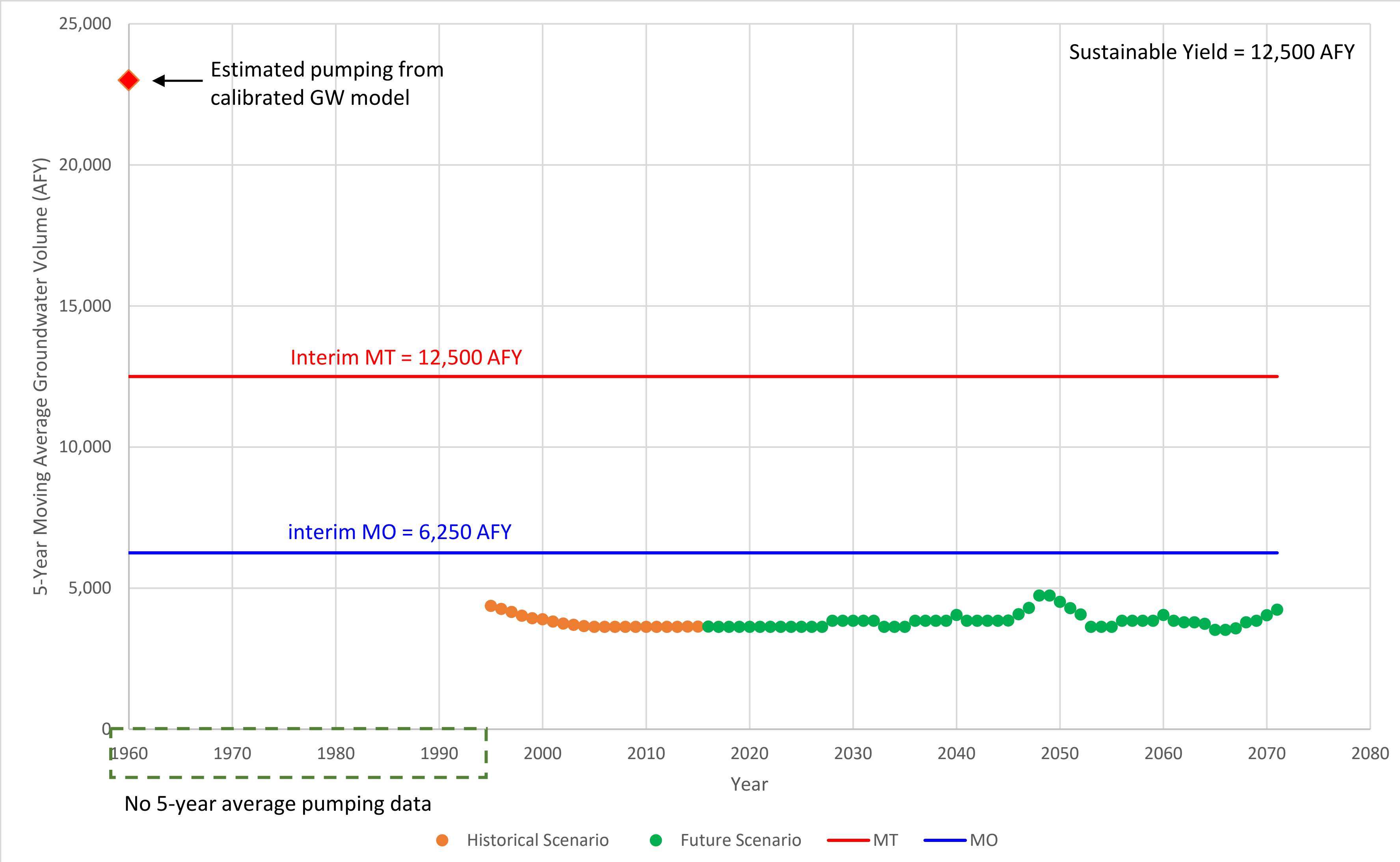


LSCE TEAM

Potential Impacts to Adjacent Subbasins

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-5

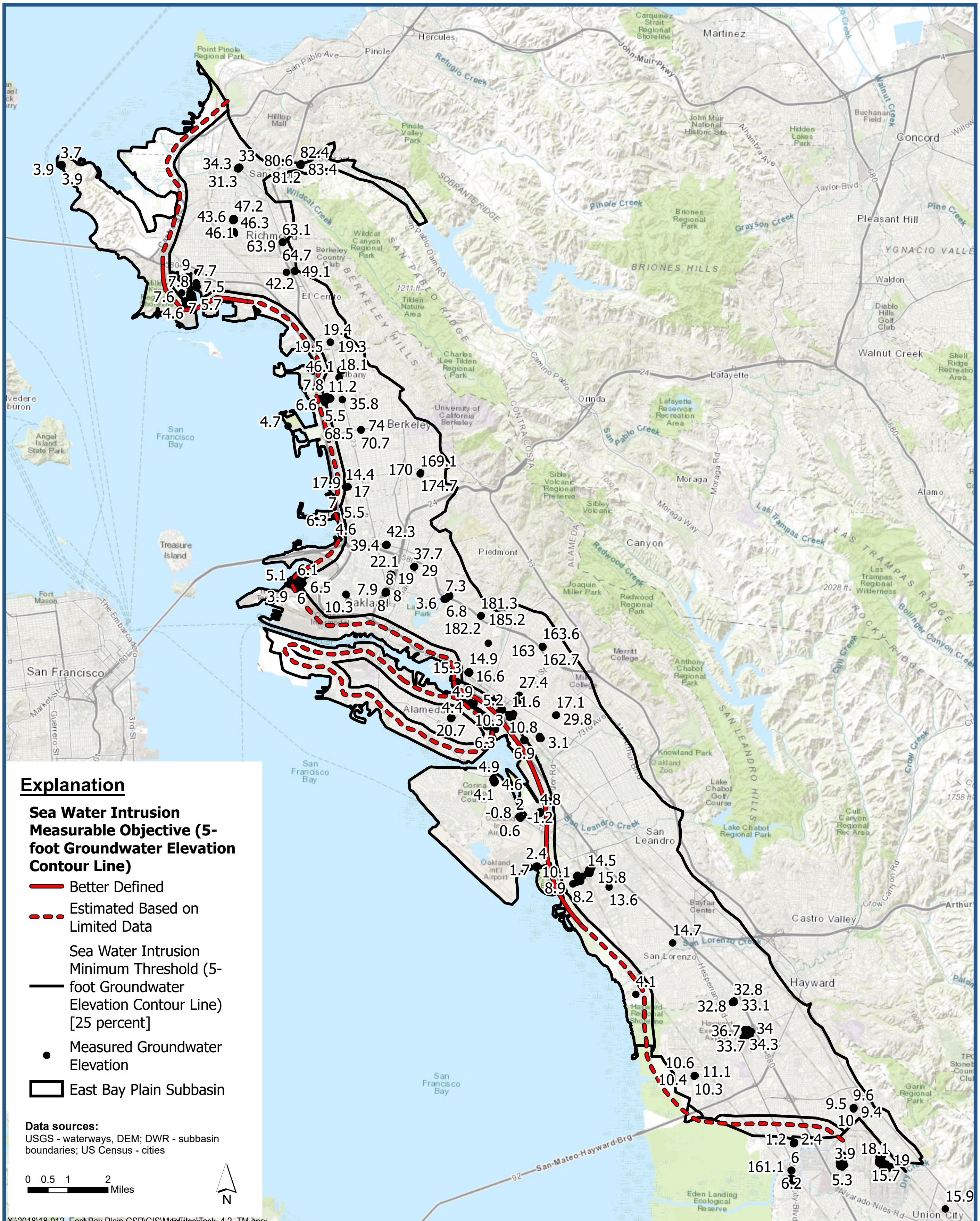


LSCE TEAM

Groundwater Storage Minimum Threshold

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-6

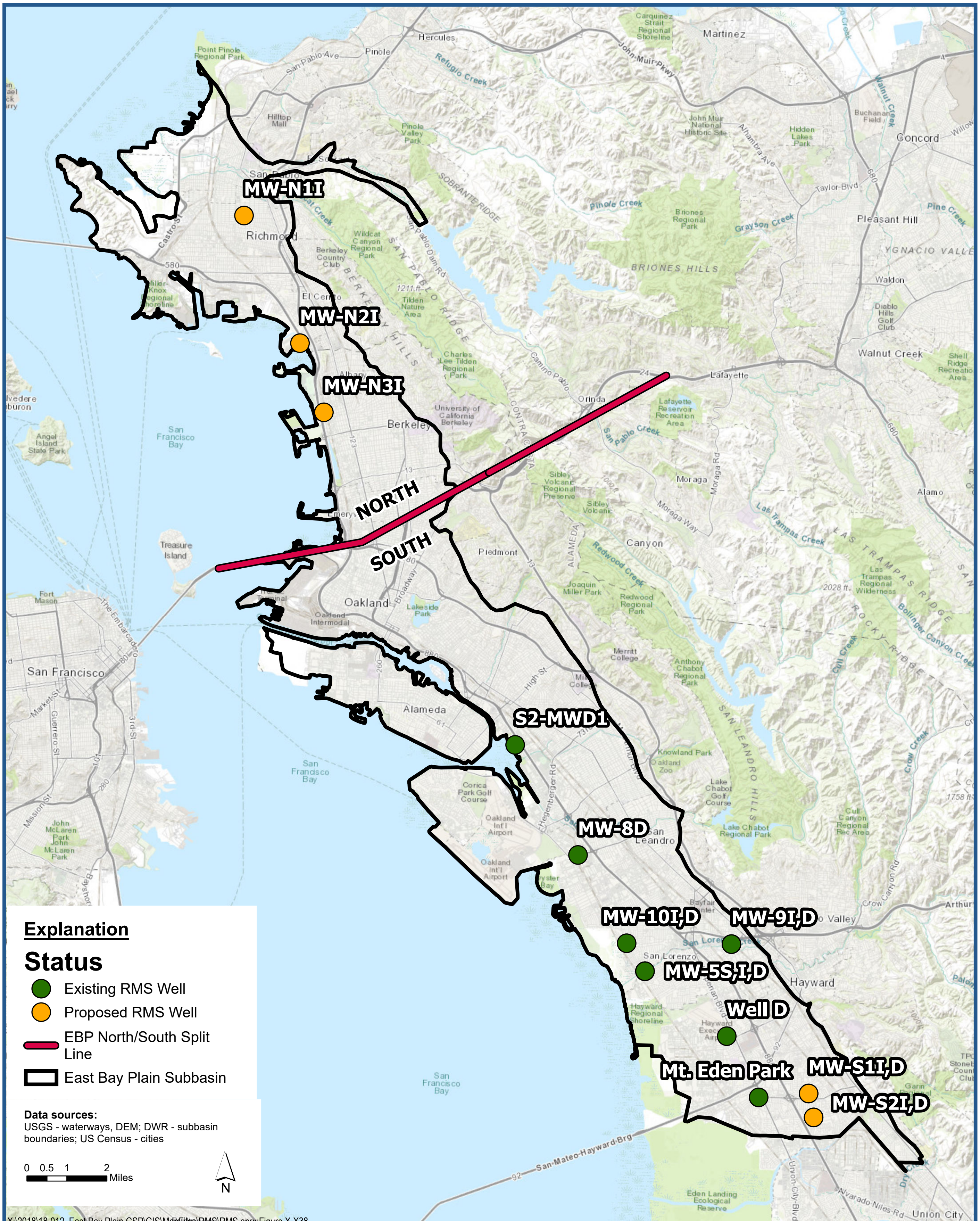


Seawater Intrusion Minimum Threshold and Measurable Objective

East Bay Plain Subbasin
Groundwater Sustainability Plan

LSCE TEAM

Figure 3-7



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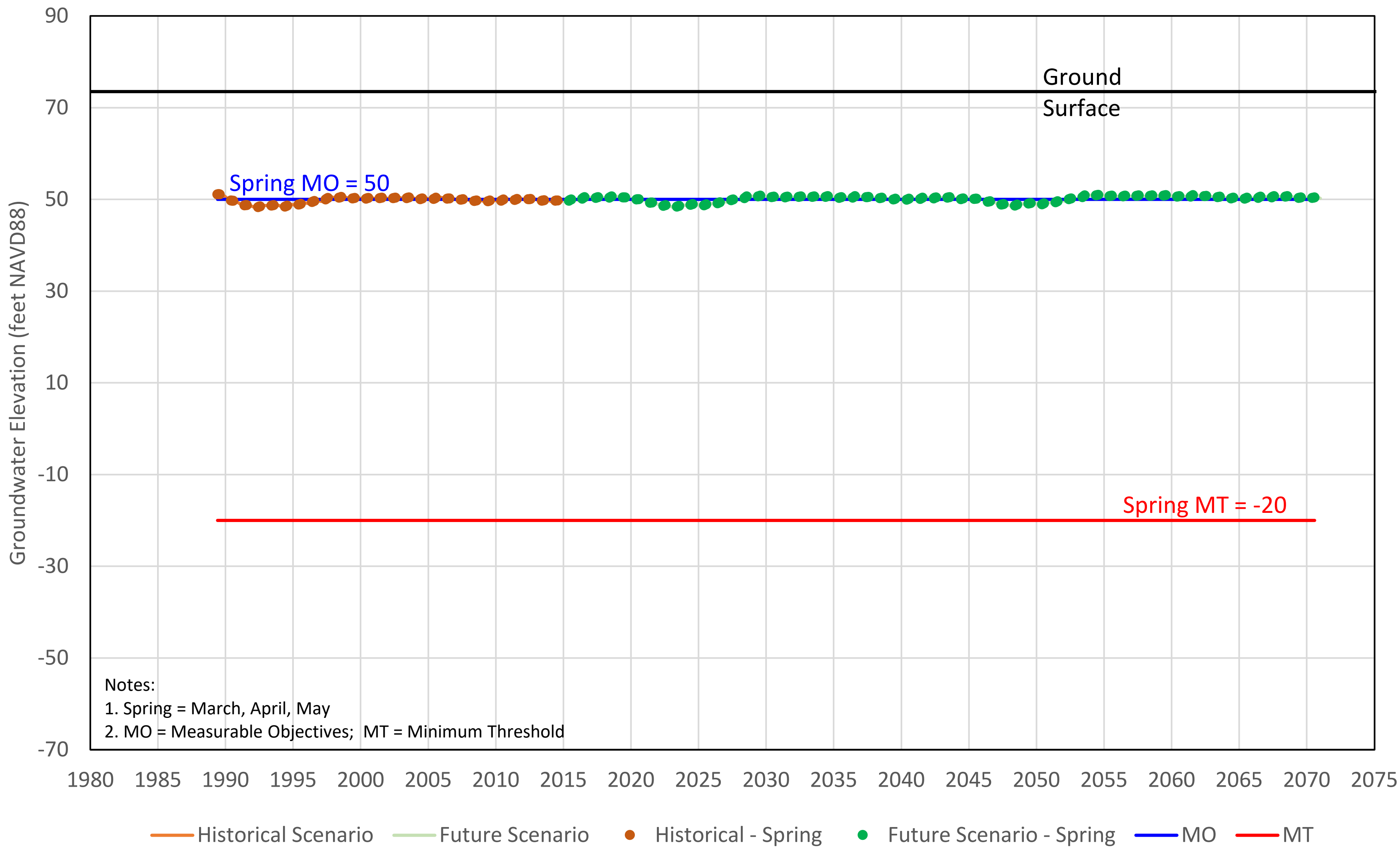
Land Subsidence RMS Wells

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-8

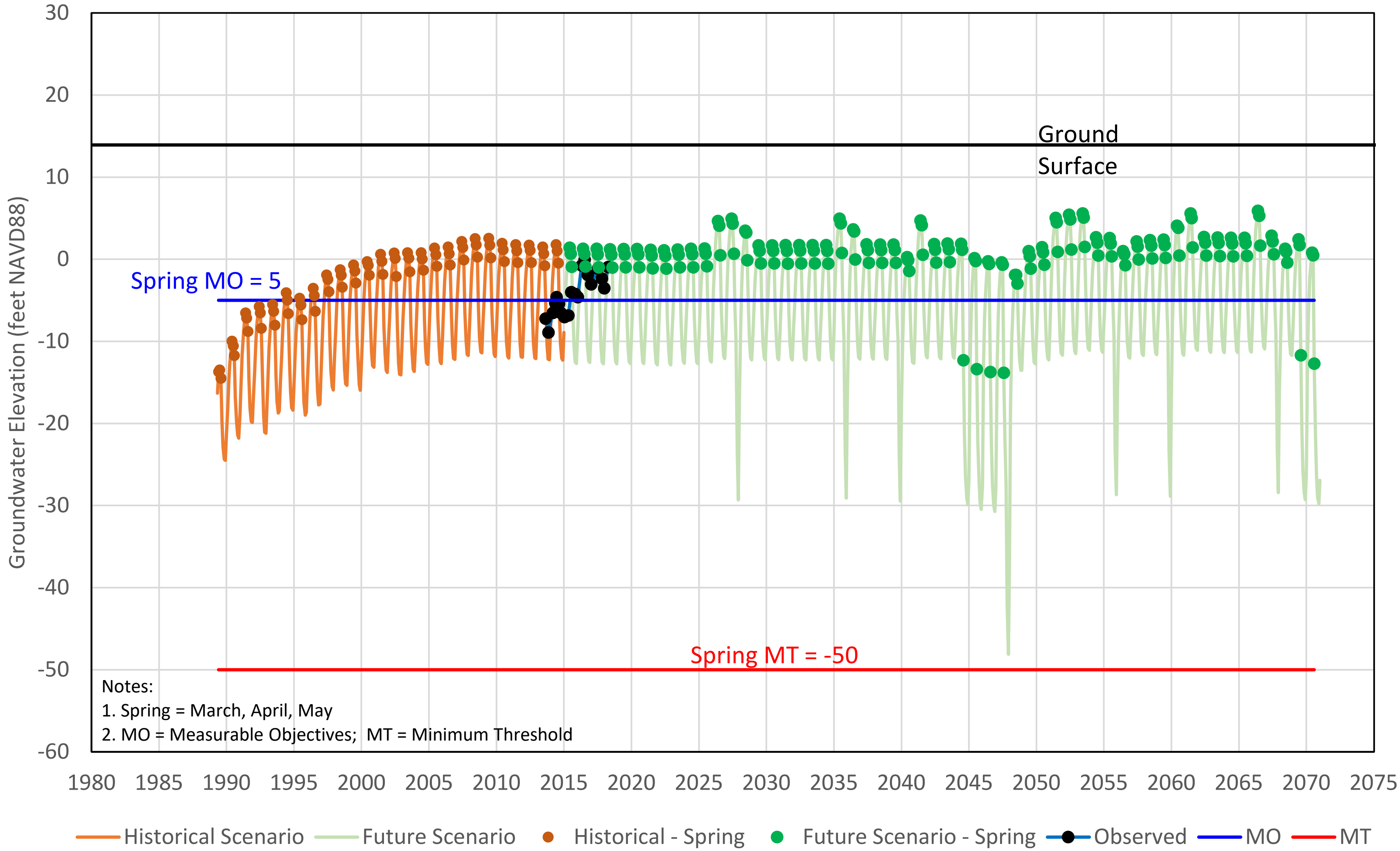


LSCE TEAM

MW-N1I Subsidence Hydrograph

East Bay Plan Subbasin
Groundwater Sustainability Plan

Figure 3-9



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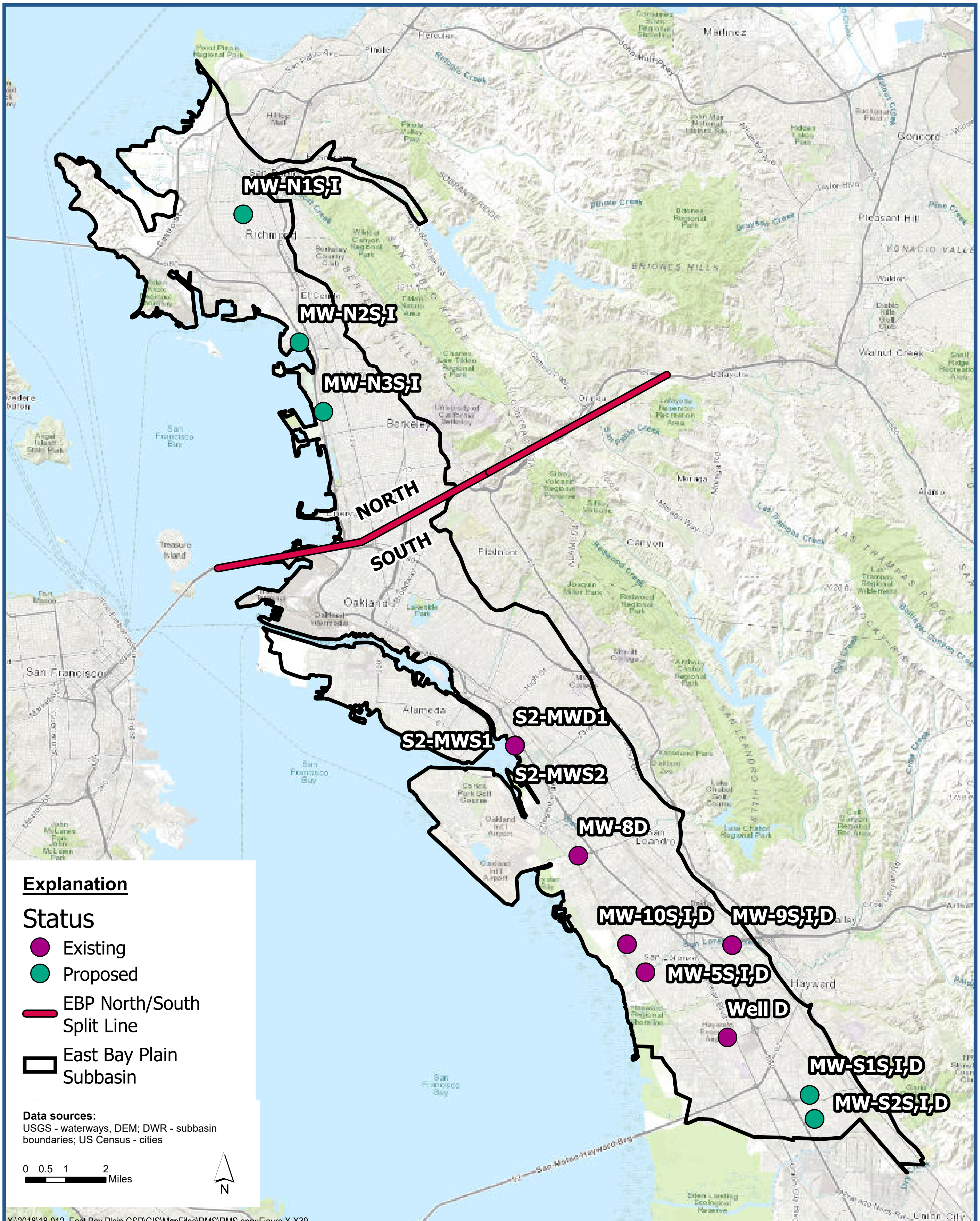
MW-5D Subsidence Hydrograph

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-10

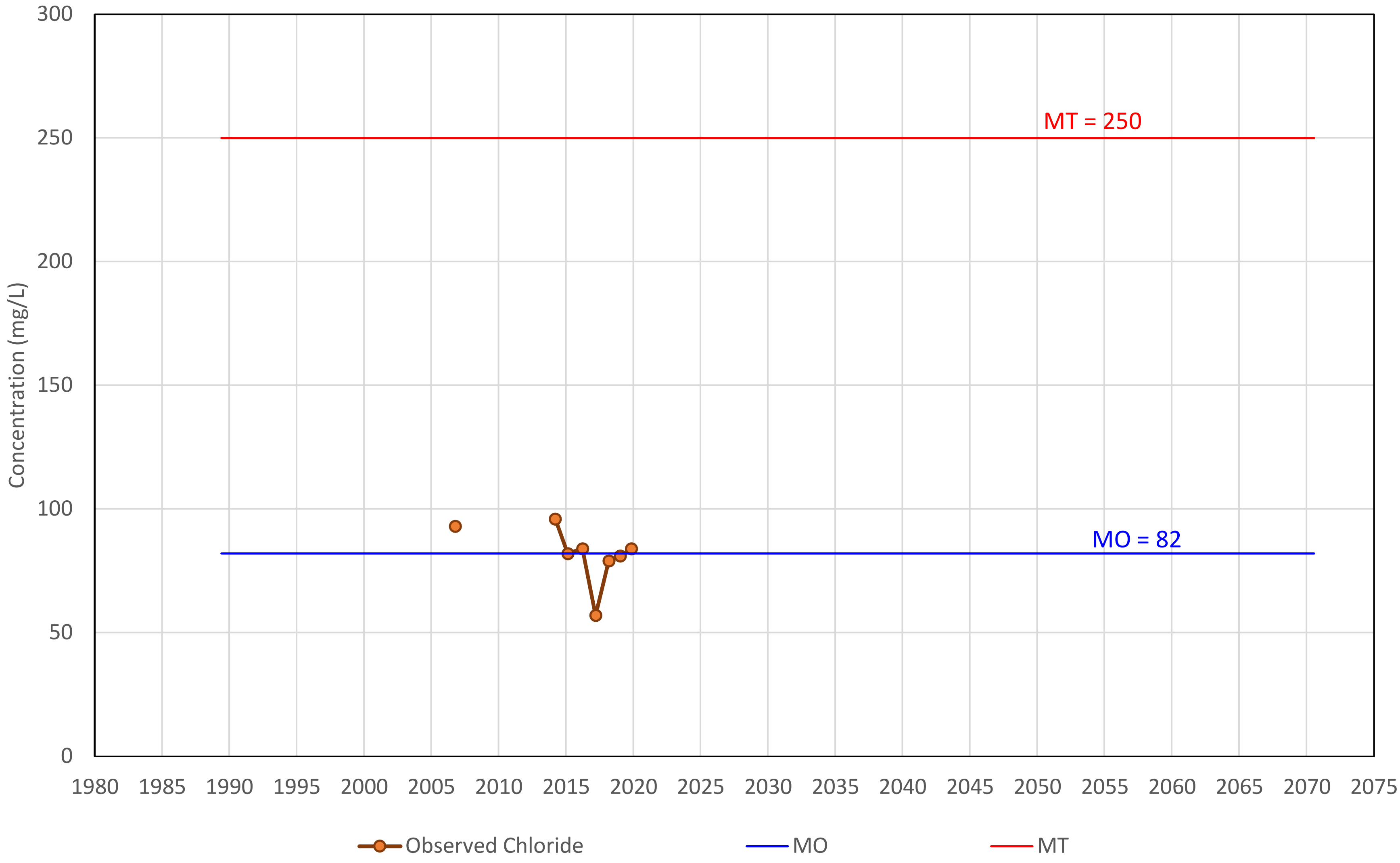


LSCE TEAM

Groundwater Quality RMS Wells

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-11



LSCE TEAM

MW-5D Groundwater Quality SMC Time Series Plot for Chloride

East Bay Plain Subbasin
Groundwater Sustainability Plan

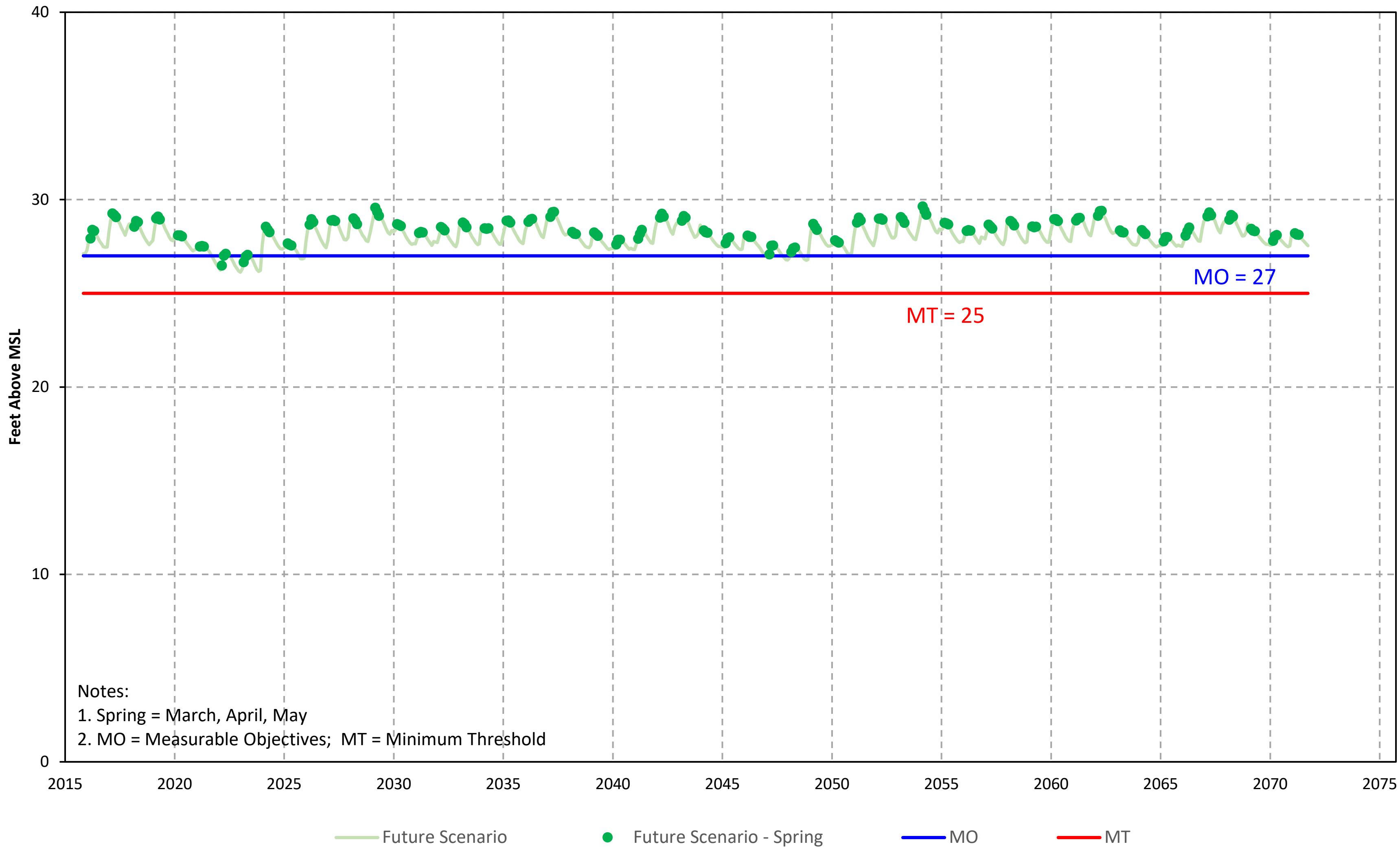
Figure 3-12

LSCE TEAM

Stream Depletion RMS Location Map

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-13

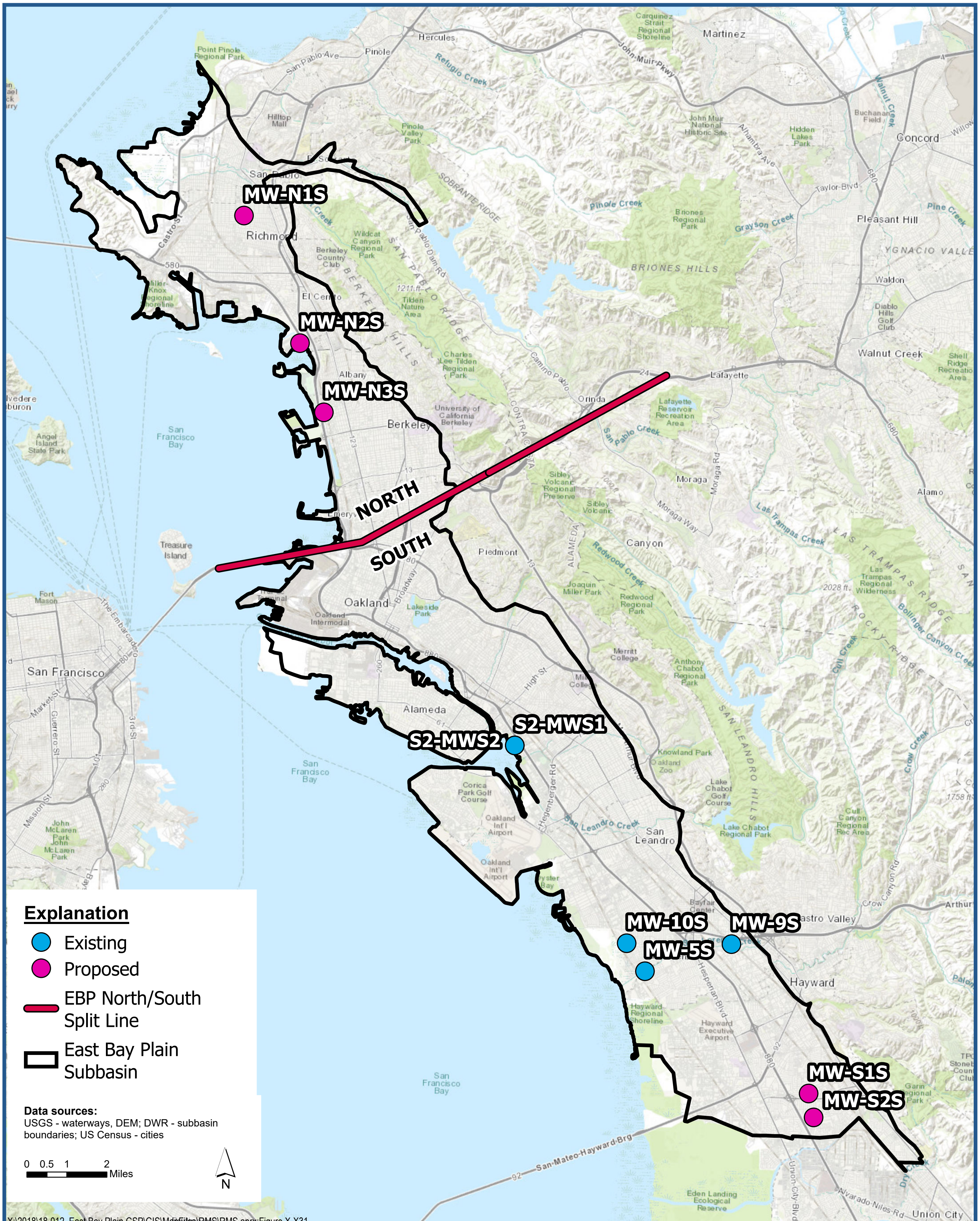


LSCE TEAM

SPC-1 SMC Hydrograph

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-14

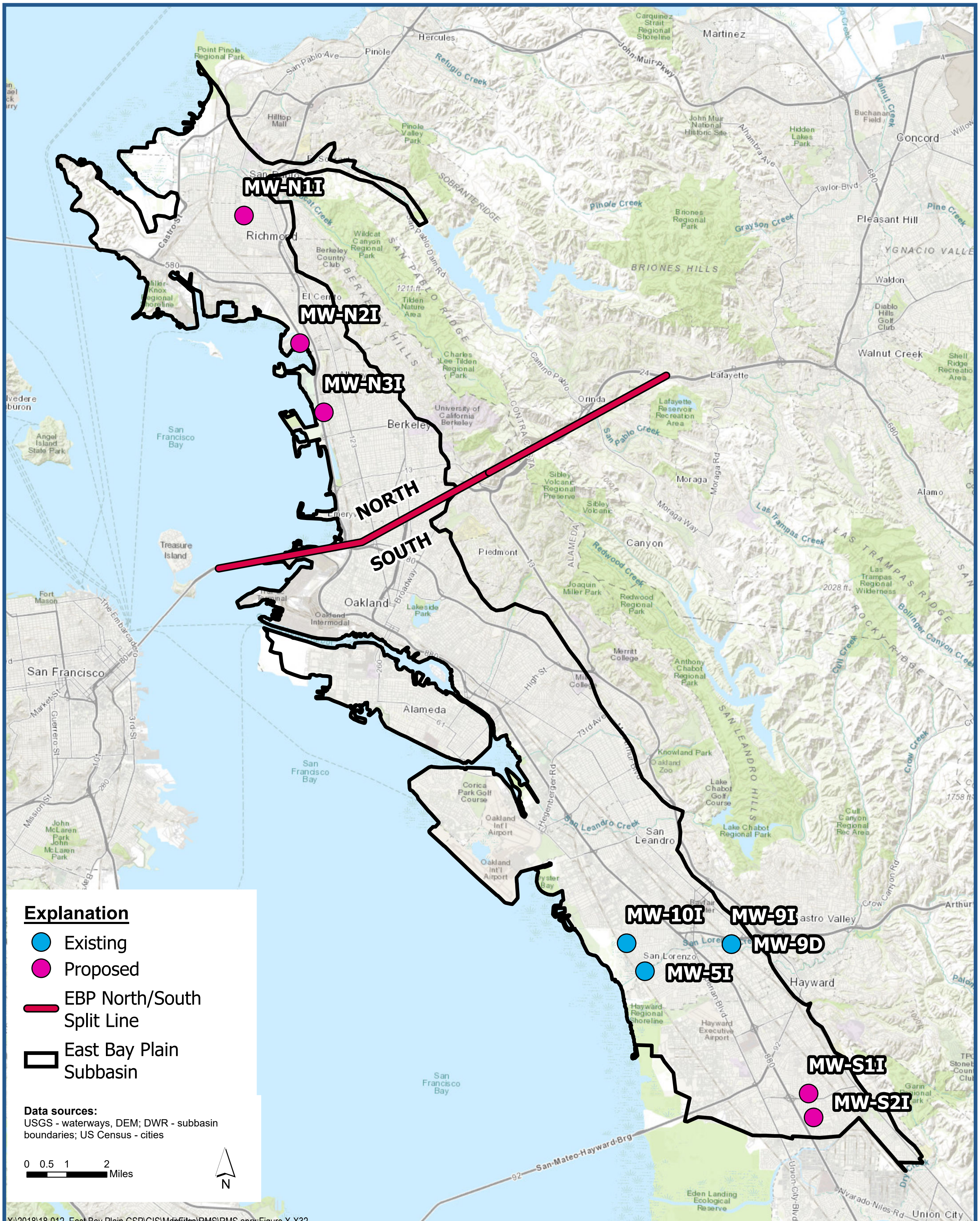


LSCE TEAM

Shallow Aquifer Groundwater Level RMS Wells

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-15

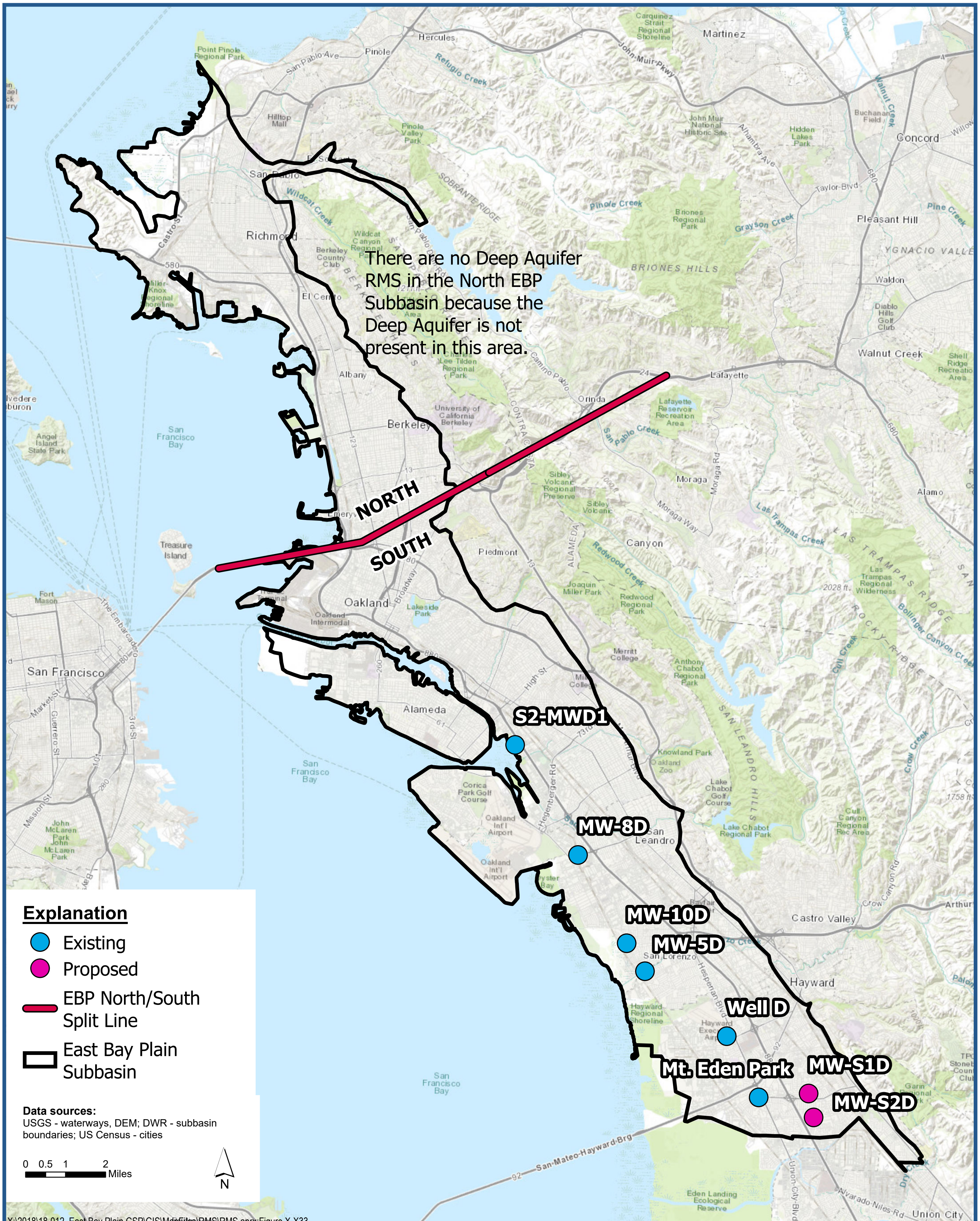


LSCE TEAM

Intermediate Aquifer Groundwater Level RMS Wells

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-16



LSCE TEAM

Deep Aquifer Groundwater Level RMS Wells

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 3-17

JANUARY 2022

EAST BAY PLAIN SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN
CHAPTER 4 – PROJECTS AND MANAGEMENT ACTIONS

PREPARED FOR

East Bay Municipal Utility District GSA and
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LSCE TEAM

4. SUBBASIN PROJECTS AND MANAGEMENT ACTIONS

(California Code of Regulations) [CCR] Title 23, Section 354.42)

This chapter describes the proposed projects and management actions necessary to maintain sustainability goals and measurable objectives while avoiding undesirable results for the East Bay Plain (EBP) Subbasin. The detailed discussion of SMC for each of the sustainability indicators in Chapter 3, including graphics for individual RMS wells in the appendices, demonstrates how undesirable results are avoided with implementation of the projects and management actions described in this chapter.

The project and management actions are described in accordance with of CCR Title 23 Sections 354.42 and 354.44 and are described separately for each GSA since each GSA will implement the projects and managements actions within the portion of the EBP Subbasin underlying its service area (see Chapter 1). A general description of anticipated projects and management actions and the associated costs are presented in **Tables 4-1 and 4-2,** while **Table 4-3** further summarizes the total gross benefits and costs of the projects developed for each GSA.

The GSAs are committed to maintaining sustainability within the EBP Subbasin, and the proposed projects and management actions reflect the GSA's desire to fill data gaps and let science-based decision-making drive the feasibility of additional future groundwater pumping.

4.1 EBMUD GSA Projects and Management Actions

(CCR Title 23, Section 354.44)

The proposed projects and management actions within the EBP Subbasin underlying EBMUD's service area reflect EBMUD's desire to maintain sustainability with the EBP Subbasin, fill known data gaps, and let science-based decisions drive the feasibility and size of future groundwater projects. Consequently, only EBMUD's Bayside Phase 1 facility is proposed for implementation, while the proposed management actions will fill data gaps, monitor the EBP Subbasin, and allow EBMUD to evaluate whether three potential future projects (Additional Bayside Phase(s), Irrigation with Groundwater, and Chabot Recovery) are feasible. EBMUD's plans for financing proposed projects and management actions, along with coordination with other GSAs, is also presented.

4.1.1 EBMUD's Bayside Phase 1

Construction of the Bayside Groundwater Project Phase 1 facilities was completed in 2010 (**Figure 4-1**), with construction of a facility that enables EBMUD to inject potable drinking water into the deep aquifer of the EBP Subbasin during years with surplus water and also to extract, treat, and use groundwater as a supplemental supply during times of drought. The Phase 1 facility consists of an injection/extraction well, a water treatment plant and pipelines connecting the treatment plant to the well, a subsidence monitoring system, and a network of groundwater monitoring wells. The injection/extraction system uses an approximately 650-foot deep well located on property leased from the Oro Loma Sanitary District in San Leandro. When operated in injection mode, treated water from EBMUD's distribution system is directed through the injection/extraction well into the deep aquifer of the East Bay Plain Subbasin. The injection mode operation will take place during years when surplus water is available for storage. During droughts, water will be extracted and treated to meet all federal and state drinking water standards prior to distribution to customers.

Table 4-1. Existing and Potential Future Projects and Water Sources in the East Bay Plain Subbasin								
GSA	Existing Facilities or Potential Future	Project Type	Estimated Average Annual Operating Cost ($/year)	Project Mechanism	Water Source			
					East Bay Hills Watershed	Tuolumne River Watershed	East Bay Plain Subbasin	Treated Wastewater
EBMUD	Existing	Bayside Phase 1 Injection	$30,000 to $40,000	Increase Recharge	X			
EBMUD	Potential Future	Bayside Phase 2 Injection[1]	TBD[2]	Increase Recharge	X			
EBMUD	Potential Future	Bayside Phase 3 Injection[1]	TBD	Increase Recharge	X			
EBMUD	Existing	Bayside Phase 1 Extraction	$30,000 to $200,000	Expand Dry-Year Water Supply Portfolio			X	
EBMUD	Potential Future	Bayside Phase 2 Extraction[1]	TBD	Expand Dry-Year Water Supply Portfolio			X	
EBMUD	Potential Future	Bayside Phase 3 Extraction[1]	TBD	Expand Dry-Year Water Supply Portfolio			X	
Hayward	Existing	Extraction	$60,000 to $500,000	Emergency Water Supply			X	
Hayward	Potential Future	Extraction	TBD	Expand Dry-Year Water Supply Portfolio			X	
EBMUD	Existing	Recycled Water for Irrigation	See EBMUD Recycled Water Master Plan (2019)	Reduce SW Use and/or GW Pumping				X
EBMUD	Potential Future	Groundwater for Irrigation[1]	TBD	Reduce SW Use			X	
EBMUD	Potential Future	Groundwater for Supplemental Surface Water Flows[1]	TBD	Conserve Reservoir Storage			X	

[1] Implementation of this project will be based on science (i.e., collection of monitoring data with implementation of existing projects, filling data gaps, and additional data analysis).

[2] To Be Determined (TBD) if this potential future project is implemented.

Table 4-2. East Bay Plain Subbasin Management Actions

GSA	Action	First Year of Implementation	Completion Date	Number of Monitoring Stations	Minimum Frequency	Estimated Capital Cost	Estimated 5-Year Operating Costs
EBMUD	RMS[1] GW[2] Level Monitoring	2022	Ongoing	19	Semi-Annual	NA[3]	$72,500
EBMUD	Non-RMS GW Level Monitoring	2022	Ongoing	Additional Evaluation Needed	Semi-Annual	NA	$100,000
EBMUD	RMS GW Quality Monitoring	2022	Ongoing	19	Annual	NA	$110,000
EBMUD	Baseline GW Quality Sampling	2023	2024	19	Semi-Annual	NA	$88,000
EBMUD	Synoptic Stream Monitoring	2023	2030	NA[3]	NA[3]	NA	$75,000
EBMUD	Isotopic Sampling	2024	2024	NA	NA	NA	$100,000
EBMUD	Subsidence Monitoring	2022	Ongoing	2	Continuous	NA	$77,500
EBMUD	Baseline GDE[4]/Biologic Survey	2023	2023	NA	NA	NA	$150,000
EBMUD	Biological Surveys	2023	Ongoing	NA	Every 5 Years	NA	$50,000
EBMUD	Install Shallow RMS Wells Near Creeks	2023	2024	10	NA	$115,000	NA
EBMUD	Monitoring Shallow Wells for GW Levels	2024	Ongoing	10	Semi-Annual	NA	$21,000
EBMUD	Monitoring Shallow Wells for GW Quality	2024	Ongoing	10	Annual	NA	$30,000
EBMUD	Install New Nested Monitoring Wells	2023	2024	3	NA	$400,000	NA
EBMUD	Monitoring New Nested Wells for GW Levels	2024	Ongoing	9	Semi-Annual	NA	$21,000
EBMUD	Monitoring New Nested Wells for GW Quality	2024	Ongoing	9	Annual	NA	$30,000
EBMUD	Install Stream Gages	2024	2024	2	NA	$65,000	NA
EBMUD	Monitor Stream Gages	2024	Ongoing	2	Monthly	NA	$87,500
Hayward	RMS GW Level Monitoring	2022	Ongoing	8	Semi-Annual	NA	$27,500
Hayward	Non-RMS GW Level Monitoring	2022	Ongoing	Additional Evaluation Needed	Semi-Annual	NA	$25,000
Hayward	RMS GW Quality Monitoring	2022	Ongoing	7	Annual	NA	$40,000
Hayward	Baseline GW Quality Sampling	2023	2024	7	Semi-Annual	NA	$32,000
Both	Annual Reporting	2022	Ongoing	NA	Annual	NA	$275,000
Both	GSP Five-Year Updates	2027	Ongoing	NA	Every 5 Years	NA	$250,000
Both	DMS[5]	2022	Ongoing	NA	Annual	NA	$50,000
Both	Update Plume Info	2023	Ongoing	NA	Every 2 Years	NA	$20,000
Both	Fate/Transport Modeling	TBD[6]	TBD	NA	TBD	NA	$100,000

[1] Representative Monitoring Site (RMS)
[2] Groundwater (GW)
[3] Not Applicable (NA), No capital costs associated with this project, or Number of Monitoring Stations/Frequency do not apply to this Action
[4] Groundwater Dependent Ecosystems (GDE)
[5] Data Management System (DMS)
[6] To Be Determined (TBD), need for fate/transport modeling is uncertain/unknown

Table 4-3. Summary of East Bay Plain Subbasin Projects by GSA			
GSA	Gross Average Annual Benefit at Full Implementation	Estimated Capital Cost	Estimated Average Annual Operating Cost
EBMUD	Recharge = 47 AFY; Extraction = 134 AFY; Net Extraction = 87 AFY; Average Annual over 50 years	\$0[1]	\$30,000 to \$200,000[2]
Hayward	Extraction = 1,062 AFY (in years when operated)	\$0[1]	\$60,000 to \$500,000
Total	**Recharge = 47 AFY; Extraction = 134 AFY + 1,062 AFY in Years Hayward Emergency wells operate[3]**		

[1] Project is already built and does not have additional future capital costs.

[2] Average estimated annual operating costs are \$30,000/year with no injection/extraction operations; \$40,000/year with injection operations; and \$200,000/year with extraction operations.

[3] EBMUD recharge is 196 AFY in the years for which injection occurs or 47 AFY on average over 50 years based on an assumed 12 years of operation during that 50-year period; EBMUD extraction is 1,120 AFY in years for which extraction occurs or 134 AFY on average over 50 years based on an assumed 6 years of operation during that 50-year period; Hayward Emergency wells extraction is 1,062 AFY for years in which an emergency is declared and Hayward wells would operate.

4.1.1.1 Historical Operations

Bayside Phase 1 is operated in accordance with General Waste Discharge Requirements (WDR) of Order No. R2-2007-0038, adopted by the San Francisco Regional Water Quality Control Board (RWQCB) on May 9, 2007. In accordance with permit requirements, the annual reports include groundwater level and quality measurements and injection and extraction amounts each year.

The Bayside Phase 1 Well has an operational injection capacity of approximately 0.35 MGD and an extraction capacity of 2 MGD. Between 2009 – 2011, a total of about 29 million gallons of potable water was injected into the Deep Aquifer of the EBP Subbasin as part of startup testing of the facility (**Table 4-4**). Between 2017 - 2019, a total of about 18 million gallons of potable water was injected as shown in **Table 4-4**. Injection of water into the Bayside Phase 1 Well can only occur during years when surplus water is available, if pre-1914 water is available from the San Leandro Creek watershed, and if EBMUD's Upper San Leandro Water Treatment Plant is operational and in use at the time of injection. The extraction volumes from 2009 to 2020 were relatively minor, ranging from 4,545,000 to 113,000,000 gallons per year. However, as shown in **Table 4-4**, since conducting startup testing of the facility in 2009 and a pump test in 2010, no extraction has occurred except for groundwater sampling and maintenance operation. EBMUD still needs to obtain a drinking water permit before piloting extraction for use in EBMUD's distribution system.

Table 4-4. Summary of Historical Bayside Phase 1 Well Operations

Year	Extraction (gallons)	Injection (gallons)	Comments
2009	4,545,000	445,000	Startup Testing
2010	113,000,000	0	Aquifer Test: Extraction from August 4 to September 29 associated with regional aquifer test at continuous pumping rate of 1,400 gpm (2.0 MGD).
2011	0	28,432,401	Startup testing injection occurred from June 1 to August 1; average rate of injection was 318 gpm (0.459 MGD).
2012	0	0	
2013	0	0	
2014	0	0	
2015	0	0	
2016	0	0	
2017	0	1,310,000	Injection occurred from February 10 to February 15 at rates ranging from 160 to 250 gpm (0.216 to 0.360 MGD).
2018	0	8,340,000	Injection occurred from October 9 to November 1 at an average rate of 252 gpm (0.363 MGD).
2019	0	8,390,000	Injection occurred from November 18 to December 11 at an average rate of 253 gpm (0.365 MGD).
2020	0	0	
Total	**117,545,000**	**46,917,401**	

4.1.1.2 Project Benefits, Planned Injection, and Planned Extraction Operations

For evaluation purposes in the GSP only, it was assumed EBMUD will begin implementing the Bayside Phase 1 project in 2022, where injection only occurs when surplus water is available, which for the purposes of this evaluation is assumed to occur for each year defined as a wet year, and extraction in the third (and any subsequent) year of a drought for a period of up to 6 months. EBMUD expects that the project will be operated in approximately one out of every three years on average for either injection or extraction over the long term (i.e., 50 years or more).

Injection wells provide groundwater benefits by recharging the EBP Subbasin when surface water is abundant. The estimated project benefits developed for the GSP are based on representative average hydrologic conditions. Based on a hydrologic and operations analysis covering the future 50-year period from 2022 to 2071, and the resulting frequency and rate of injection expected, the average annual net recharge benefit for the existing Bayside well would be 47 AFY as a 50-year annual average. The benefit in a year in which injection occurs is 196 AF. The reliability of source water is based on historical hydrology being a good projection of future hydrology. **Table 4-5** summarizes the estimated annual net recharge benefit, expected probability of water year type, and the weighted-average annual recharge for the injection well.

Table 4-5. EBMUD Bayside Phase 1 Well Average Injection Recharge			
Year Type	Total Annual Volume (AF)	% of Years	Weighted Average Volume (AFY)
Wet (Surplus water available)	196	24%	47
Average	0	40%	0
Drought	0	36%	0
Average Annual			**47**

Extraction will help make EBMUD's overall water supply portfolio during droughts more diversified and resilient. Based on a hydrologic and operations analysis covering the future 50-year period from 2022 to 2071 and the resulting frequency and rate of extraction expected, the average annual net extraction benefit for the existing Bayside well would be 134 AFY as a 50-year annual average. The benefit in a year in which extraction occurs is 1,120 AF. The reliability of source water is based on historical hydrology being a good projection of future hydrology. **Table 4-6** summarizes the estimated annual net extraction benefit, expected probability of water year type, and the weighted-average annual water supply from the extraction well.

The EBP Subbasin is not overdrafted, and current groundwater pumping is a relatively small fraction of estimated sustainable yield. Implementation of this project is consistent with meeting measurable objectives, avoiding the exceedance of minimum thresholds, and avoiding undesirable results for all six sustainability indicators. There will be notice provided to the public and other agencies regarding possible future implementation of other EBMUD GSP projects through GSA stakeholder outreach (e.g., website postings, meetings, press releases), and the California Environmental Quality Act (CEQA) process.

Table 4-6. EBMUD Bayside Phase 1 Well Average Extraction			
Year Type	Total Annual Volume (AF)	% of Years	Weighted Average Volume (AFY)
Wet (Surplus water available)	0	24%	0
Average	0	40%	0
First/Second Year in Drought	0	24%	0
Third Year or later in Drought	1,120	12%	134
Average Annual			**134**

4.1.1.3 Water Source

Water for injection during years when surplus water is available will be obtained from pre-1914 waters from San Leandro Creek watershed either through direct diversion or withdrawal from previously collected pre-1914 waters in Upper San Leandro Creek Reservoir. Water for extraction will be derived from the Deep Aquifer in the EBP Subbasin. Some of the water extracted from the Deep Aquifer will have been sourced from surface water supply from the San Leandro Creek watershed injected into the Deep Aquifer. The remaining water extracted from the Deep Aquifer will be derived from native/local recharge in the EBP Subbasin.

4.1.1.4 Project Costs

Future costs relate only to ongoing annual maintenance and operation costs, which are estimated at $30,000 (years with no extraction) to $200,000 per year (years with extraction).

4.1.2 Management Actions

EBMUD GSP management actions (MA or actions) include a number of items to address sustainable groundwater management of EBP Subbasin. These actions can be grouped into broad categories that include monitoring, construction of new monitoring facilities, special studies, biological surveys, GSP reporting, and other actions. These actions will help fill existing data gaps and facilitate ongoing sustainable management in the EBP Subbasin in accordance with this GSP. These actions are described in more detail in this section.

4.1.2.1 Management Actions Overview

The MA to be conducted by EBMUD are summarized in **Table 4-7**, along with estimated capital costs and annual operating costs. In some cases (e.g., Five-Year GSP Update Report), costs are incurred in one year but are spread out over time to derive the reported average annual operating cost in **Table 4-7**. More detailed estimated costs by year are provided in **Appendix 4.B**.

4.1.2.1.1 Monitoring

The RMS wells in the groundwater level monitoring network are shown on **Figure 3-1**. The costs for RMS groundwater level monitoring includes both existing RMS wells and RMS wells planned for construction under a DWR Proposition 68 grant that are anticipated to be completed by the end of 2022. Most of these wells have (or will have) transducers installed for automated water level monitoring, and semi-annual manual measurements and transducer downloads will be conducted as part of this action. In addition to RMS groundwater level monitoring wells, a broader network of groundwater level monitoring wells (non-RMS wells) is being investigated for inclusion in the overall monitoring network (**Appendix 3.G**). Non-RMS wells being investigated include current CASGEM wells that are not RMS wells, Port of Oakland monitoring wells, and EBMUD monitoring wells that are not currently CASGEM or RMS wells. The current status of Port of Oakland wells is unknown and will require further coordination and investigation with the Port of Oakland. It is anticipated that the initial network of non-RMS wells to be included in the broader GSP monitoring network will be established by the end of 2023.

Table 4-7. EBMUD EBP Subbasin Management Actions

Project	First Year of Implementation	Completion Date	Number of Monitoring Stations	Minimum Frequency	Estimated Capital Cost	Estimated Five-Year Costs
Monitoring Actions						
RMS[1] GW[2] Level Monitoring	2022	Ongoing	19	Semi-Annual	NA[3]	$72,500
Non-RMS GW Level Monitoring	2022	Ongoing	TBD[4]	Semi-Annual	NA	$100,000
RMS GW Quality Monitoring	2022	Ongoing	19	Annual	NA	$110,000
Baseline GW Quality Sampling	2023	2024	19	Semi-Annual	NA	$88,000
Subsidence Monitoring	2022	Ongoing	2	Daily	NA	$77,500
Synoptic Stream Monitoring	2023	2030	NA[5]	NA[5]	NA	$75,000
Construction of New Monitoring Facilities						
Install Shallow RMS Wells Near Creeks	2023	2024	10	NA	$115,000	$115,000
Monitoring Shallow Wells for GWL	2024	Ongoing	10	Semi-Annual	NA	$21,000
Monitoring Shallow Wells for GWQ	2024	Ongoing	10	Annual	NA	$30,000
Install Stream Gages	2024	2024	2	NA	$65,000	$65,000
Monitor Stream Gages	2024	Ongoing	2	Monthly	NA	$87,500
Install New Nested Monitoring Wells	2023	2024	3	NA	$400,000	$400,000
Monitoring New Nested Wells for GWL	2024	Ongoing	9	Semi-Annual	NA	$21,000
Monitoring New Nested Wells for GW Quality	2024	Ongoing	9	Annual	NA	$30,000
Special Studies						
Isotopic Sampling	2028	2028	NA	NA	NA	$100,000
GDE/Biological Monitoring						
Baseline GDE/Biological Surveys	2023	2023	NA	NA	NA	$150,000
Biological Surveys	2023	Ongoing	NA	Every 5 Years	NA	$50,000

Table 4-7. EBMUD EBP Subbasin Management Actions

Project	First Year of Implementation	Completion Date	Number of Monitoring Stations	Minimum Frequency	Estimated Capital Cost	Estimated Five-Year Costs
Reporting						
Annual Reporting	2022	Ongoing	NA	Annual	NA	$178,750
GSP Five-Year Updates	2027	Ongoing	NA	Every 5 Years	NA	$162,500
Other						
DMS	2022	Ongoing	NA	Annual	NA	$25,000
Update Plume Info	2023	Ongoing	NA	Every 2 Years	NA	$13,000
Fate/Transport Modeling	TBD[6]	TBD	NA	TBD	NA	$65,000

[1] Representative Monitoring Site (RMS)

[2] Groundwater (GW)

[3] Not Applicable (NA); no associated capital costs

[4] To Be Determined (TBD); candidate non-RMS wells need further evaluation

[5] Not Applicable (NA), Number of Monitoring Stations/Frequency does not apply to this Action

[6] To Be Determined (TBD); Start Date, Completion Date, and Frequency are unknown at this time

The RMS groundwater quality wells are the same group of wells as for RMS groundwater level monitoring (**Figure 3-11**). In the long-term, these wells will be sampled annually for arsenic, nitrate, chloride, and TDS; and a more comprehensive constituent analysis suite will occur every five years (e.g., full general mineral suite). In addition, baseline sampling of the groundwater quality RMS wells for key constituents is needed over the initial four years of GSP implementation to confirm the baseline for establishing MO and MT. Baseline sampling will include a minimum of four samples collected in both spring and fall over at least two different years, preferably different water year types (e.g., wet and dry). The non-RMS monitoring well network (**Appendix 3.G**) will be evaluated for supplemental water quality sampling for selected key constituents that may inform characterization of basin conditions (e.g., chloride samples in non-RMS wells along Bay margin that may be useful as sentinel wells for seawater intrusion).

Synoptic (also known as hydrometric) stream monitoring involves collecting stream discharge measurements along the course of a stream on the same day as close together in time as possible to improve understanding of gaining and losing reaches along a length of stream. Typically, stream discharge measurements will be collected at four or more locations along a stream for each synoptic event. Synoptic stream monitoring events during different seasons and different water year types enable a more comprehensive understanding of gaining and losing reaches. These stream synoptic monitoring events in EBP Subbasin will initially focus on San Pablo, Wildcat, and San Leandro Creeks (**Figure 2-6**).

4.1.2.1.2 Construction of New Monitoring Facilities

New monitoring facility construction will largely correspond to streamflow measurement and understanding the interaction between streams and shallow groundwater levels. Ten new shallow single completion monitoring wells (likely 20 to 40 feet deep) will be installed at locations to be determined along major creeks (San Pablo, Wildcat, San Leandro, and possibly San Lorenzo Creeks) and in potential GDE areas (**Figure 2-6 and 2-38**). Groundwater levels (with transducers installed) and groundwater quality will be monitored at these locations to establish baseline conditions, and then MT and MO will be assigned and incorporated into the RMS monitoring network. These wells are planned to address the surface water depletion sustainability indicator along with the chronic groundwater level decline sustainability indicator.

New monitoring facility construction will also include installation of two new stream gages; one will be located on San Pablo Creek and another on San Leandro Creek (**Figure 2-6**). The locations of the new gages remain to be determined; potential locations for the gages will be identified from which to select the optimal locations. Automated stream stage data collection equipment would then be installed, a rating curve established (between stream stage and stream discharge), and ongoing measurements collected. These stream gages will be used in conjunction with synoptic stream monitoring and shallow groundwater monitoring wells to better inform overall understanding of the surface water depletion sustainability indicator.

A third component of new construction will include drilling and installation of up to three new deep nested well monitoring sites with up to three different well depth completions at each site. One of these sites is planned to be located in north central Oakland to fill a data gap in that area. The two other locations remain to be determined following an updated assessment of data gap areas. Baseline water level and water quality sampling would be conducted at these new monitoring facilities for subsequent incorporation into the RMS monitoring network.

4.1.2.1.3 Special Studies

Periodic special studies are anticipated to fill data gaps and enhance the understanding of groundwater basin conditions. A special study is currently underway under a DWR Proposition 68 grant to conduct stream discharge and isotope sampling along San Pablo and San Leandro Creeks to improve the understanding of stream-aquifer interaction. Results from this ongoing isotopic study are expected by the end of 2022, along with other GSP Implementation work related to streams. Additional studies using isotopes may be identified to further refine the understanding of stream-aquifer interaction. It is assumed one additional study may occur within the initial ten years of the GSP Implementation Period.

Another special study being conducted under the DWR Proposition 68 grant involves developing additional data related to the hydrogeologic boundary that occurs between EBP Subbasin and Niles Cone Subbasin. This special study involves a combination of long-term regional aquifer testing and collection of groundwater isotope data. It builds upon previous work conducted by USGS (2019), LSCE (2003), Fugro (2011), and the HCM for this GSP (Chapter 2). Other presently unidentified studies that support sustainable groundwater management may be conducted in the future.

4.1.2.1.4 Biological Surveys

Biological surveys planned to be conducted include a baseline field investigation to further characterize and validate potential GDEs, including identification of specific species at each location to allow more specific evaluation of rooting depths. Work conducted to date has included review of available GDE databases provided by TNC and others; however, no fieldwork has been conducted to further refine and validate potential GDE locations and species identification. The planned baseline field investigation would also establish current conditions for ecological health at each potential GDE location (**Figure 2-38**) to provide a basis for comparison for future surveys to be conducted every five years.

During the baseline map refinement and field verification of potential GDEs, biologists would classify the vegetation communities, record the dominant plant species present, specifically noting any native riparian phreatophyte species, and take notes on water sources. They will also review available survey data for salmonids in San Pablo, San Leandro, and Wildcat Creeks from EBMUD and East Bay Regional Parks, habitat mapping where available, and survey data for California red-legged frogs and other special-status species. If possible, representative areas within each major system of GDEs will be visited, where public access is available. If access is limited, bridges or other overlook areas will be used where possible, using binoculars, if needed. If ground-level visual assessment is not possible, aerial photo interpretation, groundwater mapping, and potentially other information (e.g., historical topography maps) will be used to make an assessment. Where site access is feasible, biologists will also record habitat suitability for special-status species so that this information can be incorporated into the baseline data for each GDE and evaluated later to determine whether groundwater conditions in the basin may have potential effects on GDEs that support these species and whether negative effects may occur. Local information on sensitive species and the potential relationship to groundwater will be incorporated during this step.

The information from the field assessments will be integrated in the GDE mapping data, with the main goal of determining which of the 537 acres of potential GDEs that were identified as requiring additional assessments should be classified as likely GDEs, based on available field data. The product of the baseline map refinement and field verification will be a data layer with refined GDE boundaries and attributed vegetation community information. Areas determined to not meet the criteria will have documentation for the basis for determining no hydrologic connection between the vegetation community and groundwater.

A subset of verified GDEs will be selected for baseline and ongoing ecological condition assessment. Wherever possible, sites will be selected that are representative of a plant community type, at a location near a groundwater well, and where other hydrologic data (e.g., stream gauge data) or biological survey data is available. Sites will also be selected based upon ecological value such as GDEs supporting populations of special status species (e.g., Western pond turtle). Ecological condition is a measure of how a GDE is functioning with respect to providing habitat and performing water quality functions. At each location the vegetation and hydrology will be assessed within a discrete monitoring area. The locations will be recorded using a GPS unit. Each of the locations will be chosen to be publicly accessible.

Following the baseline survey to be conducted within the initial five years of GSP implementation, there will be periodic biological surveys every five years prior to Five-Year Update Reports to allow for assessment of the ecological health of potential GDEs compared to the baseline survey. These GDE biological surveys will be analyzed in conjunction with groundwater level and quality data collected from the planned shallow monitoring wells. The Five-Year Update Report would describe the results of the GDE biological surveys along with discussion of shallow zone groundwater level fluctuations and groundwater quality.

4.1.2.1.5 GSP Reporting

The GSAs will prepare GSP Annual Reports in accordance with GSP regulations to document groundwater levels, groundwater storage change, basin water balance conditions, progress on implementation of projects and management actions, and comparisons to MT, IM, and MO. In addition, a Five-Year Update Report will be prepared beginning in 2027 and every five years thereafter. The Five-Year Update Reports will be more detailed than Annual Reports as these are key checkpoints during the GSP Implementation Period to report on groundwater basin status compared to Interim Milestones and to report the status of projects and management actions compared to the schedule presented in the GSP. A groundwater model update is also likely to occur at Five-Year intervals to incorporate new data, refine model structure as needed, and potentially recalibrate the model to recent water levels and streamflow data. In addition, the Five-Year Update Report will include more detailed reporting on other data sets being collected such as groundwater quality data and subsidence (extensometer) data.

4.1.2.1.6 Other Actions

Other actions following submittal of the GSP include data input and maintenance of the DMS, periodic assessment of contaminant plumes that may be in proximity to GSA projects, and possible fate and transport modeling related to potential future groundwater quality issues.

4.1.2.2 Implementation

Implementation of management actions will begin in 2022 following GSP submittal. Certain actions will begin immediately (e.g., RMS groundwater level monitoring), while other activities will require additional time to identify and vet optimum construction locations (e.g., installation of shallow monitoring wells along creeks) and resolve other logistical issues (e.g., property access, permitting, consultant/contractor retention). The GSP implementation schedule is discussed in more detail in Chapter 5.

4.1.2.3 Management Action Operations and Monitoring

EBMUD will be responsible for MA operations and monitoring. EBMUD is already conducting groundwater level monitoring and groundwater quality sampling in selected wells. EBMUD will likely implement the various MA listed above using a combination of EBMUD staff, consultants to provide specific professional services, and outside contractors.

4.1.2.4 Management Action Benefits

The benefits of implementation the MA outlined above are primarily two-fold: 1) Allows for good groundwater basin management and meeting GSP/SGMA requirements; and 2) A significantly improved understanding of groundwater basin conditions, including stream-aquifer interaction. The MA are expected to greatly improve the spatial and vertical distribution of data needed to optimize groundwater basin management. Data gaps will be further evaluated as identified MA are implemented to determine if additional MA are warranted to further enhance the understanding of the EBP Subbasin and its management.

MA are also expected to provide substantial benefits towards tracking MO, IM, and MT, and assist with avoiding the occurrence of UR. Notification of the public and other agencies regarding implementation of MA will occur through EBMUD GSA stakeholder outreach, meetings, and press releases.

4.1.2.5 Management Action Costs

The estimated costs for EBMUD management actions are summarized in **Table 4-7**; with a more detailed year by year estimate provided in **Appendix 4.B**. The overall costs for the first ten years of the implementation period amount to an estimated $3,301,250, or an average of $330,125 on an annual basis.

4.1.3 Future EBMUD Projects Pending Data and Science

EBMUD has and will continue to look for opportunities to diversify its water supply portfolio to help improve resiliency to changing climate, regulations, and water supply needs. Consequently, EBMUD has identified three potential local groundwater projects that may be investigated in the future once data gaps are filled and there is sufficient information to evaluate their feasibility relative to maintaining sustainability within the EBP Subbasin while avoiding undesirable results. The three projects include:

- Future Phases of Bayside
- Irrigation with Groundwater
- Chabot Recovery

Each is briefly described below.

4.1.3.1 Future Phases of Bayside

Future phases of Bayside would involve constructing additional ASR wells. Data collected as part of the proposed management actions will be used to make science-based decisions regarding whether future phases are feasible. ASR well locations and diameter/depth of ASR wells would be selected to maximize recharge efficiency and benefits to the EBP Subbasin to maintain sustainability and avoid undesirable results.

If Bayside Phases 2 and 3 are developed, these projects will probably not occur until late in the GSP Implementation Period or during the Sustainability Period after 2042. Studies for Phase 2 and/or Phase 3 ASR facilities would include: identify sites that are good locations and conduct feasibility studies for construction of ASR wells, initiate permitting and environmental documentation, and identify and secure financing for construction. It can be anticipated that if additional ASR phases are developed in the future, the overall process will require about 10 years to complete for each phase.

4.1.3.2 Irrigation with Groundwater

This potential future project would use groundwater in lieu of using imported surface water supplies to irrigate large parcels (e.g., parks, golf courses, cemeteries). Implementation of this project will depend on filling data gaps and will be based on science.

4.1.3.3 Chabot Recovery

This potential future project would use groundwater to supplement flows in San Leandro Creek that EBMUD voluntarily releases to approximate the historic leakage flows from Lake Chabot to the creek prior to the repairs to the Chabot Dam outlet works. Implementation of this project will depend on filling data gaps and will be based on science.

4.1.4 EBMUD Project and Management Action Financing

Pursuant to CCR Title 23 Sections 354.44 and 354.6, EBMUD has evaluated the ability to cover project and management action costs. EBMUD may pursue available state and federal grants or loans to help with construction of new monitoring facilities and special studies. The remaining costs will be financed from revenues raised through water rates and/or fees and assessments. EBMUD will conduct the necessary studies and decision processes (including Proposition 218 elections, if needed) to approve rates, fees, or assessments to provide the required funding.

4.1.5 Coordination with Other GSAs and Planning Agencies

As part of the EBP Subbasin GSP implementation, EBMUD GSA will coordinate with Hayward GSA, as well as the neighboring GSAs in adjacent subbasins. Planning and coordination for various projects in the past have occurred between the GSAs (EBMUD and Hayward within EBP Subbasin, ACWD in Niles Cone Subbasin) and Alameda County. Coordination will continue among these and other agencies as needed to implement projects and management actions successfully. EBMUD GSA and Hayward GSA will work cooperatively to maximize the opportunities for recharge and groundwater extraction benefits for the southern portion of the EBP Subbasin. Coordination could potentially include pursuit of grant funding, additional injection/recharge opportunities, design and construction efforts, and additional special studies.

4.2 Hayward GSA Projects and Management Actions
(CCR Title 23, Section 354.44)

The City of Hayward (Hayward) has identified one primary project to include in its implementation of the GSP. It involves use of the City's existing groundwater extraction wells for emergency supply purposes. Hayward has also specified other management actions to be implemented to meet sustainability objectives. The project description is based on information developed during the GSP process and previous studies. The project and management action operations and integration as part of the overall GSP are described in Chapter 5.

4.2.1 Extraction

Emergency supply wells are planned for use as extraction-only wells to provide supplemental water supply to Hayward in the event of a short-term emergency, such as may occur with an earthquake that interrupts surface water supplies. The size, location, and performance of each extraction well depends on site-specific characteristics that were assessed by Hayward for their existing emergency wells.

4.2.1.1 Project Overview

Hayward has already constructed five emergency extraction wells (in the 1990s) that are screened primarily in the Deep Aquifer (Well A has one screen section in the Intermediate Aquifer Zone). Three of the five emergency wells are located within the EBP Subbasin – Well A, Well D, and Well E (**Figure 4-1**). These wells are currently permitted as standby sources and thus can operate for 15 days over the course of one year; the GSP Project Scenario assumes these three emergency wells would operate for two months in a given year when needed. It is assumed that 15-day emergency use may be inadequate, and that the state would allow the wells to run beyond the initial 15 days in a true emergency where sufficient municipal water service is not restored in that period of time. The 60-day period is reflective of a San Francisco Public Utilities Commission (SFPUC) Regional Water System disruption scenario due to a large earthquake. Additional information regarding the Hayward emergency wells is provided in **Appendix 4.C**.

4.2.1.2 Implementation

Implementation has already begun with the three emergency supply wells, although they have not yet been used for extended periods of extraction. Hayward previously conducted feasibility studies for the emergency well system in the 1980s and early 1990s and developed the project for full operations by the late 1990s. The existing three emergency wells located within EBP Subbasin have extraction capacities of 1.73, 1.22, and 3.74 MGD for Wells A, D, and E, respectively. The future scenario in this GSP assumes that the three wells would each operate on schedules of 5 days on and 1 day off (i.e., the average pumping rate over the 60-day period is 16 percent less than stated well pumping capacities). Hayward will monitor extraction well performance and impacts from the existing emergency wells to inform the potential for expanded production in the future.

4.2.1.2.1 Construction Activities and Requirements

No new construction activities are anticipated to be needed to operate the existing emergency water supply wells.

4.2.1.2.2 Water Source

Water for extraction will be derived primarily from the Deep Aquifer in the EBP Subbasin (a portion of Well A production will be derived from the Intermediate Aquifer). The extracted water will be derived from native/local recharge in the EBP Subbasin.

4.2.1.2.3 Conditions or Constraints on Implementation

The Hayward emergency wells are an existing project for the GSP, and its implementation does not depend on the performance of other projects or activities. Hayward will continue to monitor conditions in the GSA and adjacent areas to determine the impacts of the extraction well during its operations. An expanded monitoring program being implemented for the GSP will provide additional information related to Hayward emergency well operations.

4.2.1.2.4 Permitting Process and Agencies with Potential Permitting and Regulatory Control

The Hayward emergency wells are operated in accordance with permits from the SWRCB Division of Drinking Water.

4.2.1.3 Project Operations and Monitoring

Hayward will be responsible for emergency supply well project operations and monitoring. Extractions will be metered, and transducers installed in production and monitoring wells where feasible to collect ongoing groundwater level data.

4.2.1.4 Project Benefits

The emergency extraction wells provide benefits to the Hayward water supply portfolio utilizing EBP Subbasin groundwater storage when surface water supplies are severely interrupted by a major emergency (e.g., an earthquake that interrupts surface water delivery to Hayward). The estimated project benefits developed for the GSP are based on representative average hydrologic conditions. The emergency use of water supply wells by Hayward is not tied to hydrologic year type, because an emergency interruption could occur in any type of water year (i.e., wet, average, or drought). Therefore, the GSP future scenario (described in **Appendices 4.C and 6.E**) is designed to allow for evaluation of Hayward emergency well operations in different water year types and under different GSA project operation conditions (e.g., with and without EBMUD Bayside Well operations). In any given year that the Hayward emergency wells would operate, extraction from the three wells combined over two months is estimated to total 1,062 AF.

The EBP Subbasin is not overdrafted, and current groundwater pumping is a relatively small fraction of estimated sustainable yield. Implementation of this project is consistent with meeting measurable objectives, avoiding the exceedance of minimum thresholds, and avoiding undesirable results for all six sustainability indicators. There will be notice provided to the public and other agencies regarding possible future implementation of other Hayward GSP projects through GSA stakeholder outreach (e.g., website postings, meetings, press releases), and the CEQA process.

4.2.1.5 Project Costs

Hayward completed construction of the emergency well facilities between the late 1980s and late 1990s. Thus, the construction of the facilities was completed more than twenty years ago and there are no additional capital costs. Future costs relate only to ongoing annual maintenance and operation costs, which are estimated to range from $60,000 in years wells are not operated for emergency supply to between $300,000 and $500,000 during years when the wells are operated for emergency purposes. If treatment facilities (e.g., for manganese) need to be built in the future, related capital costs for a treatment system at the existing well site(s) may be needed at that time. Additional development costs for a water treatment system may include project administration, legal, permitting, and environmental review. Given the uncertainty regarding whether water treatment facilities will be built by Hayward, no estimated costs for treatment facilities are presented in this GSP.

4.2.2 Management Actions

Hayward management actions include a number of items to address EBP Subbasin management. These actions can be grouped into broad categories including monitoring, special studies, GSP reporting, and other actions. These actions will help address existing data gaps and sustainably manage the EBP Subbasin. These actions are described in more detail in this section.

4.2.2.1 Management Actions Overview

The management actions planned by Hayward are summarized in **Table 4-8**, along with estimated annual operating costs. In some cases (e.g., Five-Year GSP Update Report), costs are incurred in a single year but are spread out over time to derive the reported average annual cost in **Table 4-8**. More detailed estimated costs by year are provided in **Appendix 4.D**.

Table 4-8. Hayward EBP Subbasin Management Actions

Project	First Year of Implementation	Completion Date	Number of Monitoring Stations	Minimum Frequency	Estimated Capital Cost	Estimated Five-Year Costs
Monitoring Actions						
RMS[1] GW[2] Level Monitoring	2022	Ongoing	8	Semi-Annual	NA[3]	$27,500
Non-RMS GW Level Monitoring	2022	Ongoing	TBD[4]	Semi-Annual	NA	$25,000
RMS GW Quality Monitoring	2022	Ongoing	8	Annual	NA	$40,000
Baseline GW Quality Sampling	2023	2024	8	Semi-Annual	NA	$32,000
Special Studies						
Isotopic Sampling	TBD	TBD	NA[5]	NA[5]	NA	TBD[6]
Reporting						
Annual Reporting	2022	Ongoing	NA	Annual	NA	$96,250
GSP Five-Year Updates	2027	Ongoing	NA	Every 5 Years	NA	$87,500
Other						
DMS	2022	Ongoing	NA	Annual	NA	$25,000
Update Plume Info	2023	Ongoing	NA	Every 2 Years	NA	$7,000
Fate/Transport Modeling	TBD[7]	TBD	NA	TBD	NA	$35,000

1 Representative Monitoring Site (RMS)
2 Groundwater (GW)
3 Not Applicable (NA); no associated capital costs
4 To Be Determined (TBD); candidate non-RMS wells need further evaluation
5 Not Applicable (NA), Number of Monitoring Stations/Frequency does not apply to this Action
6 To Be Determined (TBD); it is uncertain if additional isotopic studies will be needed; no cost is provided at this time
7 To Be Determined (TBD); Start Date, Completion Date, and Frequency are unknown at this time

4.2.2.1.1 Monitoring

RMS wells in the groundwater level monitoring network are shown on **Figure 3-1**. The costs for RMS groundwater level monitoring include both existing RMS wells and RMS wells planned for construction under a DWR Proposition 68 grant that is anticipated to be completed by the end of 2022. Most of these wells have (or will have) transducers installed for automated water level monitoring, and semi-annual manual measurements and transducer downloads will be conducted as part of this action. In addition to RMS groundwater level monitoring wells, a broader network of groundwater level monitoring wells (non-RMS wells) is being investigated for inclusion into the overall monitoring network. Non-RMS wells being investigated include Hayward wells not included as RMS wells (**Appendix 3.G**). The initial network of non-RMS wells in the broader GSP monitoring network is anticipated to be established by 2023.

The RMS groundwater quality wells are the same group of wells as for RMS groundwater level monitoring (**Figure 3-11**). In the long-term, these wells will be sampled annually for arsenic, nitrate, chloride, and TDS; and a more comprehensive sampling would occur every five years (e.g., full general mineral suite). Baseline sampling of the RMS groundwater quality wells for key constituents is needed over the initial four years of GSP implementation to confirm the basis for establishing MO and MT. Baseline sampling will include a minimum of four samples collected in both spring and fall over at least two different years, preferably different water year types (e.g., wet, and dry). The non-RMS monitoring well network (**Appendix 3.G**) will be evaluated for supplemental water quality sampling for selected key constituents to characterize basin conditions (e.g., chloride samples in non-RMS wells along Bay margin that may be useful as sentinel wells for seawater intrusion).

4.2.2.1.2 Special Studies

A special study currently (in 2021 and 2022) being conducted under the DWR Proposition 68 grant involves developing additional data and information related to the hydrogeologic boundary between the EBP and the Niles Cone Subbasin. This special study involves a combination of long-term regional aquifer testing and collection of groundwater isotope data. It builds upon previous work conducted by USGS (2019), LSCE (2003), Fugro (2011), and the HCM for this GSP (Chapter 2). Other unidentified special studies may be conducted in the future.

4.2.2.1.3 GSP Reporting

The GSAs will prepare annual GSP reports each year documenting groundwater levels, groundwater storage change, basin water balance conditions, progress on implementation of projects and management actions, and comparisons to MT, IM, and MO. In addition, a Five-Year Update Report will be prepared beginning in 2027, and every five years thereafter. The Five-Year Update Reports will be more detailed than Annual Reports as these are key checkpoints during the GSP Implementation Period to report on groundwater basin status compared to Interim Milestones and to report status of project and management action implementation compared to the schedule presented in the GSP. A periodic groundwater model update is likely to incorporate new data, refine model structure as needed, and potentially recalibrate to recent water levels and streamflow data. In addition, the Five-Year Update Report will include more detailed reporting on other data sets being collected such as groundwater quality data.

4.2.2.1.4 Other Actions

Other actions following submittal of the GSP include data input and maintenance of the DMS, periodic assessment of contaminant plumes that may be in proximity to GSA projects, and fate and transport modeling related to potential future groundwater quality issues.

4.2.2.2 Implementation

Implementation of management actions will begin in 2022 following submittal of the GSP. The implementation schedule is provided in Chapter 5.

4.2.2.3 Management Action Operations and Monitoring

Hayward will be responsible for management action operations and monitoring. Hayward will conduct groundwater level monitoring and groundwater quality sampling in selected RMS wells and other wells within Hayward GSA included in the broader monitoring network. Hayward will likely implement the various management actions listed above using a combination of Hayward staff, consultants to provide specific professional services, and outside contractors.

4.2.2.4 Management Action Benefits

The benefits of management action implementation outlined above are primarily two-fold: 1) Allows for good groundwater basin management and meeting GSP/SGMA requirements; and 2) improves understanding of groundwater basin conditions. The management actions are expected to greatly improve the spatial and vertical distribution of data needed to optimize groundwater basin management. Data gaps will be further evaluated as identified management actions are implemented to determine if additional management actions are warranted to advance the understanding of the EBP Subbasin and its sustainable management.

Management actions are also expected to provide substantial benefits towards tracking MO, IM, and MT, and assist with avoiding the occurrence of UR. Notification of the public and other agencies regarding implementation of MA will occur through Hayward GSA stakeholder outreach and meetings.

4.2.2.5 Management Action Costs

The estimated costs for Hayward management actions are summarized in **Table 4-8**; a more detailed year by year estimate is provided in **Appendix 4.D**. The overall costs for the first ten years of the implementation period amount to an estimated $713,250, or an average of $71,325 on an annual basis.

4.2.3 Hayward Project Financing

Pursuant to CCR Time 23 Sections 354.44 and §354.6, Hayward has evaluated the ability to cover project and MA costs. The project and management action costs will be financed from revenues raised through water rates and/or fees and assessments. Hayward will conduct the necessary studies and decision processes (including Proposition 218 elections, if needed) to approve rates, fees, or assessments to provide the required funding.

4.2.4 Coordination with Other GSAs and Planning Agencies

As part of the EBP Subbasin GSP, Hayward GSA will coordinate with EBMUD GSA, as well as the neighboring GSA (ACWD) in the Niles Cone Subbasin. Planning and coordination for previous projects have occurred between the GSAs (Hayward and EBMUD within EBP Subbasin, ACWD in Niles Cone Subbasin) and Alameda County. Coordination will continue among these and other agencies as needed to implement projects and management actions successfully. Hayward GSA and EBMUD GSA will work cooperatively to maximize the opportunities for recharge and groundwater extraction benefits for the southern portion of the EBP Subbasin. Coordination could potentially include pursuit of grant funding, additional injection/recharge opportunities, design and construction efforts, and additional special studies.

4.3 References

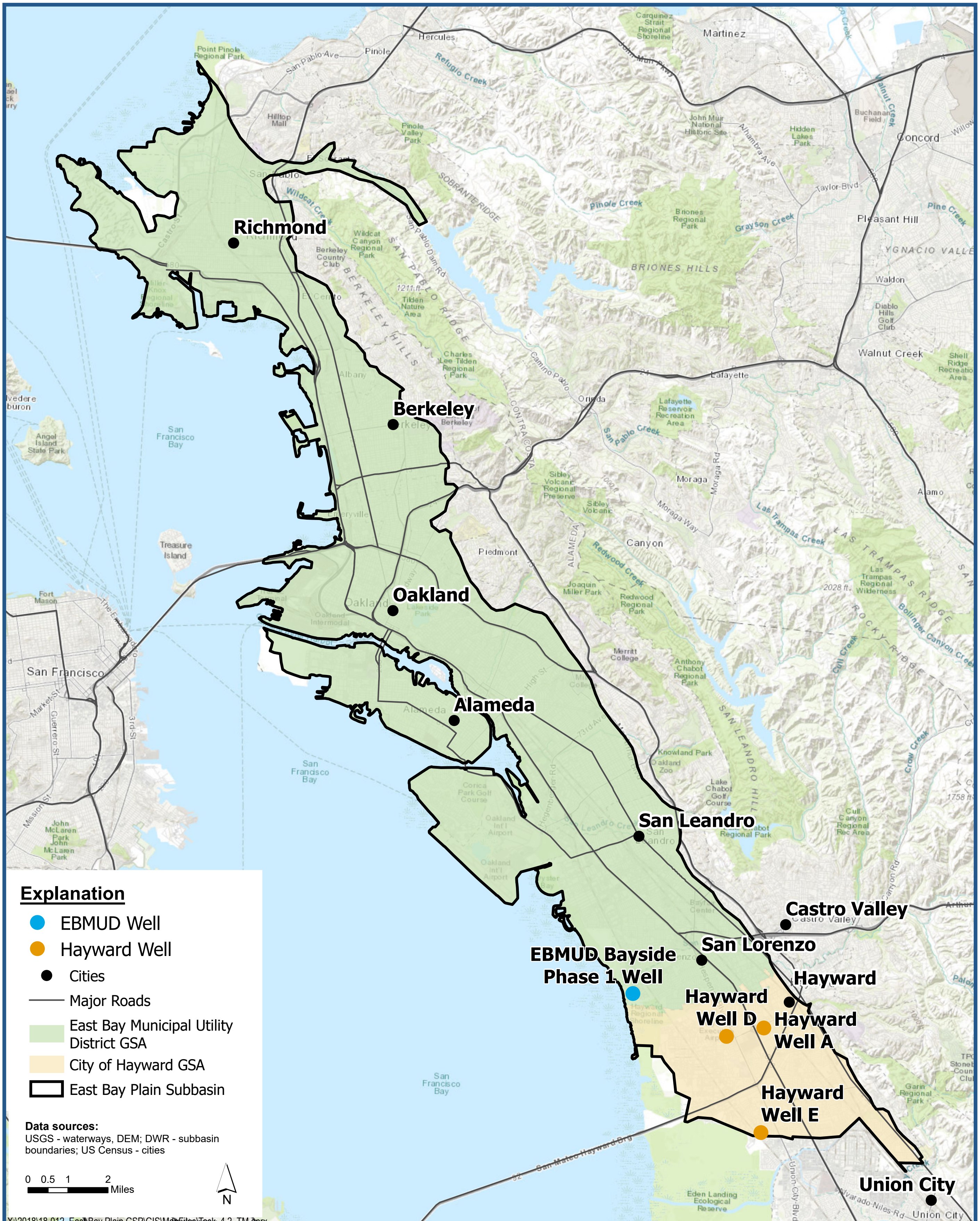
East Bay Municipal Utility District. 2010. *East Bay Municipal Utility District Bayside Groundwater Project.* 2009 Annual Report, Order No. R2-2007-0038.

Woodard & Curran, Brown and Caldwell, and Cubed, M. 2018. *Recycled Water Master Plan Update, East Bay Municipal Utility District.* Final Interim Report.

Woodard & Curran and Brown and Caldwell. 2019. *East Bay Municipal Utility District, Updated Recycled Water Master Plan*.

FIGURES

Figure 4-1



LSCE TEAM

Map of Project Locations for East Bay Plain Subbasin GSAs

East Bay Plain Subbasin
Groundwater Sustainability Plan

Figure 4-1

JANUARY 2022

EAST BAY PLAIN SUBBASIN GROUNDWATER SUSTAINABILITY PLAN CHAPTER 5 – PLAN IMPLEMENTATION

PREPARED FOR

East Bay Municipal Utility District GSA and
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5. PLAN IMPLEMENTATION

This chapter describes the activities and outlines the estimated costs and schedule to implement the EBP Subbasin GSP over the first five years and discusses how the GSAs plan to meet these costs in accordance with GSP regulations. The implementation plan is based on the hydrogeologic conceptual model, current and projected water demands, and the projected water budget, which includes considerations of climate change and sea level rise. The estimated costs presented in this Chapter are strictly GSA-related costs (e.g., GSA senior management/staff time to manage contracts with consultants/drillers for monitoring and other field activities described in Chapter 4; GSA GSP administration and project management costs, etc.) that are in addition to costs presented in Chapter 4 (e.g., costs of field work to conduct RMS monitoring conducted by consultants or GSA staff).

The EBMUD and Hayward GSAs will regularly review the budget and update the costs and schedule as needed to ensure effective GSP implementation and ongoing sustainable groundwater management of the EBP Subbasin.

This chapter describes:

- Estimated costs for the GSAs to administer GSP activities (not including the project-specific costs described in Chapter 4), as required by California Code of Regulations (CCR) Title 23, Section 354.6(e)
- Financing approaches
- Timeline and roadmap for implementing all GSA projects and management actions between 2022 and 2042
- Monitoring and reporting, including the contents of Annual and Five-Year Update Reports that must be provided to DWR (CCR Title 23, Sections 356.2 and 356.4)
- Subbasin data management system

5.1. Types of GSP Implementation Costs

Total GSP implementation costs include both project-specific costs and costs for the GSAs to administer and implement all other aspects of the GSP. The EBMUD and Hayward GSAs will incur costs for managing GSP implementation; planning and specialized studies; ongoing monitoring and installation of new facilities; and providing general administration. Projected capital and operating costs of projects and management actions are summarized in Chapter 4 and are not repeated in this chapter. For the purposes of this chapter, each GSA's implementation costs are broken down into the following seven (7) categories:

- GSA administration
- Stakeholder outreach and meetings
- GSP studies
- GSP implementation and updates
- Project planning
- Monitoring
- Contingency

The following subsections describe the general types of costs that could fall under each category. Each GSA will allocate GSP implementation costs to cost categories that are consistent with its internal bookkeeping and accounting practices.

5.1.1. GSA Administration

Administrative costs generally include reporting, record keeping, bookkeeping, legal advice, and government relations. The GSAs will also need to continue to monitor projects and management actions to assess their benefit, economic feasibility, and coordinate with other GSAs if modifications to planned projects and management actions are necessary to ensure the EBP Subbasin meets the sustainability goal.

The GSAs anticipate that significant coordination and administrative tasks will be required during GSP implementation. Some GSP projects and management actions require coordination between the two GSAs (e.g., measurement of Spring and Fall groundwater levels at approximately same time), and overall Subbasin sustainability depends on continued coordination, planning, and evaluation of groundwater conditions basin-wide. In addition, each GSA will conduct general business administration including record keeping, bookkeeping, and general management.

5.1.2. Stakeholder Outreach and Meetings

A key component of administrative costs will be continued outreach to stakeholders. The Communications and Engagement Plan will be updated to include the engagement plan during GSP implementation. The GSAs will continue to monitor projects and management actions and coordinate with stakeholders if modifications to planned projects and management actions are necessary to ensure the EBP Subbasin meets the sustainability goal. Each GSA will conduct public outreach/engagement to provide timely information to stakeholders regarding GSP progress and Subbasin conditions. Each GSA will either continue to maintain a website that will be used to post data, reports, and meeting information or alternatively, the GSAs may jointly develop a single GSP website for the EBP Subbasin to serve that purpose.

5.1.3. GSP Studies

GSP implementation will require various planning, technical, and economic/fiscal studies. These are additional costs that are not covered by the estimated costs of specific projects and management actions that are described in Chapter 4.

Planning Studies. The GSAs will continue to develop planning studies to integrate the GSP with other regional water management efforts and update the GSP to ensure that the Subbasin achieves the EBP Subbasin sustainability goal and meets all sustainable management criteria. The GSAs will continue to evaluate Subbasin conditions and adjust short- and long-term Subbasin planning efforts accordingly. Other planning studies may include evaluating projects and developing other programs to support sustainable management.

Technical Evaluations. Additional technical studies and analyses may be required beyond those already described in Chapter 4. The GSAs will conduct ongoing monitoring as described in Chapters 3 and 4 to ensure sustainable management criteria are met and to prevent undesirable results. Additional monitoring facilities will be installed as described in Chapter 4, and the GSAs will evaluate and report groundwater conditions, water use, and change in groundwater storage as required. While a plan to fill data gaps over the next five to ten years has been developed and presented in this GSP, additional technical studies may be needed in the future to further support the sustainability goal.

Economic/Fiscal Analyses. The GSAs will develop economic and fiscal studies to support implementation of projects and management actions and the overall GSP. This may include cost-effectiveness assessments and preliminary investigations of potential future projects. Fiscal and economic analyses are expected to include rate studies and other analyses required to implement fees or assessments, willingness to pay, and ability to pay. The GSAs may engage legal and technical experts to help design and perform the required economic/fiscal analysis studies. Economic impact studies will be developed to evaluate GSP implementation, understand potential cost allocations to different stakeholder groups, and identify cost control methods for reducing costs during GSP implementation.

5.1.4. GSP Implementation and Updates

GSP implementation costs include internal GSA coordination, meetings, and document preparation. This cost category includes costs not covered by GSA administration and GSP studies, in addition to costs incurred to prepare the required Annual Reports and Five-Year Update Reports.

Annual Reports. CCR Title 23 Section 356.2 requires the GSAs to prepare and submit Annual Reports to DWR. The GSAs will perform any required technical analyses and data collection including monitoring and tracking sustainable management criteria. The Annual Reports will include required data and summary documentation, including progress towards implementing the GSP, projects and management actions as applicable, and interim milestones achieved. The GSAs expect that Annual Reports will also require inter and intra-GSA coordination as well as stakeholder outreach.

Five-Year Update Reports. CCR Title 23 Section 356.4 requires the GSAs to conduct periodic evaluations of the GSP and prepare and submit Five-Year Update Reports. In contrast to the Annual Report, this report requires additional evaluation of sustainability conditions, objectives, monitoring, and documentation of new information that is available since the last update to the GSP. The GSAs expect that periodic evaluations will also require significant inter- and intra-GSA coordination and stakeholder outreach.

5.1.5. Project Planning

The GSAs will incur additional costs for project planning. Project capital and operating and maintenance (O&M) costs for projects that are included in the GSP are summarized in Chapter 4. However, the GSAs may need to evaluate other project ideas proposed by stakeholders, assess cost-effectiveness of planned projects, and evaluate the joint implementation of multiple projects to ensure the GSP continues to meet the sustainability goal. Technical studies may include feasibility assessments, environmental studies, water rights evaluations, coordination with permitting agencies, and other project planning efforts. The

GSAs may evaluate land acquisition and easements, pursue grant applications, administer grants, and engage other legal and technical services.

As needed, the GSAs will coordinate on the specific studies and analyses necessary to improve understanding of Subbasin conditions. The GSAs will use new information on Subbasin conditions to improve projects and management actions to maintain sustainability. Evaluations and updates will occur annually (Annual Report), and every five years (Five-Year Update Reports) as required by CCR Title 23, but the GSAs anticipate that planning, coordination, and studies will be continuous and ongoing.

5.1.6. Monitoring

The GSAs will conduct the monitoring programs outlined in Chapters 3 and 4. This will include tracking Subbasin conditions and sustainability indicators by collecting groundwater extraction and injection data, measuring groundwater elevations and water quality, and tracking total water use. Monitoring activities will include data management, installing and measuring monitoring wells, maintaining existing wells, working with groundwater pumpers to install meters, and deploying other technology. These monitoring activities will support evaluation of Subbasin conditions relative to established sustainable management criteria, and monitoring groundwater extraction and injection and total water use will support annual reporting requirements.

Data from the monitoring programs will be routinely evaluated to ensure progress towards maintaining sustainability and the prevention of undesirable results. The GSAs will also work to ensure all data are collected and evaluated using best management practices and applicable quality assurance and quality control guidelines.

5.1.7. Contingency

An additional contingency cost is included for fiscal planning purposes. This may include actions needed to implement additional management measures if Subbasin conditions start trending towards minimum threshold levels in any area.

5.2. GSA Implementation Costs

(CCR Title 23, Section 354.6)

The following subsections summarize estimated costs for each GSA to implement non-project-specific costs of the GSP. Costs are presented for each of the general cost categories identified above. However, the GSAs may manage costs and expenses differently and may record costs in different categories. In addition, the GSAs are still developing operating budgets and may issue requests for proposals to engage consultant technical services, but these costs are unknown at this time.

5.2.1. East Bay Municipal Utility District

The EBMUD GSA estimates that annual implementation costs will be approximately $78,500 – $136,000 per year over the next four years and $177,000 in the fifth year (**Table 5-1**). This does not include project and management action-specific costs described in Chapter 4. EBMUD will recover GSP implementation costs through grants and local revenues that are yet to be determined. EBMUD is currently evaluating options. Section 5.3 provides a general description of how EBMUD may recover GSP implementation costs.

Table 5-1. EBMUD GSA Implementation Costs

Cost Category	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
GSA Administration	$10,000	$10,000	$10,000	$10,000	$10,000
Stakeholder Outreach and Meetings	$7,000	$7,000	$7,000	$7,000	$7,000
GSP Studies	$0	$0	$30,000	$30,000	$30,000
GSP Implementation and Updates	$37,500	$37,500	$37,500	$37,500	$75,000
Project Planning	$0	$0	$15,000	$15,000	$15,000
Monitoring	$24,000	$24,000	$24,000	$24,000	$24,000
Contingency	$0	$0	$12,500	$12,500	$16,000
Total	**$78,500**	**$78,500**	**$136,000**	**$136,000**	**$177,000**

5.2.2. City of Hayward

The Hayward GSA estimates that annual implementation costs will be approximately $23,500 – $37,000 per year over the next four years and $50,000 in the fifth year (**Table 5-2**). This does not include project and management action-specific costs described in Chapter 4. Hayward will recover GSP implementation costs through grants and local revenues that are yet to be determined. Hayward is currently evaluating options. Section 5.3 provides a general description of how Hayward may recover GSP implementation costs.

Table 5-2. Hayward GSA Implementation Costs

Cost Category	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026
GSA Administration	$5,000	$5,000	$5,000	$5,000	$5,000
GSP Studies	$0	$0	$5,000	$5,000	$5,000
GSP Implementation and Updates	$11,500	$11,500	$11,500	$11,500	$23,000
Project Planning	$0	$0	$5,000	$5,000	$5,000
Monitoring	$7,000	$7,000	$7,000	$7,000	$7,000
Contingency	$0	$0	$3,500	$3,500	$5,000
Total	**$23,500**	**$23,500**	**$37,000**	**$37,000**	**$50,000**

5.3. GSP Financing

GSP administration, monitoring, and reporting are projected to cost a total of approximately $173,000 to $227,000 per year. Costs are expected to be higher during years in which a Five-Year Update Report is due, and costs are expected to be slightly lower during years in which only an Annual Report is due. The total cost does not include the capital and annual O&M costs of projects and management actions (see Chapter 4).

Development of this GSP was funded through a Proposition 1 Grant and contributions from individual GSAs (e.g., through in-kind staff time, or separately contracted consulting services). Individual GSAs are also funding additional, ancillary studies and implementation efforts. To fund GSA operations and GSP implementation, the GSAs are developing a financing plan that will include one or more of the following financing approaches:

- **Grants**: GSAs will continue to pursue grants to help fund planning studies and other GSA activities. However, grants are not expected to cover most GSA operating costs for GSP implementation.
- **Groundwater Extraction Charge**: A charge per acre-foot pumped could be used to fund GSP implementation activities.
- **Water Rates**: Customer water rates charged by the GSAs may be adjusted to reflect the increased costs associated with GSA activities and GSP implementation.
- **Other Fees and Charges**: This approach may include permitting fees for new wells or development, or other fees/charges. Depending on the justification and basis for a fee, it may be considered a property-related fee subject to voting requirements of Article XIII D of the California Constitution (passed by voters in 1996 as Proposition 218) or a regulatory fee exempt from such requirements.
- **Assessments:** Special benefit assessments under Proposition 218 could include a per-acre (or per-parcel) charge to cover GSA costs, or other fees under Proposition 26.
- **Taxes:** This could include general property related taxes that are not directly related to the benefits or costs of a service (ad valorem and parcel taxes), or special taxes imposed for specific purposes related to GSA activities.

The GSAs are pursuing a combined approach, targeting available grants, and considering a combination of fees and assessments to cover operating and program-specific costs. As required by statute and the Constitution, the GSAs would complete an engineer's report, rate study, and other necessary analyses to document and justify any rate, fee, or assessment.

5.4. Schedule for Implementation

The GSP implementation schedule allows time for the GSAs to develop and implement projects and management actions and maintain the sustainability goal through 2042 and beyond. While the primary sustainability projects began prior to SGMA becoming law and are already contributing to the Subbasin sustainability goal, the GSAs will begin implementing other GSP activities in 2022, with full implementation of projects and management actions to maintain sustainability by 2042. **Figures 5-1 and 5-2** illustrate the GSP implementation schedules for projects and management actions to be implemented by the EBMUD and Hayward GSAs. The GSP implementation schedules also show mandatory reporting and updating for each GSA, including Annual Reports and Five-Year Update Reports to be prepared and submitted to DWR.

The EBP Subbasin GSP implementation plan for projects and management actions recognizes that projects are emergency and drought-dependent with operations that are not predictable into the future; however, the projects are constructed, permitted, and operational as of 2022 and ready to operate in accordance with current plans outlined in the future scenario (**Appendix 4.A and 4.C**). The GSP implementation schedule allows time for the GSAs to collect necessary baseline data needed as the basis for setting refined and more representative MOs and MTs.

5.5. Annual Reports

CCR Title 23 Section 356.2 requires Annual Reports to be submitted to DWR by April 1 of each year following the adoption of the GSP. The GSAs will jointly prepare Annual Reports that comply with all the requirements of CCR Title 23 Section 356.2. It is anticipated that the GSAs will need to develop independent analyses and data as well as joint analyses (e.g., estimating the Subbasin-wide change in groundwater storage) for the Annual Reports. The GSAs will coordinate to prepare the Annual Report and will incur joint and individual costs in the process. Annual Reports must provide basic information about the Subbasin in addition to technical information including:

- Groundwater elevation data from monitoring wells
- Hydrographs of groundwater elevations
- Total groundwater extractions for the prior water year
- Surface water supply used in the prior water year, including for groundwater recharge or other in-lieu uses
- Change in groundwater storage
- Progress towards implementing the GSP

The following subsections of the annual report provide a general outline of the information that will be provided. The Annual Reports submitted to DWR will fully comply with the requirements of CCR Title 23 Section 356.2.

5.5.1. General Information
(CCR Title 23, Section (356.2(a))

General information will include an executive summary that highlights the key content of the Annual Report. This will include a description of the sustainability goal, a description of GSP projects, an updated implementation schedule, and a map of the Subbasin. Any important changes or updates since the last Annual Report will be noted and described.

5.5.2. Subbasin Conditions
(CCR Title 23, Section 356.2(b))

The Subbasin Conditions section of the Annual Report will provide an update on groundwater and surface water conditions in the Subbasin. Current groundwater conditions with respect to the sustainability goal in the Subbasin will be described. The GSAs will summarize the groundwater monitoring network data and report current and change in groundwater elevation. This will include groundwater elevation contour maps for each principal aquifer in the Subbasin tailored to specific hydrogeologic conditions across the region. These will show seasonal high and low conditions within the current season and show historical data from at least January 1, 2015.

Total groundwater extractions will be summarized by water use sector and the method of quantification will be identified (e.g., metering, satellite analysis, turf ET estimates, etc.). All data and methods used to characterize extractions and levels will follow best practices and be described in the Annual Report.

The groundwater system balance will be used to estimate the change in groundwater storage. Change in storage will be summarized in tabular form and as a map for each principal aquifer in the Subbasin. A graph will show the water year type, groundwater use, change in storage, and cumulative change in storage for the Subbasin using historical data starting no later than January 1, 2015.

5.5.3. Plan Implementation Progress

(CCR Title 23, Section 356.2(b))

The Annual Report will summarize GSP implementation of projects and management actions and other GSA-related activities and describe progress toward established interim milestones. It will summarize sustainability conditions in the Subbasin.

5.6. Periodic Evaluation (Five-Year Updates)

The GSAs will conduct an evaluation every five years to summarize GSP implementation, whether the GSP is meeting the sustainability goal, and summarize implementation of projects and management actions. An evaluation will also be made whenever the GSP is amended. DWR will use this evaluation to review the GSAs progress toward meeting the EBP Subbasin sustainability goal. A summary of the general information that will be included in the five-year periodic evaluation required by CCR Title 23 Section 356.4 is provided in the following subsections.

5.6.1. Sustainability Evaluation

(CCR Title 23, Sections 356.4(a) - 356.4(d))

The sustainability evaluation will summarize current groundwater conditions for each sustainability indicator and describe overall progress in maintaining sustainability. A summary of interim milestones and measurable objectives will be included, along with an evaluation of sustainability indicators and groundwater conditions in relation to minimum thresholds. Implementation of all projects and management actions will be documented and used to adaptively manage the Subbasin. This will include a summary of actual implementation timelines compared to the proposed timelines (**Figures 5-1 and 5-2**) and implementation schedules.

The evaluation will analyze and describe the effects of projects and management actions on Subbasin sustainability indicators and compare that to the estimated gross benefits of the projects and management actions presented in Chapter 4. If differences are identified, these will be described in the periodic evaluation. If projects or management actions are not performing as expected, the update will describe steps the GSAs will take to implement corrective actions, if warranted. Any changes to the implementation schedule of projects and management actions will be described in the periodic evaluation.

As GSP projects and management actions are implemented, monitoring data may indicate unanticipated effects. Also, land uses, and economic conditions may change in ways that cannot be anticipated at this time. It may be necessary to update the GSP to account for these changes. The elements of the GSP, including the basin setting, undesirable results, minimum thresholds, and measurable objectives, will be reconsidered by the GSAs during the periodic evaluations. Any proposed revisions will be documented in the periodic evaluation.

5.6.2. Monitoring Network Description

(CCR Title 23, Section 356.4(e))

Chapter 3 details the planned monitoring network and protocols. The effectiveness of the monitoring network and overall GSP implementation depends on timely, accurate, and comprehensive data. The GSP includes Data Management System (DMS) protocols, as well as an expanded network of monitoring wells and data collection. However, as described in Chapter 3, existing data gaps in the Subbasin will require further expansion of the monitoring network. As data gaps are identified and filled (e.g., with additional monitoring wells), a plan will be developed to improve the monitoring network, consistent with CCR Title 23 Section 354.38.

The GSAs expect that data gaps will be further evaluated and identified in future GSP updates. The periodic evaluations of the GSP will assess changes to the monitoring program needed to acquire additional data sources and describe how the new information will be used and incorporated into any future GSP updates. The installation of new data collection facilities and analysis of new data will be prioritized in the GSP.

5.6.3. New Information

(CCR Title 23, Section 356.4(f))

The GSAs are continuing to monitor Subbasin conditions and additional monitoring wells are being installed under a Proposition 68 grant. In addition, the DMS will allow GSAs to identify additional data gaps and implement procedures to secure additional data. The GSAs expect that new information about groundwater conditions, projects and management actions, and the sustainable management criteria will occur during GSP implementation. An adaptive management approach will be applied to identify, review, and incorporate all new information into the GSP. Periodic evaluations will indicate whether new information warrants changes to any aspect of the GSP, including the basin setting, measurable objectives, minimum thresholds, or undesirable results.

5.6.4. GSA Action

(CCR Title 23, Sections 356.4(g) - 356.4(h))

The GSAs are continuing to monitor, manage, and collaborate to meet the sustainability goal specified in the GSP. Within their allowed authorities, the GSAs are evaluating new regulations or ordinances that could be implemented to help achieve the sustainability goal. Any changes in regulations or ordinances will be summarized in the periodic update. The effect on any aspect of the GSP, including the basin setting, measurable objectives, minimum thresholds, or undesirable results, will be described.

The five-year periodic evaluation will include a summary of state laws and regulations, or local ordinances related to the GSP that have been implemented since the previous periodic evaluation and address how these may require updates to the GSP. Enforcement or legal actions taken by the GSAs in relation to the GSP will be summarized along with how such actions support ongoing sustainability in the Subbasin.

5.6.5. Plan Amendments, Coordination, and Other Information

(CCR Title 23, Sections 356.4(i) - 356.4(k))

Any proposed or completed amendments to the GSP will be described in the periodic evaluation. This will also include a summary of amendments that are being considered or developed at that time. Any changes to the basin setting, measurable objectives, minimum thresholds, or undesirable results will be described.

Any changes to the GSA coordination agreement will be documented and summarized. The GSAs will summarize any other information deemed appropriate to support the GSP and provide required information to DWR for review of an amended GSP.

5.7. Data Management System

(CCR Title 23, Sections 352.6 and 354.40)

The East Bay Plain Subbasin Data Management System (DMS) is implemented using the Opti platform. The DMS serves as a data sharing portal to enable utilization of the same data and tools for visualization and analysis to support sustainable groundwater management and transparent reporting of data and results.

The DMS is web-based and publicly accessible using common web browsers. It is a flexible and open software platform that utilizes familiar Google maps and charting tools for analysis and visualization. The link to the DMS will be made available once it is ready at www.ebmud.com/sgma and https://www.hayward-ca.gov/content/sustainable-groundwater-management.

5.7.1. Functionality of the Data Management System

The DMS is a modular system that includes numerous tools to support GSP development and ongoing implementation, including:

- User and Data Access Permissions
- Data Entry and Validation
- Visualization and Analysis
- Query and Reporting

The DMS can be configured for additional tools and functionality as needs change over time. The following sections briefly describe the currently configured tools.

5.7.1.1. User and Data Access Permissions

User access permissions are controlled through several user types that have different roles in the DMS as summarized below. These user types are broken into three high-level categories:

- **System Administrator** users manage information at a system-wide level, with access to all user accounts and entity information.

- **Managing Entity (Administrator, Power User, User)** users are responsible for managing their entity's site/monitoring data and can independently control access to this data.
- **Public** users may view data that are published but may not edit any information.

Monitoring sites and their associated datasets are added to the DMS by Managing Entity Administrators or Power Users.

5.7.1.2. Data Entry and Validation

The DMS allows Entity Administrators and Power Users to enter data either manually via interfaces, or through an import tool utilizing Excel templates. The data are validated by Managing Entity's Administrators or Power Users using a number of quality control checks prior to inclusion in the DMS. Data validation checks performed by the DMS include checks for duplicate measurements, inaccurate measurements, and incorrect data entry.

5.7.1.3. Visualization and Analysis

Data visualization and analysis are performed in both Map view (map-based interface) and List view (tabular interface). The DMS platform also allows for future analysis tools, including contouring, total water budget visualization, and management area tracking.

5.7.1.4. Query and Reporting

The DMS has the ability to format and export data and analysis at different levels of aggregation, and in different formats, to support local decision making and for submission to various statewide and local programs (i.e., SGMA, California Statewide Groundwater Elevation Monitoring (CASGEM), groundwater ambient monitoring and assessment (GAMA, etc.).

The DMS can be configured to support wide-ranging reporting needs through the Reports tool. Standard report formats may be generated based on a predetermined format and may be created. These report formats may be configured to match state agency requirements for submittals, including annual reporting of monitoring data that must be submitted electronically on forms provided by the DWR.

5.7.2. Data Included in the Data Management System

The DMS is configured to include a wide variety of monitoring data types and associated parameters. Based on the analysis of existing datasets within the EBP Subbasin and the GSP needs, the data types shown below were identified to be included in the DMS. Additional data types will be added in the future as the DMS grows.

- Groundwater extraction
- Groundwater level
  - Depth to groundwater
  - Groundwater elevation
- Groundwater quality
  - Field parameters (e.g., temperature, pH, conductivity)
  - Key Constituents (arsenic, chloride, total dissolved solids, and nitrate)

    - Additional Constituents (e.g., bicarbonate, carbonate, sodium, and sulfate)
- Precipitation
- Streamflow
- Subsidence

The data are collected from a variety of sources including DWR CASGEM, EnviroStor, GeoTracker, GAMA, U.S. Geological Survey, and local data. Each dataset is reviewed for overall quality and consistency prior to consolidation and inclusion in the database. More data sources will be added in the future as necessary.

5.8. References

No References

FIGURES

Figures 5-1 and 5-2

Figure 5-1. EBP Subbasin GSP Implementation Schedule for EBMUD GSA

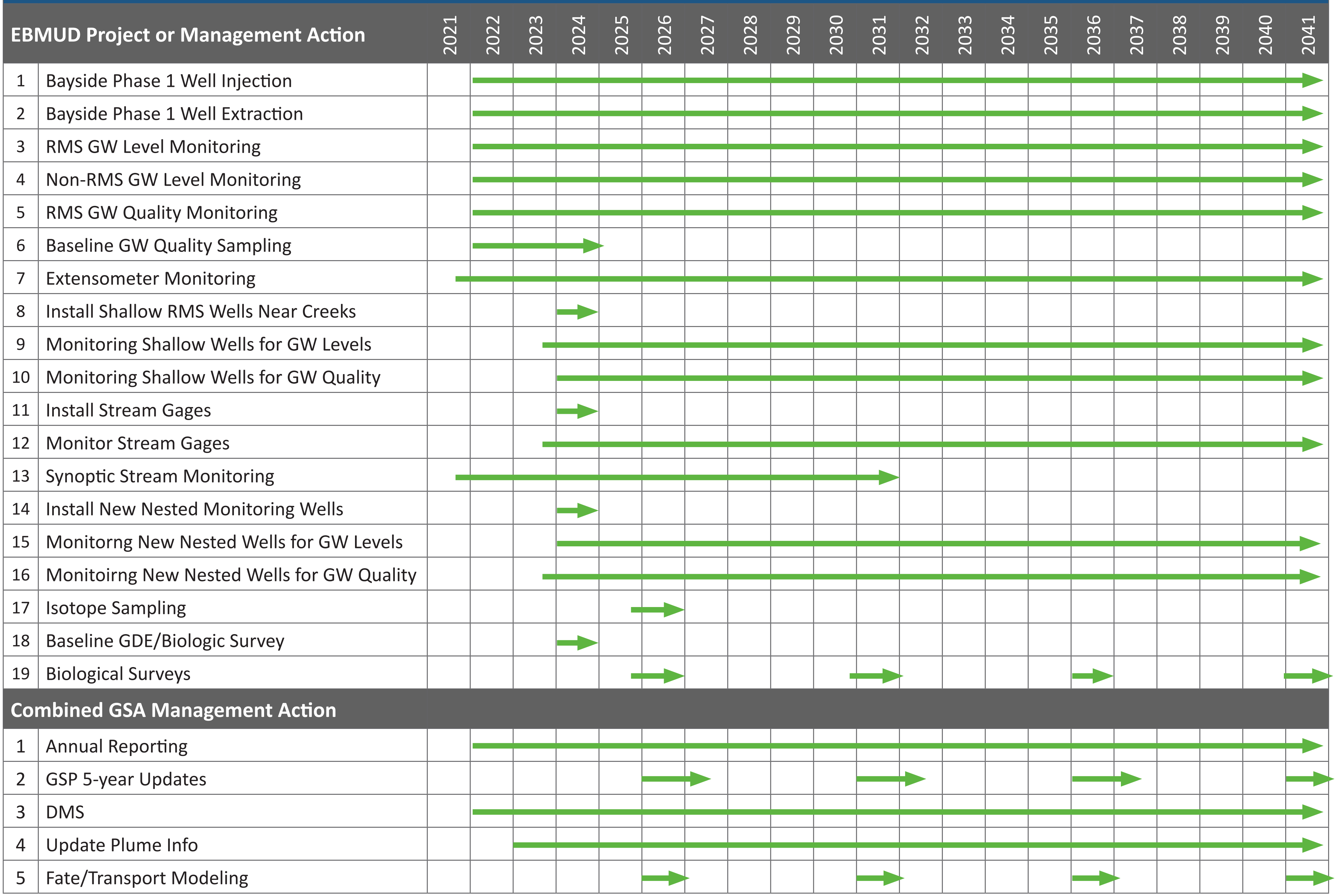

Figure 5-2. EBP Subbasin GSP Implementation Schedule for Hayward GSA