EAST
CONTRA COSTA
SUBBASIN
Groundwater Sustainability Plan

East Contra Costa Subbasin Groundwater Sustainability Plan

Prepared for ECC GSA Working Group

Luhdorff & Scalmanini
Consulting Engineers

October, 2021

October 2021

EAST CONTRA COSTA SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

PREPARED FOR

ECC GSA WORKING GROUP

EAST CONTRA COSTA SUBBASIN

Groundwater Sustainability Plan

PROFESSIONAL GEOLOGIST
DEBRA CANNON
No. 8073
STATE OF CALIFORNIA

PROFESSIONAL GEOLOGIST
BARBARA ANNE DALGISH
No. 8714
STATE OF CALIFORNIA

Debra Cannon

Barbara Dalgish

PREPARED BY

Luhdorff & Scalmanini
Consulting Engineers

EAST CONTRA COSTA SUBBASIN
GROUNDWATER SUSTAINABILITY PLAN

OCTOBER 15, 2021

ACKNOWLEDGEMENTS

The East Contra Costa (ECC) Subbasin Working Group appreciates and acknowledges the funding of $538,000 from the California Department of Water Resources (DWR) funding under the Sustainable Groundwater Planning Grant Program (SGWP), authorized by the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1) in 2017. The ECC Subbasin is using these funds for development of the ECC Subbasin Groundwater Sustainability Plan (GSP).

The ECC Subbasin was also successful in securing $1,078,600 from the California Drought, Parks, Climate, Coastal Protection, and Outdoor Access for All Act of 2018 (Proposition 68). Tasks under this grant include extended outreach, expanding knowledge regarding data gaps within the groundwater monitoring system, and continuing GSP development.

Additional funding for GSP development has come from direct contributions and in-kind services from the ECC Working Group.

ECC Working Group

City of Antioch GSA, Byron-Bethany Irrigation District GSA, City of Brentwood GSA, Contra Costa Water District, County of Contra Costa GSA, Diablo Water District GSA, Discovery Bay Community Services District GSA, and East Contra Costa County Irrigation District GSA comprise the ECC Subbasin Working Group.

LSCE TEAM

Luhdorff & Scalmanini Consulting Engineers and ERA Economics compose the LSCE Team for the ECC Subbasin Groundwater Sustainability Plan.

Luhdorff & Scalmanini Consulting Engineers

Debbie Cannon PG, Senior Hydrogeologist

Tom Elson, Senior Principal Engineer

Charlie Jenkins PG, Project Geologist

Faithe Lovelace Carr, Project Hydrogeologist

Priyanka Swadi, Database Specialist

Barbara Dalgish PG, Senior Hydrogeologist

Vicki Kretsinger Grabert, Senior Principal Hydrologist

Lisa Lavagnino, Project Geologist

Jeevan Jayakody PG, Project Hydrogeologist

Ken Utley PG, CEG, Senior Geologist

ERA Economics
Environment • Resources • Agriculture

Henry Ferdon MS, Associate Economist

Duncan MacEwan PhD, Principal Economist

Public outreach efforts and facilitation services were supported by Stantec through the DWR-funded Facilitation Support Services.

Stantec

Lisa Beutler, Executive Facilitator

Megan Murray ENV SP, Water Resources Planner

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICIES

LIST OF ACRONYMS & ABBREVIATIONS

AB	Assembly Bill
AC	Advisory Councils
ACS	US Census American Community Survey
AF	Acre Feet
AFY	Acre feet per year
AMI	Automatic Meter Infrastructure
AMR	Automated Meter Reading
AMSL	above mean sea level
AN	Above Normal
ASR	Aquifer Storage & Recovery
AWMP	Agricultural Water Management Plan
BAC	Bacon Island at Old River
B&C	Brown & Caldwell
BBID	Byron Bethany Irrigation District
BBM	Basin Boundary Modification
bgs	Below Ground Surface
BIMID	Bethel Island Municipal Improvement District
bm	bench mark
BMP	Best Management Practices
BN	Below Normal
BPs	Best Water Use Practices
C	Critical
CA	California
Caltrans	State Department of Transportation
CASGEM	California Statewide Groundwater Elevation
CCC	Contra Costa County
CCCDCD	Contra Costa County Department of Conservation and Development
CCCEHD	Contra Costa County Environmental Health Division
CCCGP	Contra Costa County General Plan
CCHSHMP	Contra Costa Health Services Hazardous Materials Programs
CCR	California Code of Regulations
CCWD	Contra Costa Water District
CEC	Constituent of Emerging Concern
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
Cfs	Cubic Feet per Second

CGMA	Cooperative Monitoring/Adaptive Groundwater Management Agreement
CGPS	Continuous Global Positioning System
CIMIS	California Irrigation Management Information System
COA	Cooperated Use Agreement
CoAGP	City of Antioch General Plan
COB or Brentwood	City of Brentwood
CoBGP	City of Brentwood General Plan
CoOGP	City of Oakley General Plan
COBWTP	City of Brentwood Water Treatment Plant
CPTs	Cone Penetrating Testing
CSD	Community Services District
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVRWQCB or Regional Board	Central Valley Regional Water Quality Control Board
CWC	California Water Code
D	Dry
DA	Disadvantaged Area
DAC	Disadvantaged Community
DBCSD	Discovery Bay Community Service District
days/yr	days per year
DD	Delta Diablo
DDW	California Division of Drinking Water
DFW	Department of Fish and Wildlife
DMS	Data Management System
DNPG	De Novo Water District
DO	dissolved oxygen
DOD	Department of Defense
DPC	Delta Protection Commission
DQO	Data Quality Objectives
ds/m	decimeters per meter
DTW	Depth to water
DWD	Diablo Water District
DWR	Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection
DZ	Deep Zone
EBMUD	East Bay Municipal Utilities District

EC	Electrical Conductivity
ECC or Subbasin	East Contra Costa Subbasin
ECCID	East Contra Costa Irrigation District
ECCSims	East Contra Costa Groundwater Surface Water Simulation Model
ECCWMA	East Contra Costa Water Management Association
EDA	Economically Distressed Area
EIR	Environmental Impact Report (under CEQA)
EIS	Environmental Impact Study (under NEPA)
EISIP	Expanded irrigation System Improvement Program
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
eWRIMS	Electric Water Rights Information Management System
ET (or ETo)	evapotranspiration
EWM	Water Data Library
EWMP	Efficient Water Management Practices
FMMP	California Department of Conservation, Division of Land Resource Protection, Farmland Mapping and Monitoring Program
FONSI	Finding of no significant impact
ft	feet or foot
ft/day	feet per day
ft/yr	feet per year
ft bgs	feet below ground surface
ft msl	feet above mean sea level
FSS	Facilitation Support Services
FTE	Fulltime equivalent
GAMA	Groundwater Ambient Monitoring and Assessment
GDE	Groundwater Dependent Ecosystem
GDEi	Groundwater Dependent Ecosystem indicators
GIS	geographic information systems
GMP	Groundwater Management Plan
gpd/ft	gallons per day per foot
gpm	gallons per minute
GPS	Global Positioning System
GQMP	Groundwater Quality Management Plant
GQTM	Groundwater Quality Trend Monitoring Plan
GSP or Plan	Groundwater Sustainability Plan
GSA	Groundwater Sustainability Agency

GSFLOW	Groundwater and Surface-water Flow Model
GSI	GSI Water Solutions, Inc.
GW	Groundwater
GWE	Groundwater Elevation
GWMP	Groundwater Management Program
HCM	Hydrogeologic Conceptual Model
ILRP	Irrigated Lands Regulatory Program
IMs	Interim Milestones
InSAR	Interferometric Synthetic-Aperture Radar
IRWM	Integrated Regional Water Management
IRWMP	Integrated Regional Water Management Plan
ISD	Ironhouse Sanitary District
IWFM	Integrated Water Flow Model
JPA	Joint Powers Authority
KDSA	Kenneth D. Schmidt & Associates
LID	Low Impact Development
LAO	Legislative Analyst's Office
LSA	LSA Associates
LSCE	Luhdorff & Scalmanini Consulting Engineers
LU	Land Use
LUST	Leaky Underground Storage Tank
MAF	Million Acre-Feet
MCL	Maximum Containment Level
MGD	Million gallons per day
µg/L	microgram per liter
mg/L	milligrams per liter
MHI	Median Household Income
MMP	Monitoring and Mitigation Program
MNM	Monitoring Network Module
MO	Measurable Objectives
MOA	Memorandum of Agreement
Model	Groundwater Model
MODFLOW	Modular Finite-difference Flow Model
MOU	Memorandum of Understanding
MRMP	Mitigation Monitoring and Reporting Program
msl	Mean seal level
MT	Minimum Thresholds

MTBE	methyl tertiary-butyl ether
MW	monitoring well
MWD	Municipal Water District of South California
MWR	Master Water Report
my	million years
mya	million years ago
mybp	million years before present
N	Nitrogen
NA	Not Applicable
NAHC	Native American Heritage Commission
NAIP	National Agricultural Imagery Program
NASL	Naval Air Station Lemoore
NDVI	Normalized Derived Vegetation Index
NAVD88	North American Vertical Datum of 1988
NCCAG	Natural Communities Commonly Associated with Groundwater
NEPA	National Environmental Policy Act
NHD	National Hydrography Dataset
NHP	Natural Hydrography Database
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NPDES	Natural Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWIC	Sonoma Northwest Information Center
NWIS	National Water Information System
°C	degrees Celsius
°F	degrees Fahrenheit
O&M	operations and maintenance
ORP	Oxidation Reduction
OS	Open Space
OSWCR	DWR Online System for Well Completion Reports
PBO	Plate Boundary Observatory
pH	potential of hydrogen
PLSS	Public Land Survey System
PMAs	Projects and Management Actions
ppm	parts per million
ppt	parts per trillion
PUC	Public Utilities Commission

PWIS	CA Water Boards Public Water Information System
PWS	Public Water System
QA/QC	Quality assurance/quality control
RBWTP	Randall Bold Water Treatment Plant
RC	Resource conservation
RD	Reclamation District
RMP	Representative Monitoring Point
RMS	Representative Monitoring Sites
RP	Reference Point
RPE	Reference Point Elevation
RW	recycled water
RWQCB	Regional Water Quality Control Board
RWSA	Raw Water Service Area
SAGBI	Soil Agricultural Groundwater Banking Index
SB	Senate Bill
SCADA	Supervisory Control and Data Acquisition
SDAC	Severely Disadvantaged Communities
SRF	State Water Resources Board Revolving Fund
SGMA	Sustainable Groundwater Management Act
SJR	San Joaquin River
SMC	Sustainable Management Criteria
SMCL	Secondary Maximum Containment Level
SNL	State Notification Level
SNMP	Salt and Nutrient Management Plan
SOI	Sphere of Influence
SPI	Standardized Precipitation Index
SRF	State Water Resources Control Board Revolving Fund
SSURGO	Soil Survey Geographic Database
SWP	State Water Project
SWQCB	State Water Quality Control Board
SWRCB	California State Water Resources Control Board
SZ	Shallow Zone
TDS	Total Dissolved Solids
TMDLs	Total Maximum Daily Load
TNC	The Nature Conservancy
TODB	Town of Discovery Bay Community Services District
UAVSAR	Uninhabited Aerial Vehicle Synthetic Aperture Radar

ULL	Urban Limit Line
Umhos/cm	micromhos per centimeter
UNAVCO	University NAVSTAR Consortium
UPRR	Union Pacific Railroad
USACE	United States Army Corps of Engineers
USFWS	US Fish and Wildlife Services
USGS	United States Geologic Survey
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
UST	Underground Storage Tanks
UWMP	Urban Water Management Plan
Valley	San Joaquin Valley
VOC	volatile organic chemical
W	Wet
WCR	Well Completion Report
WDL	Water Data Library
WRAC	Water Resources Advisory Committee
WTP	Water Treatment Plant
WWTF	Wastewater Treatment Facilities
WWTP	Wastewater Treatment Plant
WY	Water Year

ES 1. EXECUTIVE SUMMARY (CCR §354.4(A))

In 2014, a legislative package, referred to as the Sustainable Groundwater Management Act (SGMA), created a fundamental change in the governance of California's groundwater. SGMA required the formation of groundwater sustainability agencies (GSAs) for over 140 groundwater basins, including the East Contra Costa (ECC) Subbasin. Signed into law by Governor Jerry Brown, and effective January 1, 2015, SGMA set forth a long-term, statewide framework to protect groundwater resources.

Under the new law, seven GSAs, each charged with the development and implementation of a groundwater sustainability plan (GSP), were formed within the ECC Subbasin (Subbasin). The purpose of a GSP is to sustainably manage groundwater and avoid undesirable results within and beyond the 50-year planning and implementation horizon. The GSAs along with partners, worked collaboratively to prepare a single GSP for the Subbasin in accordance with the codified principle that sustainable groundwater management is best achieved locally[1]. The Subbasin boundary and GSA areas are shown in **Figure ES-1**.

ES 2. CONSIDERATION OF ALL BENEFICIAL USES AND USERS (WC §10723.2)

Beneficial uses and users of water are established in the state constitution and codified in the state Code of Regulations. The State Water Board, which is charged with protection of all water resources, designates or establishes beneficial uses throughout the state. In the ECC Subbasin, which lies within the San Joaquin River Basin, groundwater is considered suitable for municipal and domestic water supply, agricultural supply, and industrial uses.

The sustainability goal for this GSP establishes the protection of all beneficial uses and users of groundwater in the ECC Subbasin. The GSAs are comprised of two cities (Antioch and Brentwood), two special districts serving agricultural water supply (Byron Bethany Irrigation District and East Contra Costa Irrigation District), a special district and community services district providing municipal supply (Diablo Water District and Town of Discovery Bay), and Contra Costa County, which represents unincorporated areas not covered by other districts or cities. Along with Contra Costa Water District, which provides water to various municipal users in the region, these agencies represent and are responsible to the needs and values of all water users present in the Subbasin including urban and rural residents, farmers, various commercial industries, and environmental users all of which rely on groundwater to one degree or another. The GSAs have endeavored to reach out and engage these constituencies to ensure that this GSP reflects all concerns over water supply whether quality, quantity, or both. From residents that rely on a small capacity well providing drinking water in their homes, to small farmers that rely wholly on groundwater for their businesses and livelihoods, and to small water systems serving disadvantaged communities, this GSP recognizes that declining water levels and degradation of water quality as potentially having particularly harmful effects on health and welfare. It also values the unique Delta environment and long history of agricultural activity for which sustainable management is vital to the character and economic diversity of the region.

The GSAs have adopted sustainable management principles that include engagement of all interested parties and stakeholders; protection of potentially underrepresented communities; recognition and prioritization of environmental justice and groundwater dependent ecosystems; and continuation of cooperative water resources management to ensure that all activities needed to maintain sustainability are identified, funded, and implemented.

[1] California Water Code, Division 1, Section 113.

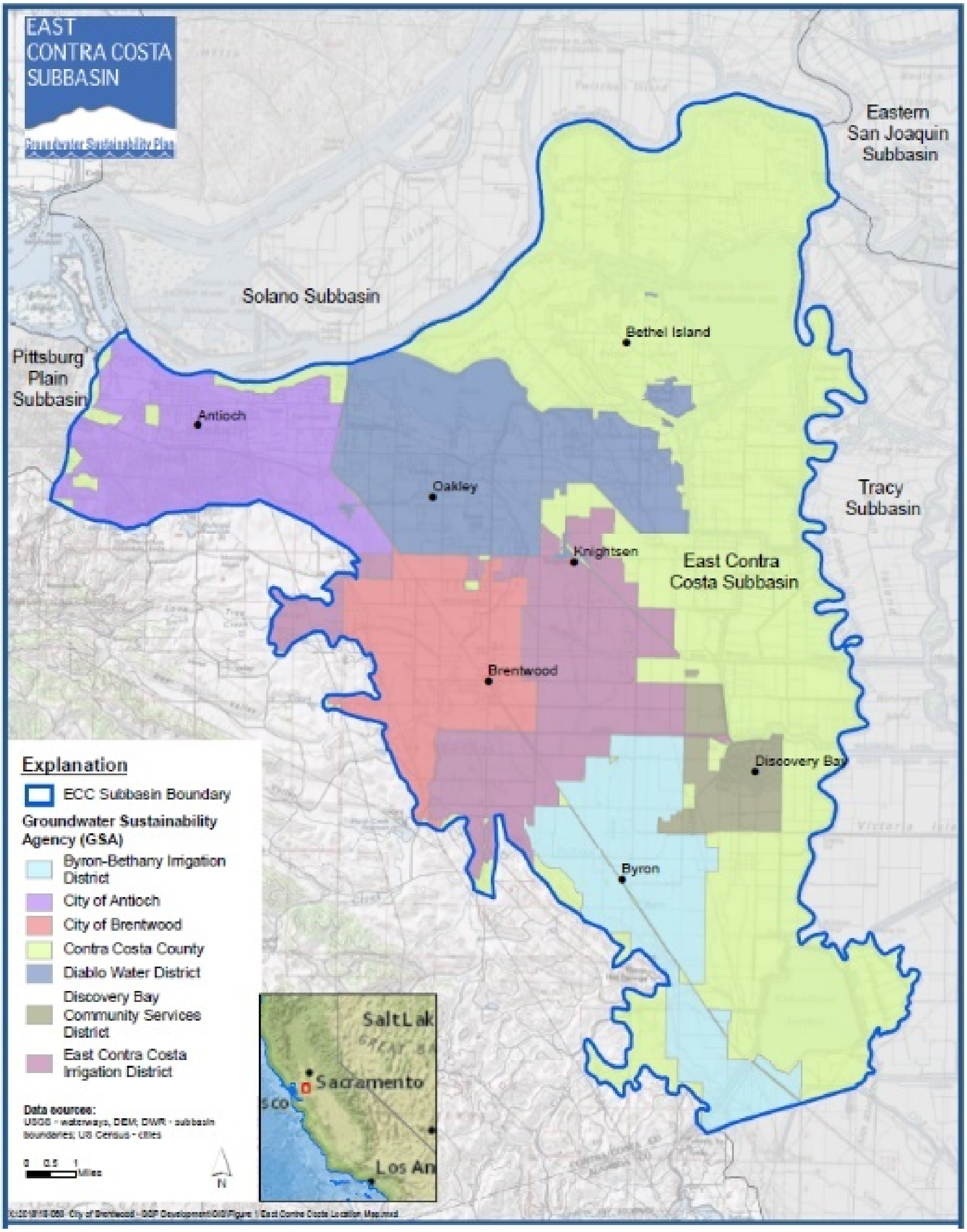


Figure ES-1 East Contra Costa Subbasin Groundwater Sustainability Agencies

ES 3. KEY FACTORS FOR THE ECC SUBBASIN GSP

Through preparation of this GSP, key factors governed the approach and planning to meet the requirements of new SGMA regulations to ensure sustainability of groundwater resources in the plan area (see **Figure ES-1**). Some of these factors are listed below.

ECC Subbasin Priority Ranking

Many groundwater basins and subbasins in the state have experienced significant adverse effects attributed to overpumping; that is, pumping that exceeds groundwater replenishment. Such basins were assigned Critically Overdrafted and High priority rankings. The ECC Subbasin shows no signs of over pumping and was assigned a Medium priority ranking and is required to submit a GSP in January 2022. Although the ECC Subbasin has not been overdrafted, its ranking was based on the importance that groundwater serves as a source of supply for varied uses including domestic, agricultural, and environmental. Domestic users include individual residences, small water systems, and municipalities. In addition, there are many disadvantaged communities[2] that rely on groundwater as a sole source of supply. East Contra Costa also has a long history of agriculture dating back over 100 years.

Sustainable Conditions in the ECC Subbasin

Groundwater conditions in the ECC Subbasin are favorable and reflect stability over the past 30 years or more. Using various analogies, the Subbasin can be described as generally full through various water-year types, including drought, and is in good "health." The favorable conditions are in part due to surface water availability that represents the largest source of supply for municipal and agricultural uses in the Subbasin.

Outlook for Future Sustainability

Using the best available data and a robust water budget model, the ECC Subbasin is projected to be sustainable under various future scenarios including those that incorporate climate change and sea level rise.

Local Management of the ECC Subbasin

On March 28, 2019, the state approved a subdivision of the Tracy Subbasin that separated the East Contra Costa portion (now called the ECC Subbasin) from the San Joaquin County portion (retained the Tracy Subbasin name), thereby providing more local control of groundwater resources. In addition, seven GSAs were formed by local public agencies to ensure that their diverse constituents are represented in this GSP. If needed, each GSA has authorities to enact policies to protect groundwater resources based on conditions within their respective jurisdictions. This provides stakeholders with more focused engagement through a local GSA.

[2] Disadvantaged communities refer to the areas which most suffer from a combination of economic, health, and environmental burdens. The state identifies these areas by collecting and analyzing information from communities all over the state.
https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/disadvantaged-communities

Non-Applicability to De Minimis Extractors

SGMA is intended to address existing and potential adverse effects typically attributed to the largest groundwater uses and users. Policies and programs aimed at achieving and maintaining sustainability may include pumping restrictions, fees, and reporting requirements. Such actions, which would be enacted locally by GSAs, *do not* apply to de minimis extractors. Under SGMA, a de minimis extractor is defined as a person who extracts two acre-feet or less per year of groundwater for domestic use. Thus, typical residential well owners are shielded from practically all potential management actions described in this GSP. Further, the GSP sustainability goal (**Section 7**) is intended to protect such users from adverse effects of sustainable management undertaken by the GSAs.

Impacts to Individual Wells

The GSP is concerned with protecting groundwater resources for future generations and maintaining sustainability as required under SGMA legislation. The GSP identifies baseline groundwater levels and water quality that protect all classes of beneficial users. The GSP *does not* mitigate conditions that were present prior to January 1, 2015 (Water Code 10727.2(b)(4)) such operational problems related to well features (e.g., depth, perforation interval, pump setting).

Water Quality

Groundwater contains numerous naturally occurring minerals that vary throughout the ECC Subbasin. While groundwater quality is generally favorable with respect to primary drinking water quality constituents, some areas have elevated total dissolved minerals, hardness, and some secondary constituents which may affect domestic and agricultural uses. The GSP is intended to avoid degradation of water quality as a result of implementing sustainable management policies, projects or actions; for example, projects that affect pumping patterns resulting in movement and mixing of groundwater sources would be evaluated to ensure that no adverse effects occur to any users. The GSP does not mitigate groundwater quality in the Subbasin that is naturally occurring during the historical baseline.

Impacts of Drought

Temporary imbalances between extraction and replenishment due to drought are not considered an undesirable result as long as groundwater conditions recover in subsequent normal to wet years. Thus, a drop in groundwater levels may occur in very dry years, which may produce a short-term impact on wells.

ES 4. GSP CONTENTS

The GSP provides information demonstrating that the past and present actions of the ECC GSAs have created a sustainably managed groundwater basin. The GSP outlines planned management oversight and activities that will result in continued sustainability of the groundwater resources in east Contra Costa.

This Executive Summary and the companion GSP are organized as follows:

- Executive Summary
- Section 1 Introduction
- Section 2 Plan Area
- Section 3 Basin Setting
- Section 4 Historical, Current, and Projected Water Supply

- Section 5 Water Budget
- Section 6 Monitoring Network and Data Management System
- Section 7 Sustainable Management Criteria
- Section 8 Project and Management Actions
- Section 9 Plan Implementation
- Section 10 Notice and Communication

An overview of each section of the ECC Subbasin GSP is presented below.

Section 1 Introduction

The ECC Subbasin, also referred to as San Joaquin Valley-East Contra Costa Subbasin (5-022.19), is a Medium priority groundwater basin based on the Groundwater Basin Prioritization by the State Department of Water Resources (DWR). Under SGMA, Medium priority subbasins must submit an adopted GSP by January 31, 2022. Management of the ECC Subbasin through the GSP will be based on achieving and maintaining groundwater sustainability over a 50-year planning and implementation horizon.

SGMA authorizes a "local public agency that has water supply, water management, or land use responsibilities within a groundwater subbasin or basin to elect to become a GSA and to develop, adopt, and implement a GSP (Water Code § 10721(n).)" The following agencies formed GSAs and coordinated preparation of this GSP. **Figure ES-1** shows the service area for each GSA.

- Byron Bethany Irrigation District (BBID) GSA
- City of Antioch GSA
- City of Brentwood GSA
- Contra Costa County (CCC) GSA
- Diablo Water District (DWD) GSA
- Discovery Bay Community Services District (DBCSD[3]) GSA
- East Contra Costa Irrigation District (ECCID) GSA

Contra Costa Water District (CCWD), while not a GSA, is a partner in the development of this jointly prepared GSP. CCWD provides surface water to various entities within its service area. Because surface water plays a part in future water resources management for the Subbasin, CCWD is an equal partner in the development of the ECC Subbasin GSP.

On May 9, 2017, the seven GSAs and CCWD entered into a Memorandum of Understanding (MOU). Under this MOU the agencies share costs and management of the development and implementation of the GSP.

[3] Also referred to as Town of Discovery Bay (TODB).

Section 2 Plan Area

The ECC Subbasin covers a 168-square mile area (107,596 acres) in the eastern portion of Contra Costa County (**Figure ES-1**). The Subbasin includes the communities of Antioch, Bethel Island, Byron, Brentwood, the Town of Discovery Bay (TODB), Knightsen, and Oakley and two agricultural districts (Byron Bethany Irrigation District and East Contra Costa Irrigation District). The Subbasin is located on the southwestern part of the Sacramento-San Joaquin Delta, which is the largest estuary on the West Coast and provides critical habitat to fish and wildlife species. The 2015 land use in the Subbasin is mainly agricultural (41 percent), followed by urban (about 23 percent), then by water and native vegetation (both about 14 percent). As quantified in Section 4, the Subbasin has three main water supply sources: surface water, groundwater, and recycled water. Surface water provides, on average, about 80 percent of the aggregate demand for all use sectors in the Subbasin. This percentage is projected to remain stable at 80 to 85 percent through at least 2050 (see **Section 4**, **Table 4-5**).

Section 3 Basin Setting

The ECC Subbasin setting is described through a hydrogeologic conceptual model depicting the physical features of the aquifer system and groundwater conditions.

Hydrogeologic Conceptual Model

- ECC Subbasin is bounded on the north, east, and south by the Contra Costa County line, which is contiguous with the San Joaquin River (north) and Old River (east). In the west, the Subbasin is bounded by marine sediments of the Coast Range.
- Topography and geological formations gently slope to the northwest. The upper 400 feet of sediments are comprised of alluvial deposits with discontinuous clay layers interspersed with more permeable coarse-grained units.
- The ECC Subbasin aquifer system is divided into the upper unconfined Shallow Zone (to about 150 feet below ground surface) and a lower semi-confined to confined Deep Zone (the Corcoran Clay is not present in the Subbasin). Most water wells are constructed within the upper 400 feet of the aquifer system.
- Groundwater conditions throughout the Subbasin are monitored through water level measurements and water quality testing. Water level data indicate that groundwater storage is largely stable and fluctuate with water-year type (wet, normal, dry).

Sustainability Indicators

DWR is charged with determining the adequacy of GSPs in meeting SGMA's requirements. Generally, to achieve sustainability, the amount of groundwater extracted must be less than or equal to the amount of groundwater replenishment. Temporary imbalances between extraction and replenishment due to drought are not considered an undesirable result as long as groundwater conditions recover in subsequent normal to wet years. In addition, the GSP regulations[4] list six sustainability indicators that must be addressed in GSPs.

[4] California Water Code § 354.26

California Department of Water Resources, 2016

Following are the ECC findings for each of the sustainability indicators.

- **Groundwater Elevations**- Groundwater levels in the ECC Subbasin are stable indicating that the Subbasin has been managed within its sustainable yield[5]. This is partially due to surface water availability for agricultural and urban uses.
- **Change in Groundwater Storage** - As determined through the water budget analysis in **Section 5**, the cumulative change in groundwater storage was unchanged between 1997 and 2018 despite three drought periods (2001-2002, 2007-2009, 2012-2016).
- **Seawater Intrusion** - The ECC Subbasin is situated in the San Francisco Bay/Sacramento-San Joaquin Delta. This GSP recognizes the potential for interactions between saline baywater and shallow groundwater. While the baywater is fresh, adverse intrusion may occur if saline water infiltrates the Delta and intrudes into shallow groundwater. This potential mechanism may be triggered or exacerbated by sea level rise and/or shifts in groundwater flow directions and gradients caused by future pumping patterns. There is no direct connection between ocean seawater and groundwater in the Subbasin.
- **Groundwater Quality** - Groundwater quality is generally favorable with respect to primary drinking water quality constituents. Naturally elevated mineral content may pose localized restrictions for domestic (e.g., hardness) and agricultural (crop sensitivity) uses. Key monitoring constituents are total dissolved solids, chloride, hardness, nitrate, and boron. With the exception of nitrate, these constituents are naturally occurring in the ECC Subbasin.
- **Land Subsidence** - There is no historical evidence of inelastic land subsidence due to groundwater withdrawal in the ECC Subbasin.
- **Depletions of Interconnected Surface Water** – This indicator is of concern where shallow groundwater and surface water are hydraulically connected. Marsh Creek, the San Joaquin River, and Old River are considered interconnected surface water bodies in the ECC Subbasin. Impacts to these features due to groundwater pumping will be managed through this GSP through monitoring of shallow wells and stream gage stations.

[5] "Sustainable yield" means the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result. Cited from: Section 10733.2, Water Code

Section 4 Historical, Current, and Projected Water Supply

This section describes the ECC Subbasin land uses, population, and metered historical, current and projected water supplies. Water supply amounts were provided by the GSAs and CCWD. When historical or projected water supply were not provided, land uses and population data were used to estimate these data. This information is integrated into the Subbasin surface water/groundwater model (GSP **Section 5**).

Section 5 Water Budget

In accordance with technical guidance documents provided by DWR, water budget scenarios were evaluated using a groundwater flow model that quantified historical, current, and projected groundwater budget conditions. The development of the ECC Groundwater-Surface Water Simulation Model (ECCSim) was a refinement of two other validated and widely used modeling platforms, IWFM and C2VSim-FG Beta2[6]. These were selected as the modeling platform due to the versatility in simulating crop-water demands in the predominantly agricultural setting of the Subbasin, groundwater surface-water interaction, the existing hydrologic inputs existing in the model for the time period through the end of water year 2015, and the ability to customize the existing C2VSim-FG Beta2 model to be more representative of local conditions in the area of the ECC Subbasin. Use of publicly available modeling platforms is a guiding principle under DWR Best Management Practices[7] and facilitates independent assessment of modeling results.

Based on the modeling results, the ECC Subbasin is historically, currently, and projected to be sustainable. **Figure ES-2** shows a breakdown in water budget components for the model base period of 1997 to 2018. The modeling results indicate that the cumulative change in groundwater storage fluctuated while cumulative storage was essentially unchanged at the end of the base period despite three state-wide drought periods (2001-2002, 2007-2009, 2012-2016). Over the base period, total pumping in the Subbasin ranged from 32,500 to 58,250 AFY and averaged 46,455 AFY.

---

[6] The development of the East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) involved starting with and evaluating the U.S. Geological Survey's Central Valley Hydrologic Model (CVHM) and the beta version (released 5/1/2018) of DWR's fine-grid version of the California Central Valley Groundwater-Surface Water Flow Model (C2VSim-FG Beta2). C2VSim-FG Beta2 utilizes the most current version of the Integrated Water Flow Model (IWFM) code available at the time of the ECCSim development.

[7] 23 CCR §352.4(f)

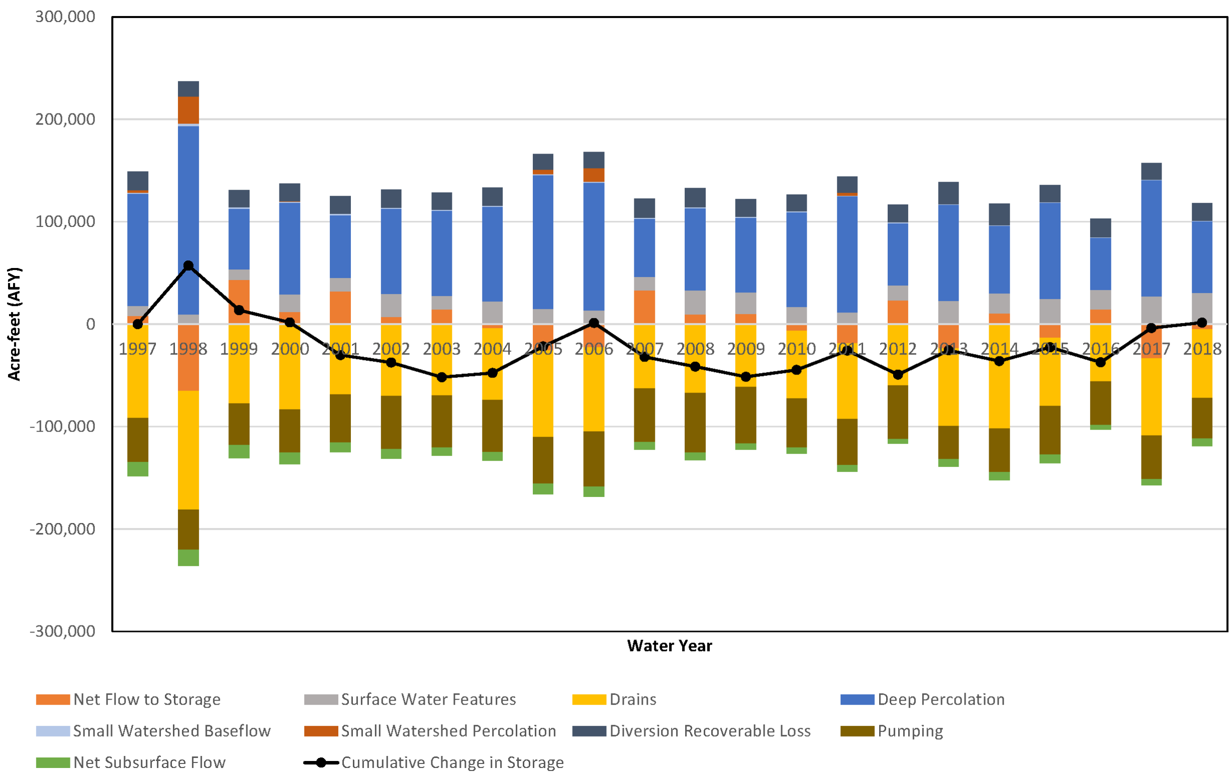


Figure ES-2 Groundwater Budget for East Contra Costa Subbasin Historical Calibration Period (1997-2018)

Various future scenarios were evaluated using the ECC Subbasin groundwater flow model including sustainable yield. The projected sustainable yield is the amount of pumping that can occur while avoiding undesirable results for the six sustainability indicators. The sustainable yield for the ECC Subbasin is estimated at approximately 72,000 AFY, or about 55 percent greater pumping than the historical average. At higher levels of pumping, the modeling indicates the potential to increase streamflow depletion and inter-basin flow beyond historical baselines. Like the base period scenario, a chronic decline in groundwater storage was not a factor in the sustainable yield threshold. The margin between the average pumping rate in the Subbasin over the base period (46,455 AFY) and the stated sustainable rate of 72,000 AFY provides an ability to meet short-term surface water supply shortages in critically dry years through increased groundwater pumping. This is a hallmark of effective conjunctive use of surface water and groundwater resources.

The projected water budget was also evaluated under climate change and sea level rise. Based on the model results, the ECC Subbasin is projected to be sustainable over the 50-year implementation and planning horizon required under SGMA.

Through adaptive management, the groundwater flow detailed in **Section 5** will be updated and refined to reflect actual future conditions and serve in the adaptive management of the ECC Subbasin using the best available information.

Section 6 Monitoring Networks and Data Management System

Monitoring networks are developed to quantify current and future groundwater conditions in the ECC Subbasin, as well as within individual GSA jurisdictions. Monitoring networks were developed for each of the six SGMA sustainability indicators. Some sustainability indicators needed to be expanded to fill data gaps and improve the ability to demonstrate sustainability and refine the hydrogeologic conceptual model. The networks include:

- **Groundwater Level Monitoring Network**- Groundwater level data from a network of monitoring wells reflect groundwater occurrence, flow direction, hydraulic gradients between principal aquifers, and interaction between groundwater and surface water features. Dedicated monitoring wells are located within the jurisdiction of the seven GSAs. The ECC Subbasin has 55 basin-wide wells and 12 of these comprise a network of representative monitoring sites (RMS) as defined under new regulations governing GSPs.
- **Groundwater Storage** – Groundwater levels serve as a proxy for the groundwater storage sustainability indicator monitoring network.
- **Seawater Intrusion** – Intrusion of saline baywater, if it occurs, is evaluated based on chloride concentrations from monitoring wells adjacent to the San Joaquin River.
- **Groundwater Quality** –Groundwater quality monitoring will be conducted at an existing network of 22 basin-wide water supply wells, 11 of these are part of a representative monitoring network.
- **Land Subsidence** – A land subsidence monitoring network is comprised of four Plate Boundary Observatory (PBO) stations in and adjacent to the ECC Subbasin and data collected by DWR using InSAR[8] satellite data.
- **Interconnected Surface Water** – Interconnected surface water will be monitored through existing stream gages (19) and Shallow Zone groundwater level monitoring wells (15). New shallow wells were installed as part of this GSP to address a data gap.

A Data Management System (DMS) was developed to store and analyze data collected as part of this GSP. With submittal and implementation of the ECC Subbasin GSP, there will be a publicly accessible weblink to view reports, maps, graphs, and current data under the Subbasin monitoring plan.

Section 7 Sustainable Management Criteria

Sustainable management criteria include establishing a sustainability goal for the Subbasin, defining undesirable results, and quantifying minimum thresholds and measurable objectives.

The sustainability goal for the ECC Subbasin GSP is to manage the groundwater Subbasin to:

- Protect and maintain safe and reliable sources of groundwater for all beneficial uses and users.
- Ensure current and future groundwater demands account for changing groundwater conditions due to climate change.

[8] InSAR is Interferometric Synthetic Aperture Radar.

- Establish and protect sustainable yield for the Subbasin by achieving measurable objectives set forth in this GSP in accordance with implementation and planning periods[9].
- Avoid undesirable results defined in the GSP in accordance with SGMA.

Sustainable management criteria (SMC) also define the conditions that constitute sustainable groundwater management. Note that undesirable results have not occurred historically in the ECC Subbasin and are not projected to occur in the future. The sustainable management criteria will commit the GSAs to meeting the sustainability goal for the Subbasin.

Table ES-1 summarizes the SMC for the six SGMA sustainability indicators and includes the minimum thresholds and measurable objectives required under GSP regulations:

Table ES-1 Sustainable Management Criteria Summary

Sustainability Indicator	Measurable Objective (MO)	Minimum Threshold (MT)	Undesirable Result
Chronic Lowering of Groundwater Levels	Average spring elevation of groundwater at the Representative Monitoring Site (RMS) and its vicinity	The lowest historical water levels observed in a well plus an additional 10 feet lower	The MT in any well is exceeded over three consecutive years, indicating a trend, and do not recover in normal to wet years
Reduction in Groundwater Storage	Use as a proxy, the MO for chronic lowering of groundwater levels	Use as a proxy, the MT for chronic lowering of groundwater levels	Use as a proxy, the undesirable result for chronic lowering of groundwater levels
Seawater intrusion	The MO at each RMS is the average chloride concentrations from 2013 to 2017.	Chloride concentration for any Shallow Zone or Deep Zone well is set at 250 mg/L secondary maximum contaminant level	A bayside monitoring well has a chloride concentration above 250 mg/L over three consecutive years and is determined to be induced by GSAs' actions.
Degraded Groundwater Quality	The MO for each RMS is the average concentrations (2013 to 2017) for each constituent of concern	The three-year running average exceedance of an MCL for a key monitoring constituent.	Any RMS that exceeds any state drinking water standard during GSP implementation because of GSAs' actions
Land Subsidence	The MO is set at UNAVCO station P256 at the average seasonal elastic movement (0.6 inch vertical).	An MT of 1-inch land surface elevation outside the historical elastic range over a three-year period as	Associated impacts due to groundwater pumping: impacts to infrastructure such as damage to roads and structures, reduced

[9] As defined under SGMA, the GSP implementation period is 20 years. The planning and implementation horizon is a 50-year time period over which the GSAs determine that plans and measures will be implemented to ensure that the basin or subbasin is operated within its sustainable yield.

Sustainability Indicator	Measurable Objective (MO)	Minimum Threshold (MT)	Undesirable Result
		shown by monitoring data at the UNAVCO site P256.	capacity of water conveyances, and increased vulnerability to flooding.
Depletion of interconnected surface water	The MO is set at the average annual groundwater pumping during the Base Period 1997 to 2018, or 54,000 AFY.	Based on the groundwater flow model results, a conservative interim MT is set at a value for sustained basin-wide pumping above the historic baseline average which induces exceedances in estimated streamflow depletion as compared to baseline conditions. [10]	Depletions that result in reductions in flow or stage of major rivers and streams that are hydrologically connected to groundwater in the Subbasin and which cause significant and unreasonable impacts on beneficial uses and users of surface water and the environment

Section 8 Projects and Management Actions

Projects and management actions (PMAs) were developed to achieve the ECC Subbasin sustainability goal by 2042 and avoid undesirable results during and beyond the GSP planning and implementation horizon. Because the ECC Subbasin is currently and projected to be sustainable (i.e., no onset of undesirable results), PMAs are not expected to be essential for sustainability. However, future conditions are uncertain and PMAs will be employed through the principle of adaptive management on an as-needed basis.

Seven projects are included in the GSP representing a variety of project types to increase water supply availability and reliability including infrastructure to provide in-lieu recharge, improve water quality, and increase use of recycled wastewater. Projects are divided into three status categories: completed, under construction, and planned. The three completed projects are operating and provide in-lieu groundwater benefits of over 5,500 AFY. The two projects under construction will be operating by 2042 and are projected to provide over 8,000 AFY.

Management actions consisting of water well policies (e.g., metering and reporting, spacing, and construction features) and demand management would be implemented locally by individual GSAs on an as-needed basis. Except for a measure designed to protect water quality, such as seal depths, such management actions are not applicable to de minimis users.

[10] The interim MT for interconnected surface water will be replaced with monitored shallow groundwater levels and calculations of the rate or volume of depletion when the data gap for shallow monitoring is filled as described in **Section 6**.

Section 9 Plan Implementation

Estimated Cost to Implement the GSP

The estimated total cost to the ECC GSP Working Group[11] over the first five years of GSP implementation is between $2.6 and 3.1 million. Costs are based on best available estimates. These costs include public outreach, monitoring and well maintenance, data management, and GSP reporting (e.g., annual and 5-year updates). Individual member agencies will continue to fund individual projects and/or management actions and monitoring activities. The budget will be adjusted over time as the GSP implementation costs are better understood through sustainable management activities and guidance from DWR on the submitted GSP and subsequent reporting.

Implementation of the projects will be borne by the project proponents.

Funding Sources and Mechanisms

GSA implementation costs will be paid for through contributions from the member GSAs and CCWD under a cost-sharing arrangement to be developed following GSP adoption. Grant funding will be pursued when available.

Schedule for Implementation

Figure ES-3 provides a projected schedule for ECC GSP implementation including outreach and communication, monitoring, and GSP reporting activities.

[11] ECC GSP Working Group consists of the seven GSAs and Contra Costa Water District.

Figure ES-3 GSP Implementation Schedule

Task Name	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Plan Implementation																					
GSP Submittal to DWR	x																				
Joint Implementation Agreement			x																		
Outreach and Communication																					
Monitoring and DMS																					
GSP Reporting																					
Annual Reports	x	x	x	x	x		x	x	x	x		x	x	x	x		x	x	x	x	
5-year GSP Evaluation Reports						x					x					x					x

x Indicates a submittal.
Indicates ongoing event.

Section 10 Notice and Communication

Development of the ECC GSP was a collaborative effort among the ECC GSP Working Group (seven GSAs and CCWD), technical consultants, community members, and stakeholders. The Working Group conducted over 40 meetings, from 2018 to 2021. Documents posted to a publicly accessible website, Working Group meeting notes, surveys, newspaper notices, and direct email outreach were used to keep the public informed of the GSP development and provide opportunities for public input.

The Working Group members also provided regular updates through individual agency public meetings and websites. Information was also provided through social media by those agencies with a presence on such platforms. Three public workshops, held between July 2020 and September 2021, were used to inform and engage beneficial users of groundwater in the ECC Subbasin and discuss each section of the GSP. Stakeholder comments were incorporated into the final GSP.

SECTION 1 CONTENTS

LIST OF FIGURES

LIST OF APPENDICIES

1. INTRODUCTION

1.1. Background

1.1.1. Purpose of the Groundwater Sustainability Plan

The Sustainable Groundwater Management Act (SGMA), effective January 1, 2015, established a framework of priorities and requirements to facilitate sustainable groundwater management throughout California. The intent of the SGMA mandate is for groundwater to be managed by local public agencies (Groundwater Sustainability Agencies [GSAs]) to ensure a groundwater basin is operated within its sustainable yield through the development and implementation of a Groundwater Sustainability Plan (GSP or Plan).

1.1.2. Sustainability Goal

Each GSP must include a sustainability goal for the basin to manage groundwater in a manner that avoids undesirable results within 20 years of the statutory deadline (i.e., by or before January 31, 2042).

"Undesirable result means one or more of the following effects caused by groundwater conditions occurring throughout the basin" (Water Code §10721.x):

1 *Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.*

2 *Significant and unreasonable reduction of groundwater storage.*

3 *Significant and unreasonable seawater intrusion.*

4 *Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.*

5 *Significant and unreasonable land subsidence that substantially interferes with surface land uses.*

6 *Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.*

As required by SGMA regulations, the ECC GSAs developed a sustainability goal for the Subbasin that is described in detail in **Section 7**.

Definitions for terms used in SGMA from the California Water Code 10721 and the California Code of Regulations Title 23 351 are included in **Appendix 1a**.

1.1.3. Description of the East Contra Costa Subbasin

The original boundary of the Tracy Groundwater Subbasin included the jurisdiction of multiple cities and the counties of Contra Costa and San Joaquin. To streamline the development of the required GSP, the GSAs in Contra Costa and San Joaquin Counties, on September 6, 2018 applied to the State to divide the Tracy Subbasin along the border of Contra Costa and San Joaquin Counties. Dividing a groundwater basin is known as a Basin Boundary Modification or BBM. This allows the GSAs in each County to develop their own GSP under the Act. On February 11, 2019, the Department of Water Resources approved dividing the

Tracy Subbasin into two subbasins (e.g., East Contra Costa Subbasin and the new Tracy Subbasin) thereby creating a separate groundwater basin entirely within Contra Costa County.

The East Contra Costa Subbasin (ECC Subbasin), also referred to as San Joaquin Valley-East Contra Costa (5-022.19), is a medium priority groundwater basin based on the Groundwater Basin Prioritization by the State Department of Water Resources (DWR) (**Figure 1-1**). Under SGMA, medium priority subbasins must submit an adopted GSP by January 31, 2022. The ECC Subbasin's boundaries are generally defined by the San Joaquin River on the north, Old River on the East, the Contra Costa County boundary on the south, and the non-water bearing geologic units on the west. As mentioned above, the ECC Subbasin is contained entirely within Contra Costa County and underlies all or portions of the Cities of Antioch, Oakley, Brentwood, the Town of Discovery Bay and the communities of Bethel Island, Byron and Knightsen.

1.2. Agency Information

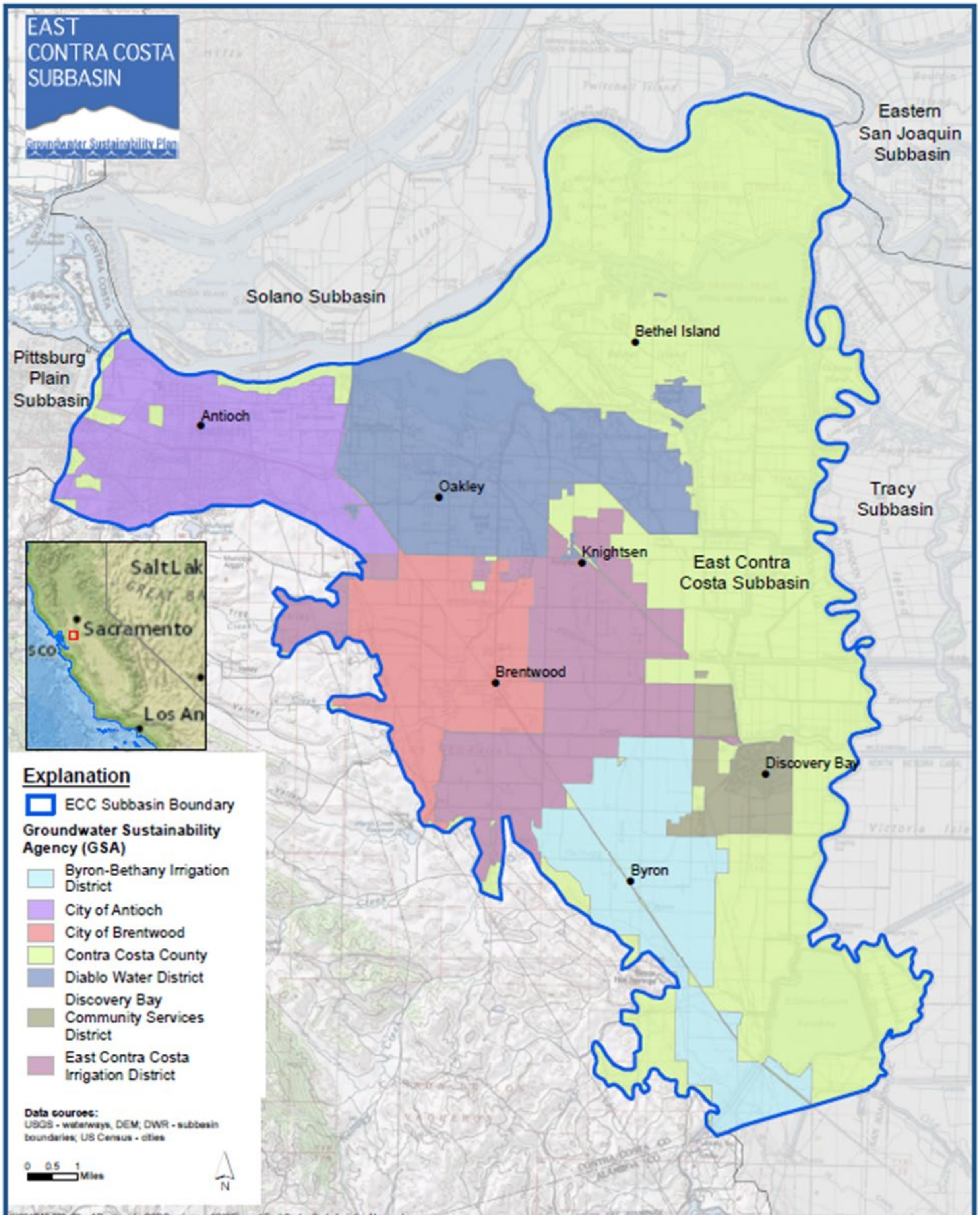
1.2.1. GSAs in East Contra Costa Subbasin

In the East Contra Costa Subbasin, eight agencies are working together in developing the GSP. The agencies include:

- Byron Bethany Irrigation District (BBID)
- City of Antioch
- City of Brentwood
- Contra Costa County (CCC)
- Contra Costa Water District (CCWD)
- Diablo Water District (DWD)
- Discovery Bay Community Services District (DBCSD or TODB)
- East Contra Costa Irrigation District (ECCID)

SGMA authorizes a "local public agency that has water supply, water management, or land use responsibilities within a groundwater subbasin or basin to elect to become a GSA and to develop, adopt, and implement a GSP (Water Code § 10721(n).)" All agencies listed above became GSAs with the exception of CCWD. CCWD is a water district that provides surface water to entities within their service area. Surface water may play a part in future management of a groundwater basin and so CCWD is an equal partner in the development of the ECC GSP. On May 9, 2017, the eight agencies entered a Memorandum of Understanding (MOU). Under this MOU the agencies share costs and management of the development and implementation of the GSP. In addition, the MOU was updated with the subbasin name change as a result of the BBM in March 2020 when the eight agencies signed an updated MOU to develop a GSP (**Appendix 1b**).

Prior to the basin boundary modification, the Tracy Subbasin was successful in obtaining one million dollars in Proposition 1 Round 2 grant funds for GSP development. After the BBM, the ECC and Tracy Subbasins split the grant funding to prepare a GSP for each of the two subbasins. On October 24, 2019, San Joaquin County and the City of Brentwood signed an agreement for the management of the grant funds. In addition, the ECC Subbasin received Proposition 68 Round 3 funding.



East Contra Costa Subbasin, GSAs, and Adjacent Subbasins

Figure 1-1

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

1.2.2. Agency Names and Mailing Addresses

As per California Water Code §10723.8, the following contact information is provided for each GSA.

City of Brentwood GSA (**Plan Manager**)
Attention: Water Operations Manager Public Works Operations
Eric Brennan
2201 Elkins Way
Brentwood CA, 94513-7344
ebrennan@brentwoodca.gov

Byron Bethany Irrigation District
Attention: Assistant General Manager
7995 Bruns Road
Byron, CA 94514-1625

City of Antioch GSA
Attention: Project Manager
200 H Street
Antioch, CA 94509

Contra Costa County GSA
Attention: Manager, Contra Costa County Water Agency
30 Muir Road
Martinez, CA 94553

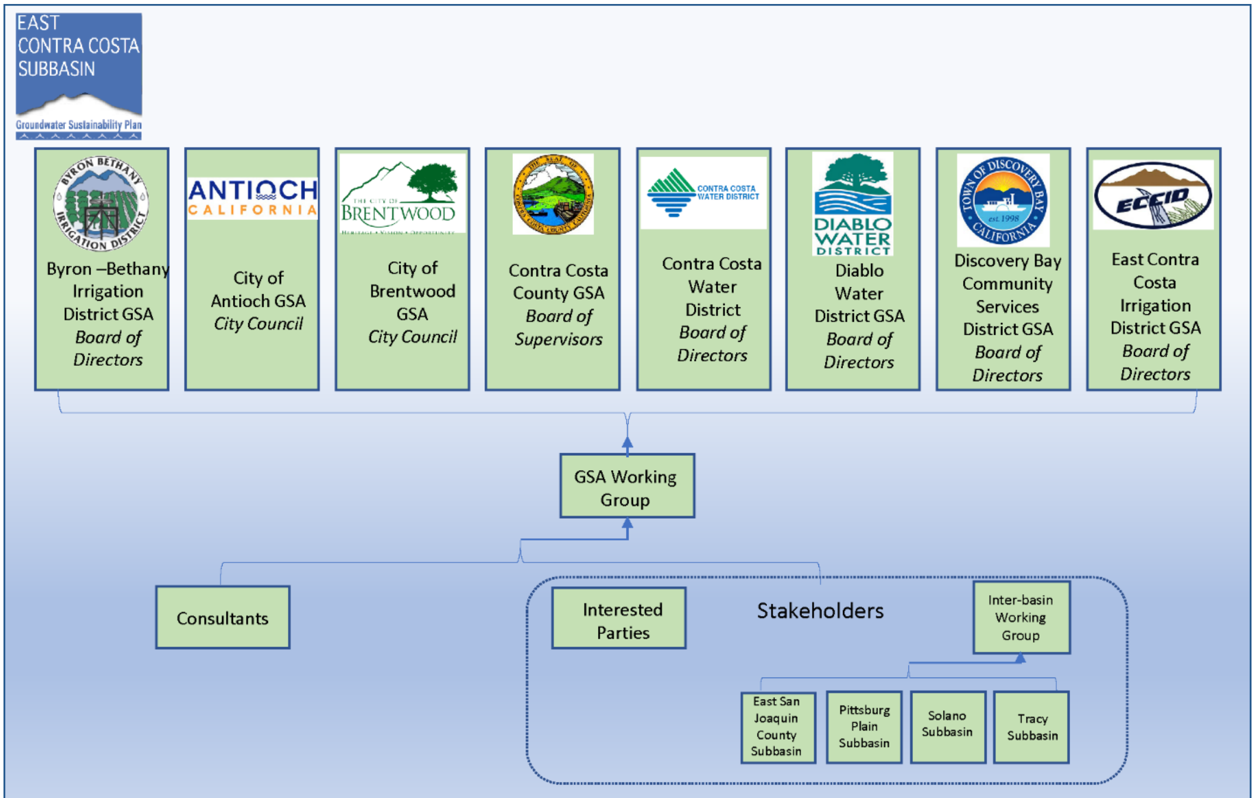
Diablo Water District GSA
Attention: General Manager
P.O. Box 127
87 Carol Lane
Oakley, CA 94561

Discovery Bay Community Services District GSA
Attention: General Manager
1800 Willow Lake Road
Discovery Bay, CA 94505-9376

East Contra Costa Irrigation District GSA
Attention: General Manager
1711 Sellers Avenue
Brentwood, CA 94513

1.2.3. Agencies' Organization, Management Structure, and Legal Authority of the GSAs and CCWD

The seven (7) GSAs that cover the ECC Subbasin and participate in the development and administration of the GSP each have their own organization and management structure and legal authority as described below. Prior to becoming a GSA, each entity submitted notifications to DWR as outlined in Water Code §10723.8. GSA boundaries are shown in **Figure 1-1,** and the ECC Subbasin management structure is shown in **Figure 1-2**. The GSA Working Group is made up of GSA representatives plus a representative from CCWD that meet monthly to coordinate GSP development. The organization and management structure for the seven GSAs and CCWD (an equal partner and financial contributor) are described below.



Luhdorff & Scalmanini Consulting Engineers

Management Structure, ECC Subbasin

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 1-2

1.2.3.1. City of Brentwood GSA (Plan Manager)

The City of Brentwood GSA operates within its current city organization and management structure as a General Law City. Government Code section 36501 authorizes general law cities be governed by a city council of five members (Mayor, Vice Mayor, and three Council Members). Bentwood's GSA activities are staffed through the City's Public Works Department and one member attends the monthly GSA Working Group meeting that coordinates GSP activities. The person with management authority for implementation of the Plan is the City Manager or designee.

1.2.3.2. Byron-Bethany Irrigation District GSA

Byron-Bethany Irrigation District GSA operates within its current organization and management structure under its seven-member Board of Directors and its legal authority as a multi-county special district, operating under Division 11 of the California Water Code. It was originally created to deliver raw, agricultural water to area farmers. The District elected to serve as the GSA for the portion of BBID that is situated within the boundaries of the ECC Subbasin. A portion of BBID is also within the adjacent Tracy Subbasin. The General Manager sits on the GSA Working Group that coordinates ECC Subbasin GSP activities. The person with management authority for implementation of the Plan is the District's General Manager.

1.2.3.3. City of Antioch GSA

The City of Antioch GSA operates within its current organization and management structure as a General Law City under its current City Council that consists of five members. Its legal authority is described in the City ordinances, and it abides by state codes. The GSA activities are staffed through the City's Capital Improvements Division. The Project Manager of the Capital Improvements Division sits on the GSA Working Group that coordinates ECC Subbasin GSP activities. The person with management authority for implementation of the Plan is the City Manager or designee.

1.2.3.4. Contra Costa County GSA

The Contra Costa County GSA operates within its current organization and management structure by a five-member Board of Supervisors as well as its legal authority set forth in the Sustainable Groundwater Management Act, California Water Code section 10720, et seq. The GSA activities are staffed through the Contra Costa County Water Agency and one member sits on the monthly GSA Working Group meeting that coordinates GSP activities. The person with management authority for implementation of the Plan is the director of the Department of Conservation and Development.

1.2.3.5. Contra Costa Water District

Contra Costa Water District is not a GSA but is an equal partner and financial contributor to the development of the ECC GSP through the District's execution of the ECC MOU.

1.2.3.6. Diablo Water District GSA

The Diablo Water District GSA operates within its current organization and management structure by a five-member Board of Directors as well as its legal authority as a special district. The General Manager and staff operate the District following policies set by the Board. The General Manager and Manager of Water Operations sit on the GSA Working Group that coordinates ECC Subbasin GSP activities. The person with management authority for implementation of the Plan is the General Manager.

1.2.3.7. Discovery Bay Community Services District GSA

The Town of Discovery Bay GSA operates within its current organization and management structure as a California Independent Community Services District and is governed by a five-member Board of Directors, as well as legal authority as a special district. The District's General Manager is tasked to carry out the policy decisions of the Board and oversee day-to-day operations. The General Manager sits on the GSA Working Group that coordinates ECC Subbasin GSP activities. The person with management authority for implementation of the Plan is the General Manager.

1.2.3.8. East Contra Costa Irrigation District GSA

The East Contra Costa Irrigation District GSA operates within its current organization and management structure under a five-member Board of Directors representing five Divisions within the District as well as legal authority as a special district. The General Manager sits on the GSA Working Group that coordinates ECC Subbasin GSP activities. The person with management authority for implementation of the Plan is the General Manager.

1.2.4. Governance Structure

Figure 1-1 shows the extent of the GSP area (the entire ECC Subbasin) and each of the seven GSA jurisdictional boundaries. The following powers and authorities are granted to GSAs to implement the GSP in accordance with the requirements of California Water Code § 10725 *et seq:*

- Adopt standards for measuring and reporting water use
- Adopt rules, regulations, policies and procedures to govern the adoption and implementation of the GSP, as authorized by SGMA including funding of the GSA, and the collection of fees or charges as may be applicable
- Develop and implement conservation best management practices
- Develop and implement metering, monitoring and reporting related to groundwater pumping
- Hire consultants as determined necessary or appropriate by the GSA
- Prepare a budget

1.2.4.1. Memorandum of Understanding for GSP Development

As mentioned above, the seven GSAs and CCWD entered into a MOU on May 9, 2017. The purpose of the MOU was to collaborate to develop a single GSP for the ECC Subbasin and for each GSA to consider adopting and implementing the GSP within its GSA management area. The term of the MOU is until January 31, 2022 when the GSP is due to DWR. An updated MOU was required as a result of the BBM resulting in the new subbasin name. An updated MOU was signed on March 2020 (**Appendix 1b**).

1.2.4.2. Description of Initial Notification

The first step in preparing a GSP is notifying DWR of the intent to develop a GSP. In February 2018, the City of Brentwood submitted an Initial Notification to prepare a GSP for the Tracy Subbasin. Although the new ECC Subbasin was formed on February 2019, the ECC GSP development efforts continued from February 12, 2018 (when the Tracy Subbasin Initial Notification was submitted). The initial Notification to DWR is posted on the DWR website: https://sgma.water.ca.gov/portal/gsp/init/all.

1.3. Report Organization and Elements Guide

This Report will be organized into the following sections:

Section 1: Introduction

Section 2: Plan Area

Section 3: Basin Setting

Section 4: Historical, Current, and Projected Water Supplies

Section 5: Water Budget

Section 6: Monitoring Network and Data management System

Section 7: Sustainable Management Criteria

Section 8: Projects and Management Actions

Section 9: Plan Implementation

Section 10: Notice and Communication

DWR has provided the Elements Guide[1] that lists information required to be included in a GSP by the Sustainable Groundwater Management Act and the Groundwater Sustainability Plan Emergency Regulations. It is a cross reference to where this information can be found in the GSP (e.g., page number, figure number, and/or table number).

[1] Source: https://sgma.water.ca.gov/portal/resources: Printable Elements Guide Excel Template

1.4. References

Brown and Caldwell (B&C). 2016. Final 2015 2015 Urban Water Management Plan. Prepared for City of Brentwood. June 2016.

Bradford Island Reclamation District 2059. https://bradfordisland.com/. Accessed January 2020

California Department of Water Resources (DWR). 1981. Water Well Standards: State of California. Bulletin 74-81.

California Department of Water Resources (DWR). 1991. California Well Standards, Bulletin 74-90.

California Department of Water Resources (DWR) Well Completion Report Map Application. 2019. https://www.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37. Accessed May 2019.

California Department of Water Resources (DWR). 2019 https://gis.water.ca.gov/app/edas/. Accessed May 2019.

California Department of Water Resources (DWR). 2019. https://gis.water.ca.gov/app/dacs/. Accessed May 2019.

California Department of Water Resources (DWR). December 2016. Guidance Document for the Sustainable Management of Groundwater: Groundwater Sustainability Plan (GSP) Annotated Outline. https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GD_GSP_Outline_Final_2016-12-23.pdf. Accessed on March 26, 2020.

SECTION 2 CONTENTS

LIST OF TABLES

LIST OF FIGURES

2 PLAN AREA

2.1 Description of Plan Area

2.1.1 Summary of Jurisdictional Areas and Other Features (§354.8 a and b)

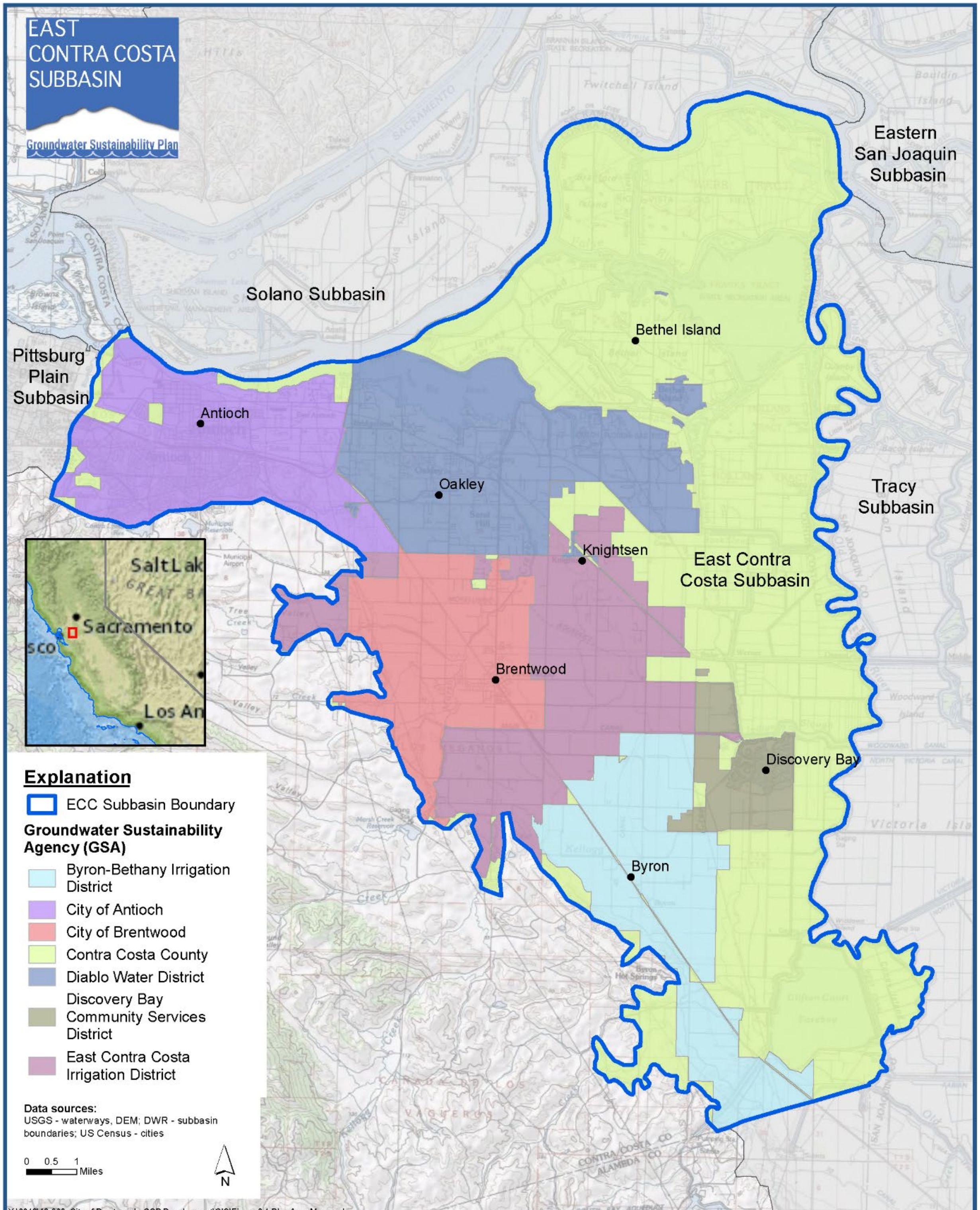
The ECC Subbasin (Subbasin) covers a 168 square mile area (107,596 acres) in the eastern portion of Contra Costa County, spans 18 miles from north to south and ranges from four to 13 miles from east to west, and includes seven communities: Antioch, Bethel Island, Byron, Brentwood, the Town of Discovery Bay (TODB), Knightsen, and Oakley. Three (Antioch, Brentwood and Oakley) are incorporated cities, Discovery Bay is a California Community Services District, Bethel Island is a Special Act District created by the California State legislature (1960) and named the Bethel Island Municipal Improvement District, the remaining two (Byron, and Knightsen) are census designated places. The Subbasin lies within the northwestern portion of the larger San Joaquin Valley Groundwater Basin. The Subbasin is bound by the Coast Range to the west and other groundwater subbasins to the northwest (Pittsburg Plain, DWR Subbasin 2-004), north (Solano Subbasin, DWR Subbasin 5-021.66), northeast (Eastern San Joaquin Basin, DWR Subbasin 5-022.01), and to the south and east (Tracy Subbasin, DWR Subbasin 5-022.15) (**Figure 2-1**). All adjacent subbasins are required to submit a GSP with the exception of Pittsburg Plain Subbasin (due to a "Very Low" basin prioritization that does not require a GSP to be completed).

2.1.1.1 Adjudicated Areas and Areas Covered by an Alternative GSP

This GSP covers the entire ECC Subbasin and is managed by seven exclusive GSAs (**Figure 2-1**). There are no known adjudicated areas within the ECC Subbasin or any areas covered by an Alternative GSP.

2.1.1.2 Cities and County Jurisdictions

Figure 2-2a shows city and county boundaries, and agencies with water management responsibilities. Apart from GSAs in the Subbasin, no other agencies have direct authority over groundwater, though Contra Costa County permits and regulates wells and septic systems throughout the Subbasin, including the cities, pursuant to Contra Costa County Ordinance code. Contra Costa Water District (CCWD) is a public water entity in Contra Costa County (County) but with no direct authority over groundwater within the Subbasin. Each City regulates land use within their city and the County regulates land use in the unincorporated areas of the Subbasin.

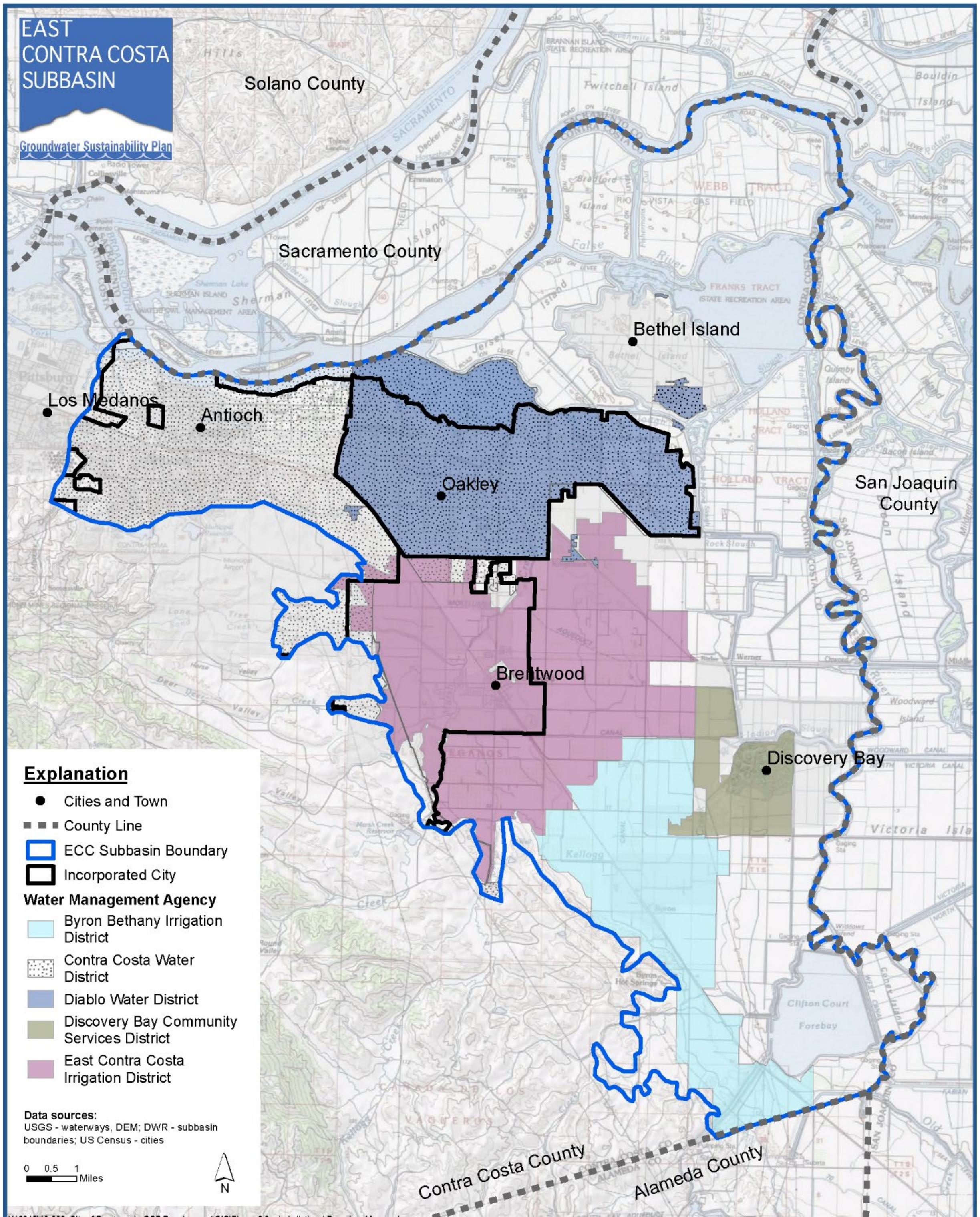


Luhdorff & Scalmanini Consulting Engineers

East Contra Costa Subbasin, and Adjacent Subbasins

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-1



Luhdorff & Scalmanini Consulting Engineers

Jurisidictional Boundaries, Cities, Counties and Agencies with Water Management Responsibilities

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-2a

2.1.1.3 Water Agency Jurisdictions and the East County Regional Water Management Association

The water agencies in East Contra Costa County are listed below with a description of their authorities and responsibilities. Each of the GSAs in the Subbasin belong to the East County Regional Water Management Association, in some capacity. Because of this association there is a long history of collaboration in water management decisions in the region. **Table 2-1** outlines the thirteen agencies joined together to form the Regional Water Management Group and their primary function (IRWMP, 2015). Seven of those members are GSAs, and they are described in more detail below.

Table 2-1. Regional Water Management Group Members and Primary Function[1]

Member Agency	Water Supply/ Quality	Wastewater	Recycled	Stormwater/ Flood Management	Watershed/ Habitat
City of Antioch	X	X	X	X	X
City of Brentwood	X	X	X	X	X
Byron-Bethany Irrigation District	X	X[2]			
Contra Costa County Flood Control				X	X
Contra Costa County		X		X	X
Contra Costa Resource Conservation District	X				X
Contra Costa Water District	X				X
Delta Diablo		X	X		
Diablo Water District	X				
Discovery Bay Community Services District	X	X		X	
East Contra Costa County Habitat Conservancy	X				X
East Contra Costa Irrigation District	X				
Ironhouse Sanitary District		X	X		

[1] Source: 2015 IRWM Plan Update

[2] BBID provides management services and operations and maintenance support to the Byron Sanitary District, which provides wastewater and sewer services to Byron residents.

City of Antioch

The City of Antioch is a public water purveyor that provides water to a population of approximately 108,000 (in 2015) within the service area (WYA, 2016); however, the City's total service area extends outside the Subbasin. Surface water is the City's only source of water supply and includes (for 2015, WYA, 2016): 1. surface water purchased from CCWD (12,000-acre feet per year [AFY]) 2. surface water diverted from the San Joaquin River through the City's intake (1,200 AFY), 3. Recycled water from Delta Diablo (50 AFY). Surface water is stored in a municipal reservoir and treated at the Antioch Water Treatment Plant. Recycled water is used to irrigate four parks and its municipal golf course. The City does not use groundwater for water supply, nor does it expect to use groundwater by the year 2040 (WYA, 2016).

City of Brentwood

The City of Brentwood is a public water purveyor that provides water to a population of over 56,000 within the service area (B&C, 2016). The City's service area within the Subbasin is a subset of its total service area. The City's annual supply includes: 1. surface water purchased from CCWD (4,720 AFY pumped to the Randall Bold Water Treatment Plant (RBWTP) from the Rock Slough intake via the Contra Costa Canal), 2. groundwater from seven active wells with a capacity of 7,000 AFY), 3. surface water from ECCID (entitlement of 14,800 AFY pumped from Rock Slough through the Contra Costa Canal for treatment at the City of Brentwood Water Treatment Plant [COBWTP]) (B&C, 2016). In drought years, the City relies upon groundwater more than in normal years.

Byron-Bethany Irrigation District (BBID)

BBID provides agricultural water to southeastern CCC. It is a public agency governed by an elected board of directors and was established for the purpose of providing water to the lands within Alameda County, Contra Costa and San Joaquin Counties. In 2012, BBID served 5,663 acres within CCC and delivered 18,484 AF of water (IRWIM, 2015). In 2014, CCWD began coordination with BBID to install an intertie between Byron Division Canal 45 and the CCWD Old River pipeline. This will facilitate water transfers with CCWD and/or storage of BBID water in the Los Vaqueros Reservoir for later use in the northern portions of the Byron Division. By July 2015, a portion of the project had been implemented. In 2015, 214 AF of groundwater from growers' wells was used to supplement surface water during the drought. Though some private pumping occurs, landowners predominantly rely on surface water allocation in the Byron and Bethany Divisions (AWMP, 2015).

Contra Costa Water District (CCWD)

The CCWD was formed in 1936 to provide water for irrigation and industry. It is currently one of California's largest urban water districts that provides untreated and treated water to municipal, residential, commercial, industrial, landscape irrigation, and agricultural customers. It draws its water from the Delta primarily under a contract with the federal Central Valley Project (CVP). CCWD manages the Los Vaqueros Reservoir. The Contra Costa Canal is the backbone of CCWD conveyance system that was originally owned by the U.S. Bureau of Reclamation (USBR). CCWD is currently taking ownership of the Canal (expected by 2022) and will continue to operate and maintain the facility. Water is supplied to the canal from Rock Slough as well as from Old and Middle Rivers via pipelines. One of CCWD's two water treatment plants is located in the Subbasin (e.g., RBWTP in Oakley [jointly with DWD]). CCWD supplies water to the Cities of Antioch and Brentwood and Diablo Water District.

Diablo Water District (DWD)

DWD was established in 1953 to provide water to customers in downtown Oakley and now serves the City of Oakley, the Town of Knightsen, and some of Bethel Island. It serves a population of about 42,000 people in a 21 square mile area (e.g., Oakley, Cypress Corridor, Hotchkiss Tract, and Summer Lakes, Bethel Island, and Knightsen). The majority (about 80% per CDM Smith, 2016) of water delivered is surface water supplied by CCWD and treated in RBWTP[1] (owned jointly with CCWD). Two municipal wells supplement DWD's surface water source providing about 2,000 AFY (CDM Smith, 2016).

East Contra Costa Irrigation District (ECCID)

ECCID is an independent special district established in 1926 to provide agricultural irrigation water to properties within ECCID (IRWM, 2019). ECCID boundaries include the City of Brentwood, and portions of the Cities of Oakley and Antioch and the unincorporated community of Knightsen. ECCID has a 1912 appropriative right to divert water from Indian Slough on Old River and also operates nine groundwater wells (IRWM, 2019*).* In 2012, ECCID pumped about 330 AF of groundwater.

Town of Discovery Bay Community Services District (TODB)

The TODB was formed in 1998 to provide over 15,000 residents with water, treatment, distribution, and storage. All the water supply is from six groundwater supply wells (IRWM, 2019) pumping about 3,000 AFY.

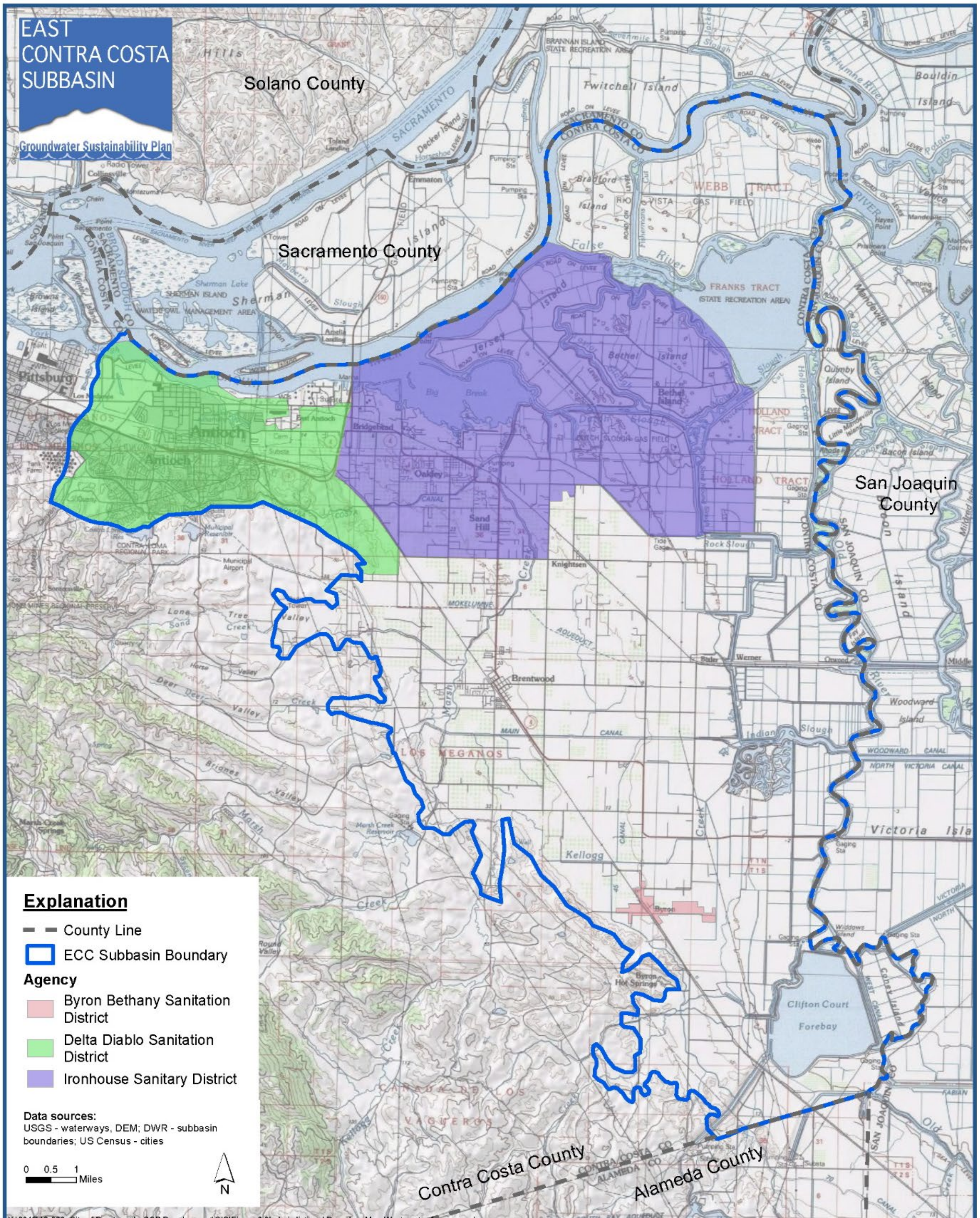
Other Agencies

Ironhouse Sanitary District (ISD) maintains sanitary services for nearly 30,000 customers in the Oakley and Bethel Island area (**Figure 2-2b**). Water is treated at its facility in Oakley California and recycled water is spread on its 3,600-acre Jersey Island fields, which are used for grazing of cattle. In addition, the fields are used for wildlife and habitat for waterfowl. ISD processes 4,800 AFY of recycled water and half is spread on ISD fields near the Oakley facility on Jersey Island to water hay fields and the other half is released into the San Joaquin River (SJR).

Delta Diablo (DD) District provides wastewater treatment and recycled water production for the City of Antioch, Bay Point and Pittsburg, however, only the City of Antioch is in the Subbasin. It treats 15,000 AFY of water (2016) and releases the treated water into New York Slough. It provides about 9,000 AFY of recycled water (treated domestic wastewater used more than once) used for cooling two power generating plants and irrigation of two golf courses and 12 city parks in the DD service area (**Figure 2-2b**).

Bethel Island Municipal Improvement District (BIMID) is responsible for maintaining levees and drainage on Bethel Island but also has the authority to create and maintain parks and playgrounds https://bimid.com/about-bimid/).

[1] Randall Bold Water Treatment Plant



Luhdorff & Scalmanini
Consulting Engineers

Jurisdictional Boundaries,Wastewater Agencies

Figure 2-2b

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Byron Sanitary District[2] encompasses the unincorporated community of Byron and serves a population of 800. It is an independent special district with a five-member board of directors, and a General Manager. The wastewater treatment and disposal facility is located on 30 acres of land with 8 acres of evaporation ponds and 10 acres irrigated with treated effluent.

Small Water Systems

Small water systems and mutual water companies supply drinking water to communities between 2 and 199 service connections; or serve 25 or more people at least 60 days per year (days/yr). Three areas in the Subbasin (Bethel Island [twelve systems], Oakley [six systems], and Byron [four systems]) have small community water systems (15 to 199 service connections) that rely on groundwater as the only water supply source (IRWM, 2019, pg 2-31). Small community water systems are regulated by Contra Costa Environmental Health[3].

2.1.1.4 Federal, State, Tribal, and Special District Jurisdictions

Other entities have authority and responsibilities within the Subbasin that need to be considered when developing a GSP. **Figure 2-3** shows Federal-owned and state-owned lands and the agency with jurisdiction over the land. Dutch Slough (managed by DWR) is 1,187 acres of land that is being transformed into tidal marsh to provide habitat for salmon and other native fish and wildlife. In addition, the map includes lands owned and managed by East Bay Regional Park District (a special district) that preserves natural and cultural resources in Alameda and Contra Costa Counties.

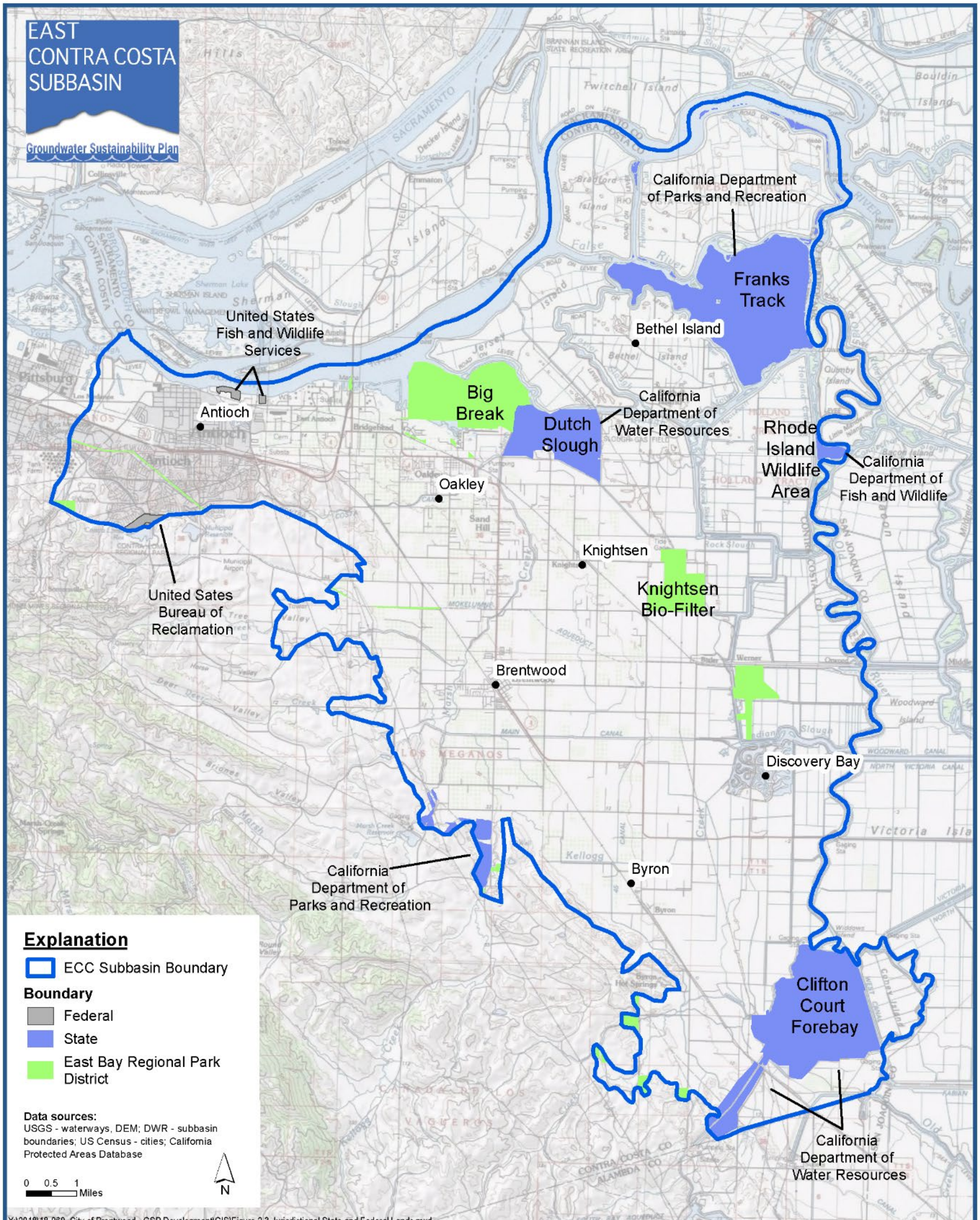
There are no known federally designated tribal lands or tribes in the Subbasin. The Sonoma Northwest Information Center (NWIC) (Sonoma State) searched for sacred lands, and none were found in the area. The Native American Heritage Commission (NAHC) record search returned no information for the Subbasin. NAHC further recommended contacting individual tribal leaders and provided a list of seven people for the GSAs to contact. On April 18, 2019, a separate email was sent to each person recommended by NAHC requesting information on whether there was knowledge of sacred lands in the vicinity of the Subbasin, followed by a phone call. To date, we received no responses identifying federally designated tribal lands in the East Contra Costa Subbasin.

2.1.1.5 Major Water Related Infrastructure

Major water-related infrastructure in the Subbasin **Figure 2-4** is relied upon by multiple cities, water agencies and private water users. These facilities deliver supplies to GSA members and to the State Water Project (SWP) including the California Aqueduct and the Delta Mendota Canal.

[2] Source: https://contracostasda.specialdistrict.org/byron-sanitary-district-3715f00

[3] In addition to small community water systems listed above there are also Local Small Water Systems (2-4 connections), State Small Water Systems (5-14 connections), as well as non-community public water systems all regulated by Contra Costa Environment Health.

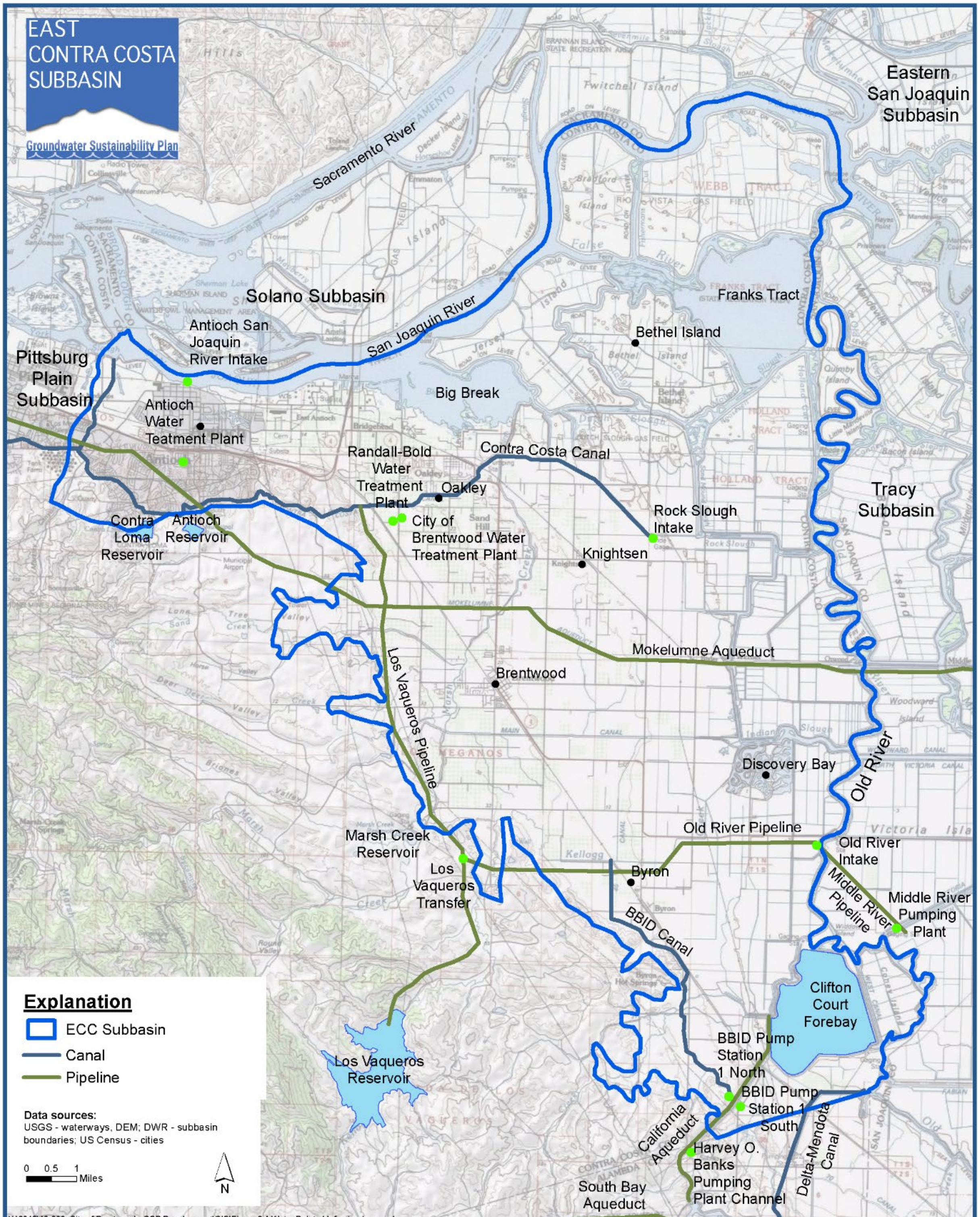


Luhdorff & Scalmanini Consulting Engineers

Jurisdictional Boundaries, State, Federal Lands, and Special Districts

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-3



Luhdorff & Scalmanini Consulting Engineers

Water Related Infrastructure

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-4

Contra Costa Water District Facilities

The Contra Costa Water District facilities in the ECC Subbasin are shown on **Figure 2-4.** CCWD jointly owns RBWTP with DWD which has been operated by CCWD since the plant came online in 1992. Raw water is conveyed to the RBWTP from the Rock Slough intake via the Contra Costa Canal (operated by CCWD) as well as from the Old River and Middle River intakes via pipelines. Water can be stored in the Los Vaqueros Reservoir from the Old River and Middle River intakes during periods of low salinity (winter and spring) in the Delta. It is then later used (late summer and early fall) to blend with raw water from the Rock Slough intake when high salinity conditions are experienced in the Delta. Surface water supplies for the City of Brentwood originate from Rock Slough. The supply is transported through the Contra Costa Canal for treatment at the City of Brentwood Water Treatment Plant (COBWTP). CCWD supplies water to the City of Antioch from diversions at the Middle River (Victoria Canal), Rock Slough, and Old River. The Los Vaqueros Reservoir Phase 2 Expansion project would increase capacity from 160,000 to 275,000-acre feet and is scheduled for completion by 2027. This expansion will improve water supply reliability while protecting Delta fisheries.

Byron-Bethany Irrigation District Facilities

BBID service area is both within the ECC Subbasin (Byron Division) and in the Tracy Subbasin (Bethany Division, raw water service area (RWSA) 1 and 2, and CVP Service Area). The water supply distribution system for the Byron, Bethany Divisions and RWSA1 includes pump stations on the intake channel at the Harvey O. Banks Pumping Plant (**Figure 2-4**). BBID Pump 1 diverts the District's pre-1914 water supply north to the Byron Division and south to the Bethany Division and RWSA 1.

State Water Project (SWP)

Clifton Court Forebay is part of the SWP and serves as the starting point of the California Aqueduct, which delivers water to Southern California. In addition, it provides water via the Delta-Mendota Canal to the San Joaquin Valley. The Harvey O. Banks Pumping Plant at Clifton Court Forebay lifts the water from the Delta into the California Aqueduct (**Figure 2-4**). Eleven pumps at the Banks Pumping Plant (2.5 miles southwest of Clifton Court Forebay) pull water from Old River. This water has been diverted from the Sacramento River near Walnut Grove (via Delta Cross Channel and Snodgrass Slough) to the Mokelumne River into the SJR and then south up Old River.

2.1.1.6 Sacramento-San Joaquin River Delta (the Delta)

The Sacramento-San Joaquin Delta is the center of California's water supply, providing fresh water to the majority of the state's population and to millings of acres of farmland. It is the largest estuary on the West Coast and provides critical habitat to fish and wildlife species. The East Contra Costa Groundwater Subbasin is located on the southwestern part of the Delta. The Delta is a 1,300 square mile area where the Sacramento, San Joaquin, and Mokelumne Rivers come together that was once a tule marsh. In the mid to late 1800s and early 1900s, settlers installed a levee system that formed many of the islands. When the islands were dewatered for agricultural development, land subsidence resulted from oxidation of organic soils, some Delta Islands in the Subbasin have lowered more than 15 feet in response to peat oxidation (not related to groundwater extraction). Problems facing the delta are compounding because subsiding delta islands and rising sea levels would increase pressure on the levees and rising sea level would and push salt water further into the delta.

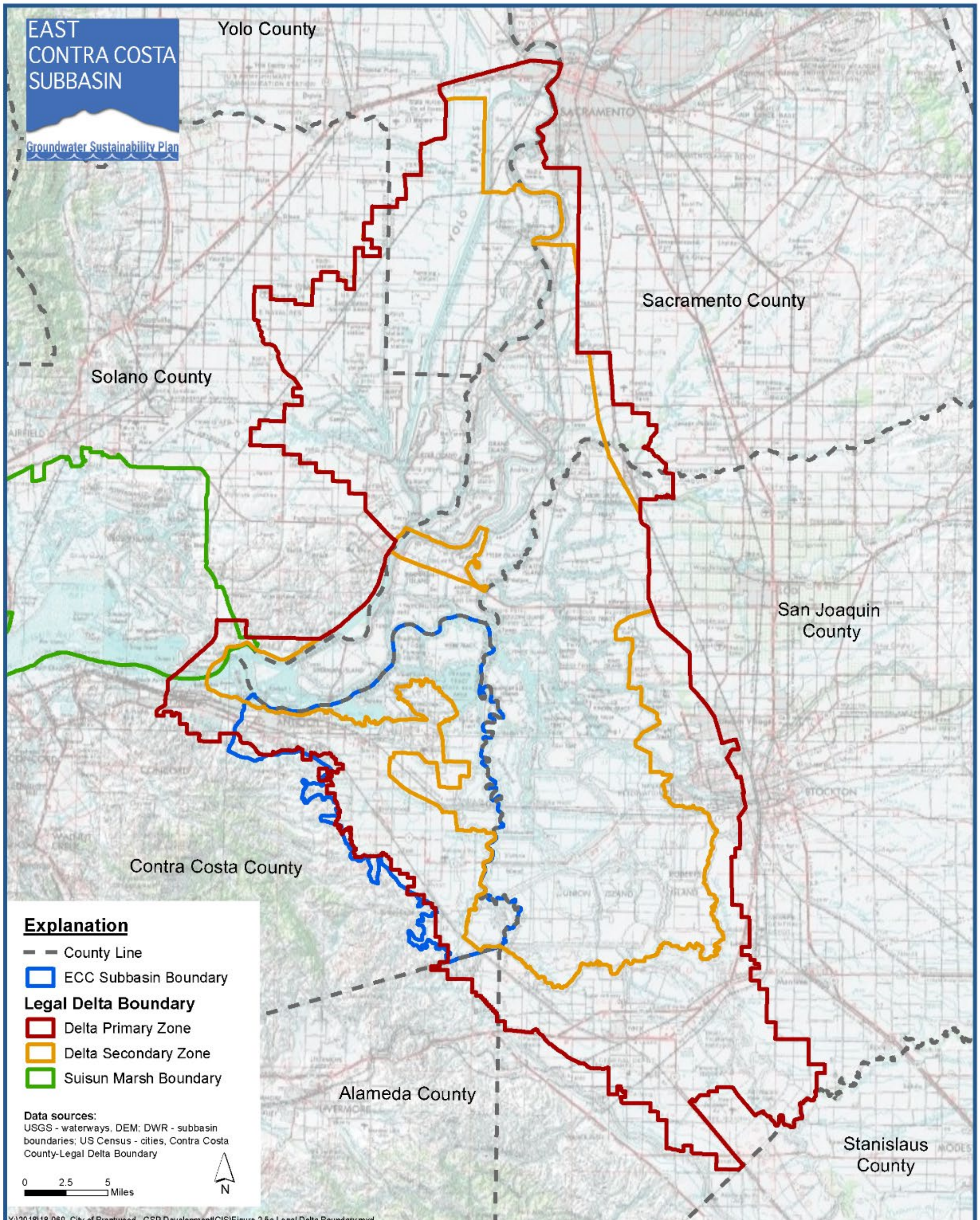
The Delta is composed of three zones. The Primary Zone is the center of the Delta (**Figure 2-5a, b**), the largest zone (490,050 acres) and is primarily rural farmland but includes a few small towns[4]. The Secondary Zone includes 247,320 acres of farmland and cities and suburbs. The third area (Suisun Marsh) is northwest of the Primary Zone and not discussed in this section. Two state agencies have land use jurisdiction in the Delta: Delta Stewardship Council described in the Delta Plan, 2013, and the Delta Protection Commission (DPC). The Council and the DPC have concurrent jurisdiction in the Delta's Primary Zone to ensure that local land use planning is consistent with their own laws and plans.

About two-thirds of the islands and tracts in the Sacramento-San Joaquin Delta are below sea level and are surrounded by levees that protect the land from floods and high tides. There are more than 1,100 miles of levees in the delta contracted to protect farmland. The predominant land use of the islands in the ECC Subbasin is agriculture with a small population of farm workers. Agencies with responsibilities for levee maintenance and drainage systems in the Subbasin include: BIMID, RD 2024 (Orwood and Palm Tracts), RD 2025 (Holland Tract), RD 2026 (Webb Tract), RD 2059 (Bradford Island), RD 2065 (Veale Tract), RD 2090 (Quimby Island), RD 2121 (Bixler Tract), RD 2137 (Dutch Slough Restoration Project site), RD 799 (Hotchkiss Tract, planned residential development and ecological restoration project), RD 800 (Byron Tract and Discovery Bay), RD 830 (Jersey Island owned by ISD and recycled water used to grow hay).

2.1.2 Density of Wells

The density of different well types provides a general distribution of agricultural, industrial and domestic well users and identify communities dependent on groundwater; another tool to understand groundwater use in the Subbasin. Well data and well construction information were obtained from DWR's well completion report database, ECC pumping records, and from DWR's Well Completion Report Map Application (DWR, 2019). DWR Well Completions Report Map Application is an interactive mapping tool that displays submitted well completions reports. DWR categorizes wells in the mapping application as either domestic, production and public supply, and this database was used to create **Figures 2-6a**, **b**, and **c**. **Figure 2-6a** illustrates the well density of domestic wells by each Public Land Survey System (PLSS) township-range and section (typically a 1-mile by 1-mile square grid). This map indicates that the highest density of domestic wells occurs along an east-west swath between Knightsen and Brentwood, as well as near Byron. The domestic wells are considered de minimis extractors, pumping less than two AF annually and would collectively pump less than 2,000 AFY. **Figure 2-6b** illustrates the well density of production wells per square mile and shows the highest density of these types of wells to be located in the vicinity of Oakley, Knightsen, and Brentwood, with others located in the Town of Discovery Bay and Byron. DWR defines "production wells" as "those wells that are designated as irrigation, municipal, public, or industrial on Well Completion Reports". **Figure 2-6c** illustrates the well density of public supply wells, with the highest density of public supply wells occurring in the Town of Discovery Bay. The DWR database allows the wells to be filtered for planned use and wells with the designation of Irrigation-Agriculture are illustrated on **Figure 2-6d** with the highest density of these wells om the Knightsen/Oakley area.

[4] The Delta Plan, Ensuring a reliable water supply for California, a healthy Delta ecosystem, and a place of enduring value.

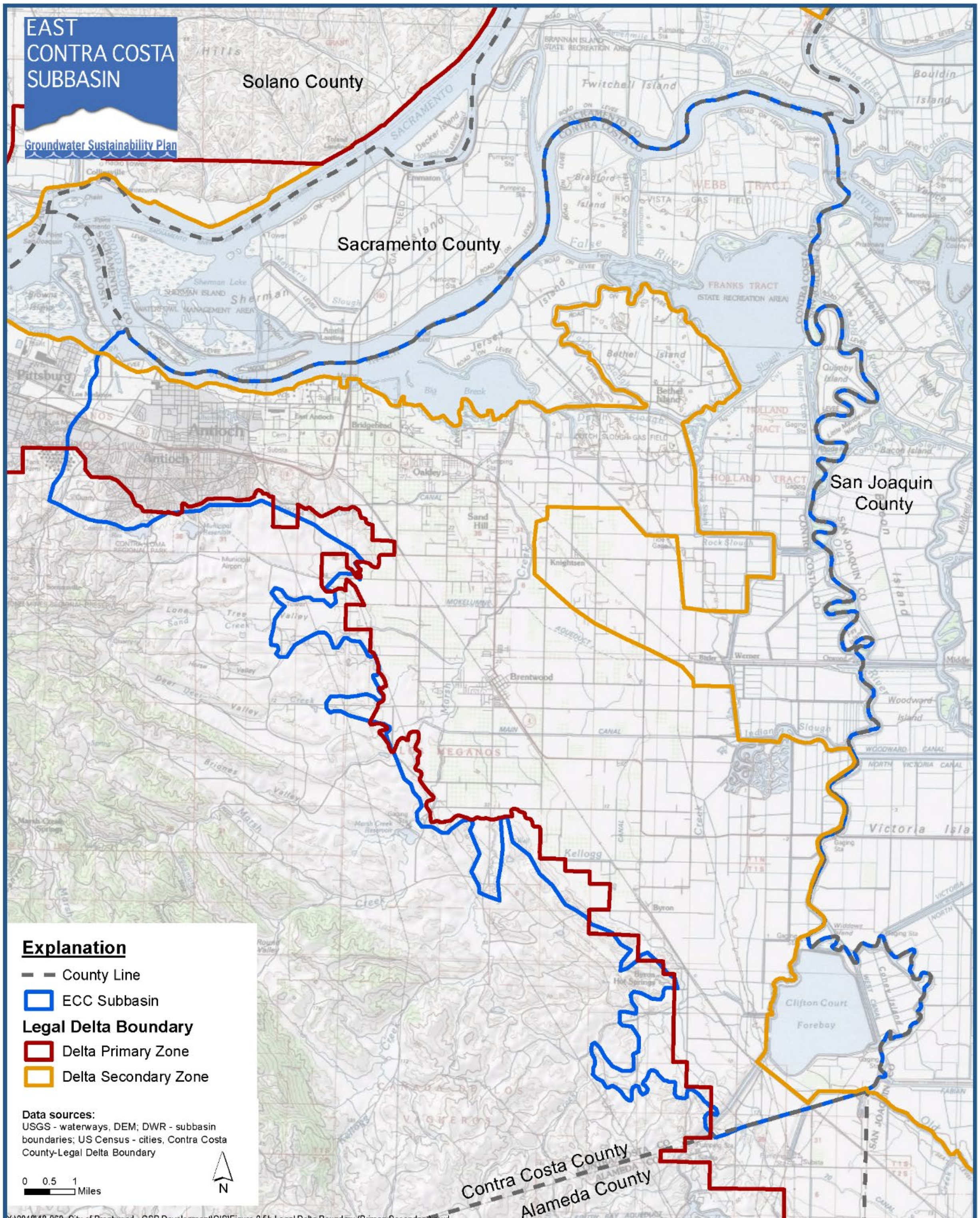


Luhdorff & Scalmanini
Consulting Engineers

Legal Delta Boundary

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-5a

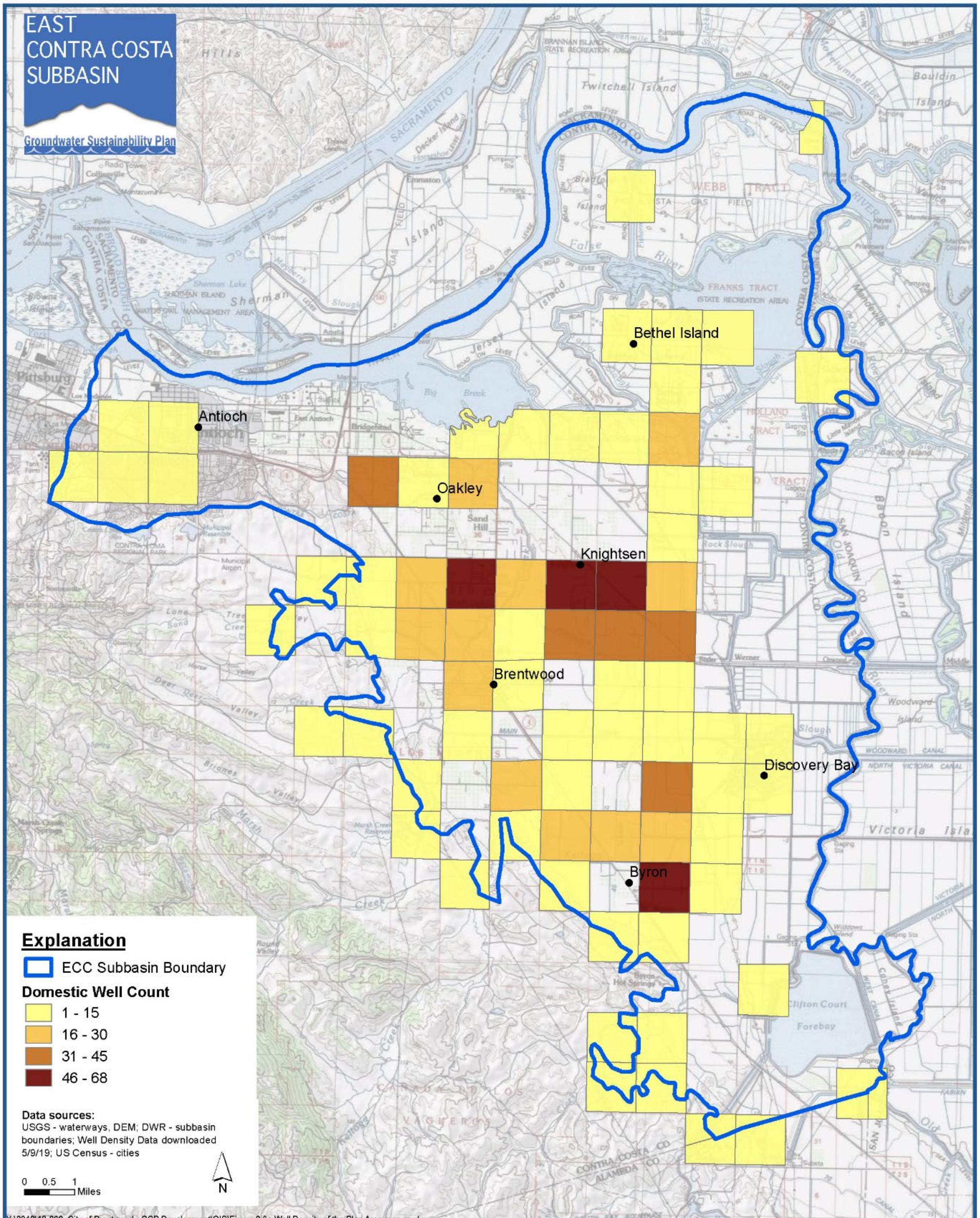


Luhdorff & Scalmanini Consulting Engineers

Legal Delta Boundary- Primary and Secondary Zones

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-5b

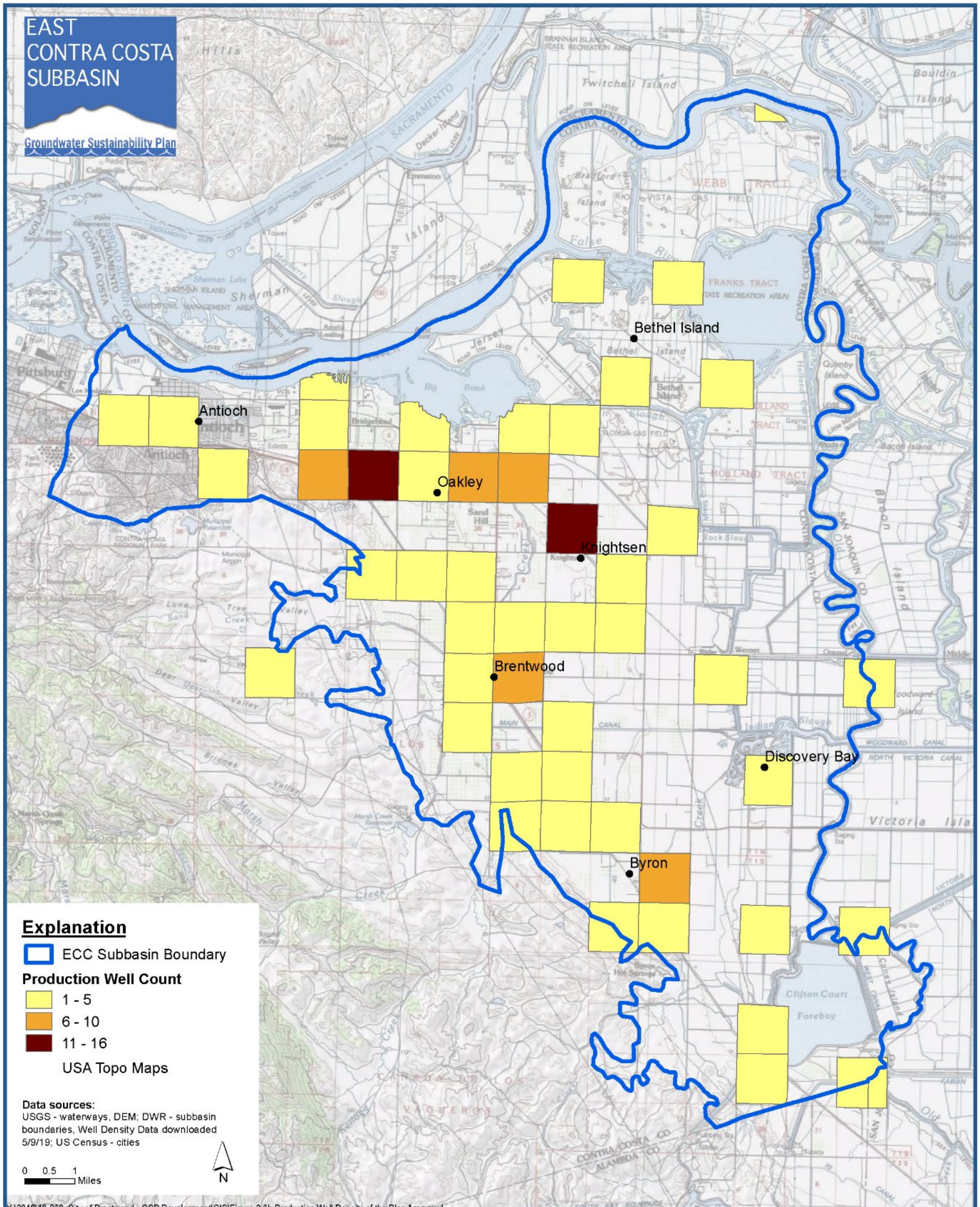


Luhdorff & Scalmanini
Consulting Engineers

Domestic Well Density per Square Mile

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-6a

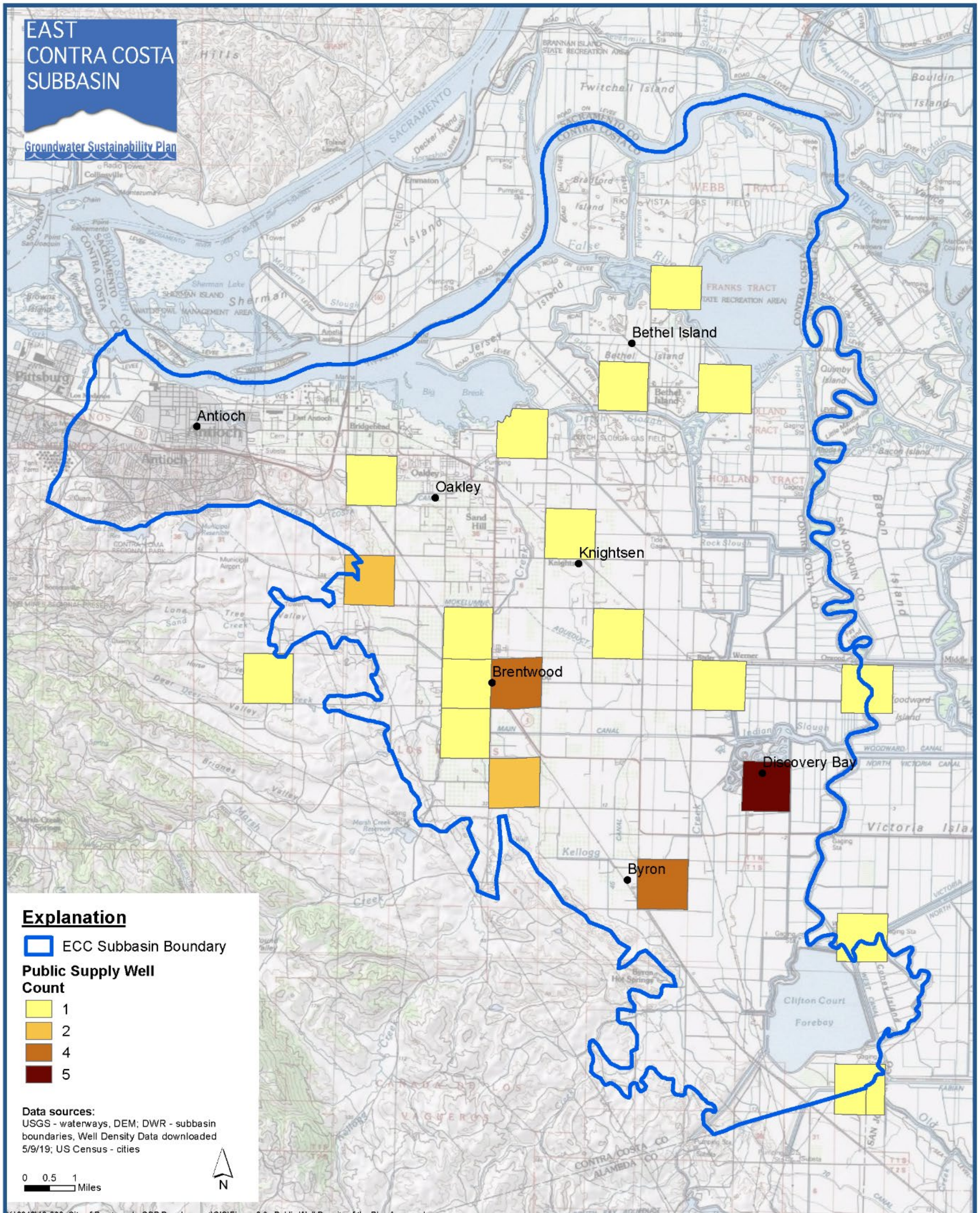


Luhdorff & Scalmanini Consulting Engineers

Production Well Density per Square Mile

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-6b

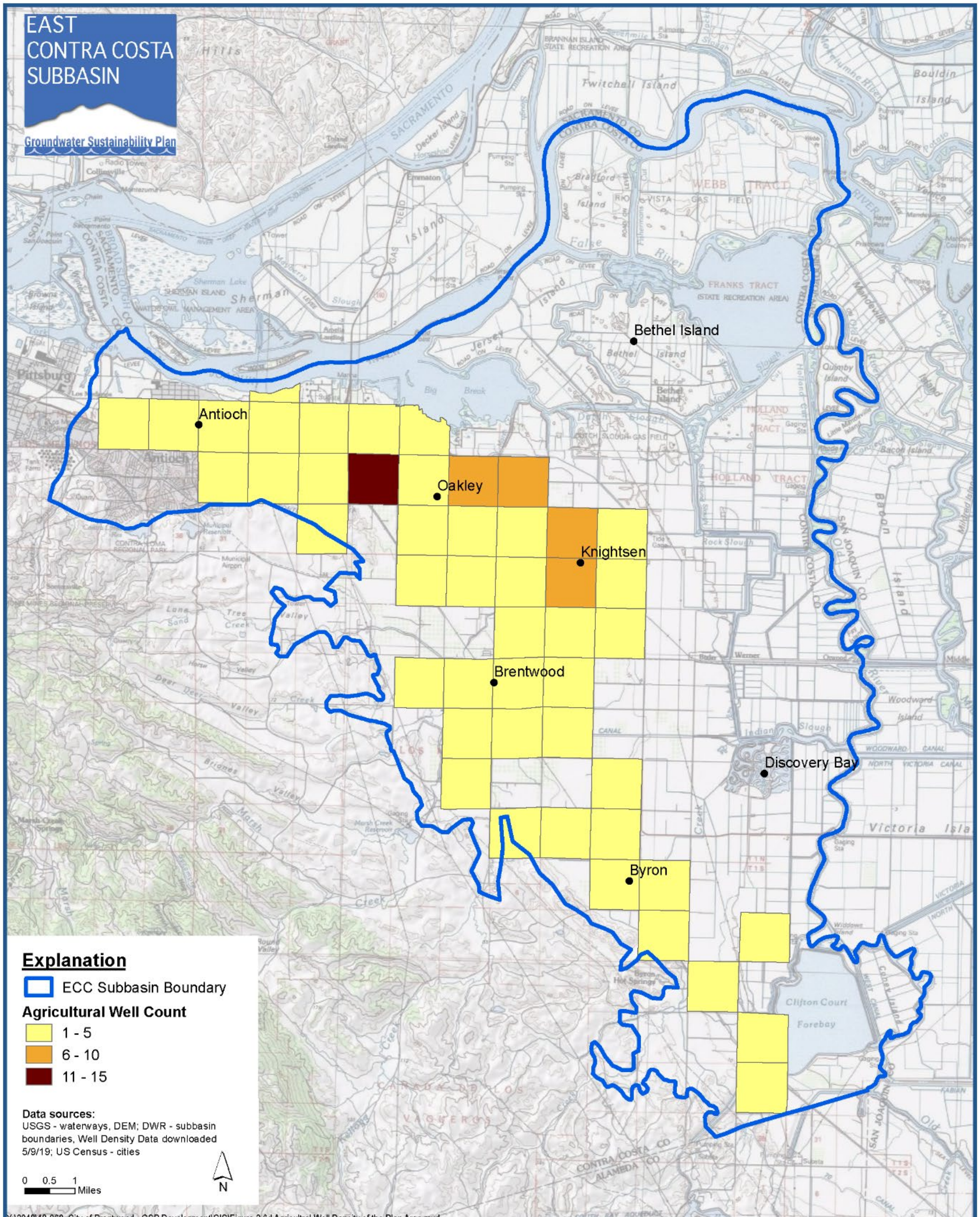


Luhdorff & Scalmanini Consulting Engineers

Public Supply Well Density per Square Mile

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-6c



Luhdorff & Scalmanini Consulting Engineers

Agricultural Well Density per Square Mile

Figure 2-6d

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

The DWR well completion database contains over 5,000 wells historically drilled in the Subbasin. The DWR mapping application estimates the number of wells in ECC at approximately 1,180 wells. The difference between the two sources is thought to be due to wells that are inactive or destroyed. **Table 2-2** summarizes well types by use for the wells in the DWR Well Completion Report Map Application. Based on DWR's map application, the estimated well density ranges from approximately 1 to 68 wells per square mile, but as stated above, there are uncertainties associated with the DWR well coverage that may double count wells and/or include missing and incorrect values.

Table 2-2. Types of Wells[1]

Type of Well	Total Wells
Domestic	975
Production	156
Public Supply	51
Agricultural	136
TOTAL	**1,182**

[1]DWR SGMA Data Viewer – Well Reports Statistics in ECC Subbasin; downloaded on May 9, 2019

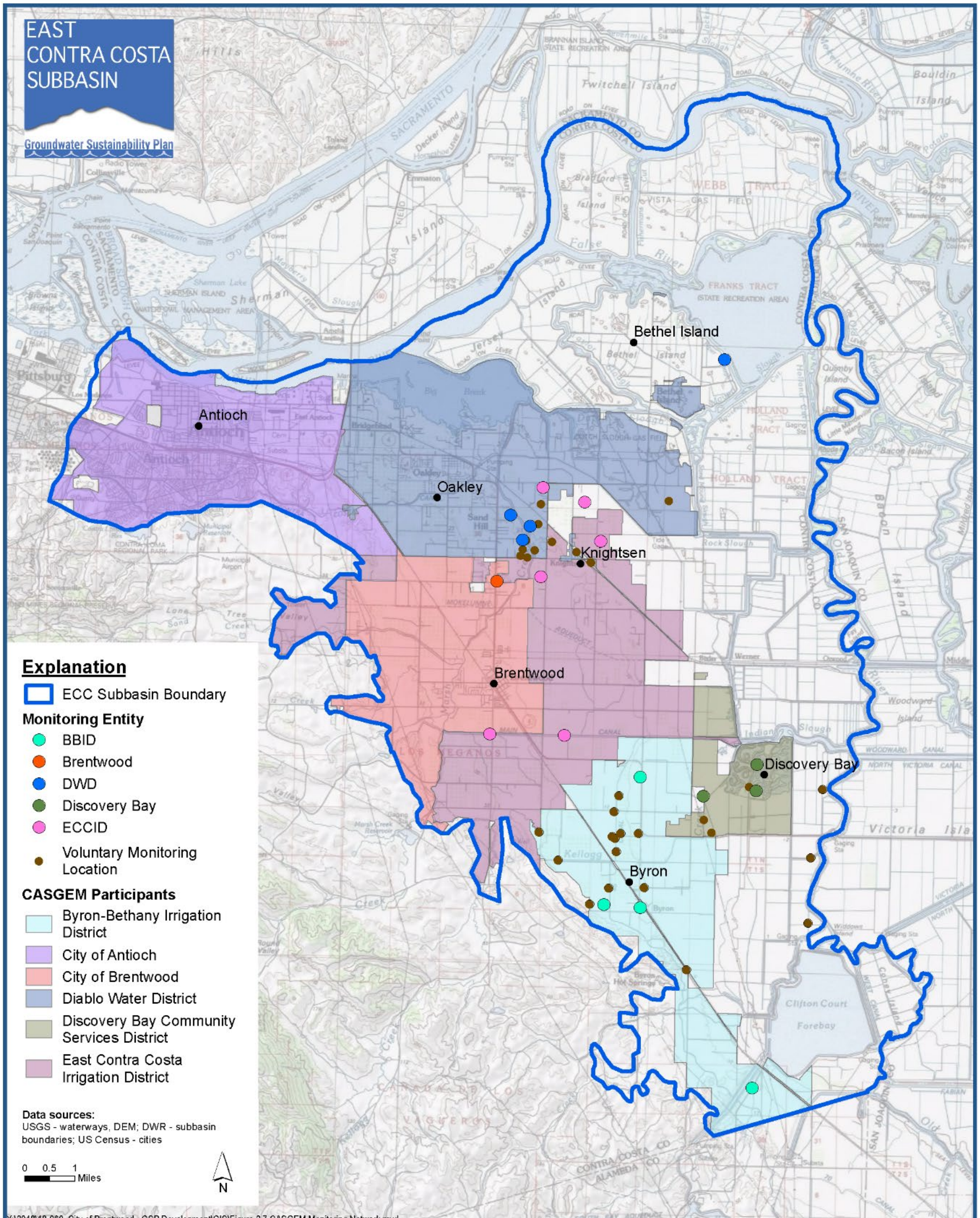
2.2 Water Resources Monitoring and Management Programs[5] (10727G) (§354.8c, d, and e)

2.2.1 CASGEM and Historical Groundwater Level Monitoring

The East Contra Costa County California Statewide Groundwater Elevation Monitoring (CASGEM) Network tracks seasonal and long-term groundwater level trends. The ECC CASGEM Network began in 2011 and is managed by DWD; it was updated in 2014 and updated again in 2018. **Figure 2-7** displays the CASGEM network of 27 wells by monitoring entity. In addition, BBID, DWD, ECCID, and TODB voluntarily share groundwater depth data for over an additional 20 wells. Once the GSP is implemented it will replace the CASGEM Monitoring Plan. The GSP monitoring well groundwater levels will be entered into the SGMA Monitoring Network Module (MNM) instead of CASGEM. However, voluntary or non-SGMA wells data will still upload the CASGEM Operating System.

Historically, groundwater levels have been monitored by various agencies since the 1950s. Numerous reports were prepared to evaluate these data and groundwater conditions in the basin and include: An Initial investigation of Ground Water Resources (LSCE, 1999) that serves as a baseline for future groundwater conditions reports, DWD Groundwater Management Plan (GMP) (LSCE, 2007), and Groundwater Quality Monitoring Plan (GQMP) (LSCE, 2018).

[5] It is not clear at this time how these programs will change with the development and implementation of the GSPs.



Luhdorff & Scalmanini
Consulting Engineers

ECC CASGEM Monitoring Network

Figure 2-7

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

2.2.2 Department of Water Resources (DWR) and EWM

DWR takes annual measurements (spring and fall) in three wells in the ECC Subbasin that are included in the Subbasin CASGEM well network. In addition, DWR manages the EWM (it used to be called the Water Data Library and then CASGEM). The EWM includes historical groundwater level measurements since the early 1900s and periodic water quality data.

2.2.3 Groundwater Ambient Monitoring and Assessment Program (GAMA)

As part of the GAMA program, the State Water Resources Control Board (SWRCB) collects data from water agencies and private well owners and makes it available to the public. The data aide interpretation of groundwater quality and monitoring efforts.

2.2.4 GeoTracker

The SWRCB provides data for sites that have impacted water quality including groundwater. These records contain not only general mineral and contaminated constituent concentrations but also groundwater levels.

2.2.5 California Division of Drinking Water (DDW)

Formerly the Department of Health Services, DDW is a division of the SWRCB that regulates public drinking water systems. They asses the quality of the drinking water and identify specific water quality problems. Public water system (PWS) wells are to meet Title 22 water quality requirements and DDW provides these PWS data to the public.

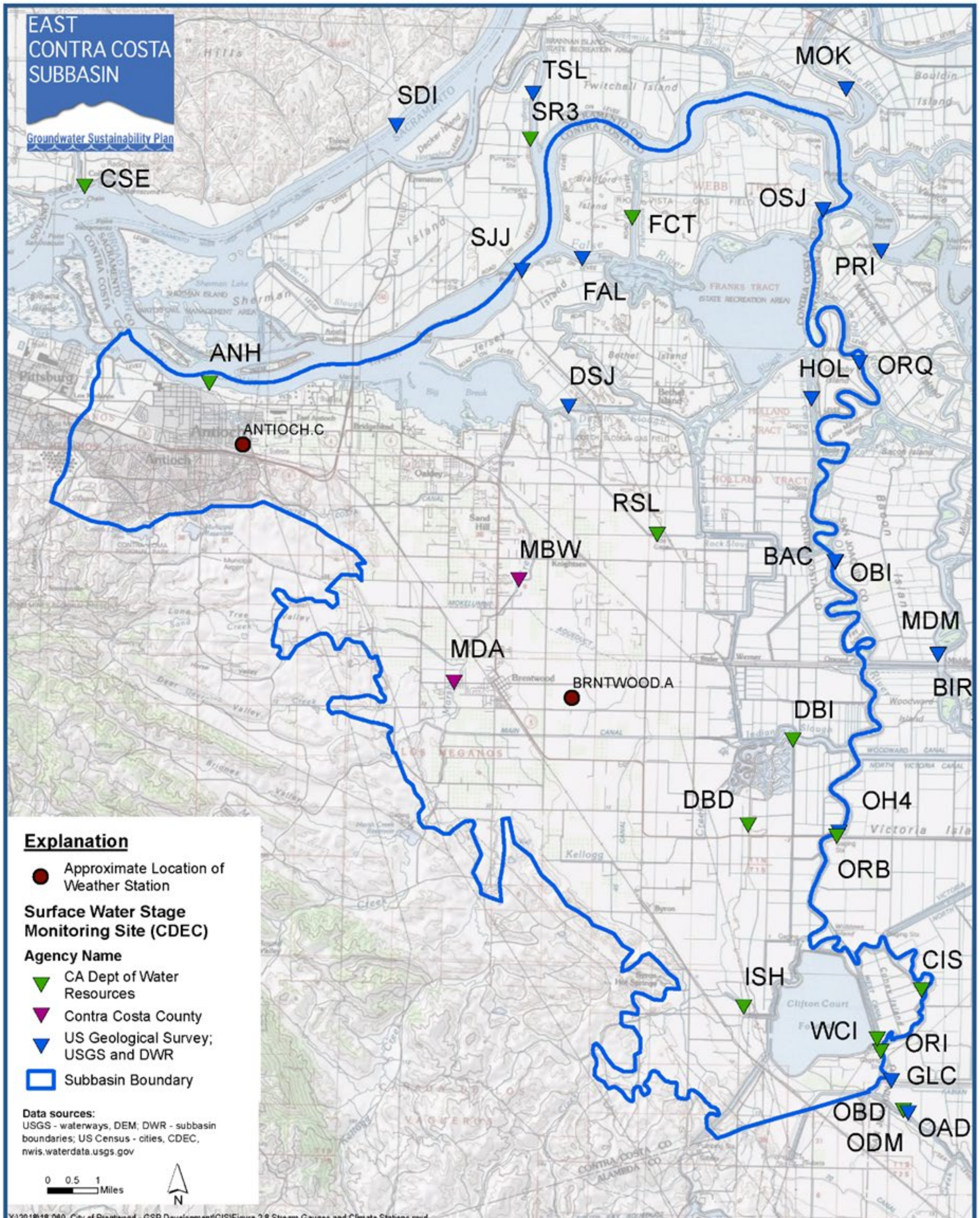
2.2.6 U.S. Geological Survey (USGS)

USGS monitors wells for water levels and water quality generally for special projects (i.e., not on a regular monitoring schedule). The USGS makes the data available for public on the National Water Information System (NWIS) website. The USGS maintains a series of stream gauges in the vicinity of the Subbasin. Fifteen of the USGS stream gauges have historical data and are currently active in the Subbasin (**Figure 2-8**).

2.2.7 Subsidence Monitoring

Subsidence monitoring in the Subbasin consists of a Continuous Global Positioning System (CGPS) station managed by the Plate Boundary Observatory/UNAVCO. These stations were generally constructed to monitor motions caused by plate tectonics, but they are also used for other applications (e.g., assessing subsidence). UNAVCO GPS (P256) is located in the ECC Subbasin with measurements starting in 2005.

Additional subsidence monitoring in adjacent subbasins includes DWR Surveying/spirit leveling (Solano and Yolo Subbasin), USGS Interferometric Synthetic-Aperture Radar (InSAR) (Delta-Mendota Subbasin), and an extensometer in the Yolo Subbasin.



Luhdorff & Scalmanini
Consulting Engineers

Stream Gauges and Climate Stations

Figure 2-8

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

2.2.8 Climate Monitoring

The locations for two climate stations (Antioch and Brentwood) are shown on **Figure 2-8.** Climate is discussed in more detail in Chapter 5 of the GSP.

2.2.9 Incorporating Existing Monitoring Programs into the GSP

The existing monitoring programs listed above will provide the basis for the GSP monitoring program. Specifically, the CASGEM Network will provide the foundation of groundwater level data, as described in more detail in Chapter 3.3 of this document that describes the GSP Monitoring Program. In addition, the GSP monitoring program will incorporate production well water quality data as well as monitoring data from existing stream gauges.

2.2.10 Limits to Operational Flexibility

The existing monitoring programs are not anticipated to limit the operational flexibility of this GSP. The current groundwater monitoring programs will form the basis of the future GSP monitoring program. This includes some CASGEM wells for water levels, proposed dedicated groundwater monitoring wells (water level and quality), DDW monitoring for water quality and existing subsidence monitoring stations as appropriate. No existing groundwater management or monitoring programs are expected to limit the operational flexibility of the groundwater Subbasin.

2.2.11 Conjunctive Use

The majority of water used in the ECC Subbasin is surface water (e.g., the City of Antioch purchases surface water only from CCWD and has a water right to river diversion water). Conjunctive use programs (coordinated use of surface water and groundwater) in the ECC Subbasin are currently implemented and planned by individual agencies.

CCWD receives its water from the Sacramento-San Joaquin Delta and in recent years it has used Los Vaqueros Reservoir to help improve water quality and as an emergency supply resource (LSCE, 2007).

The City of Brentwood primarily receive surface water deliveries and pump groundwater on an as needed basis.

TODB operates solely on groundwater and has multiple pumping wells in the town’s boundary.

DWD uses 80% surface water (CVP provides water and DWD also purchases surface water) and has the capacity to pump groundwater to meet up to 20% of the demand in its service area.

Both ECCID and BBID are able to operate fully on surface water in nearly all water years. ECCID has groundwater wells in its area to help meet water demands as needed. In 2000, the two agencies entered an agreement with CCWD that allows them to sell water to CCWD during drought years and allows CCWD to purchase a smaller amount in non-drought years (LSCE, 2007).

2.3 Land Use Elements or Topic Categories of Relevant General Plans (§354.8a and f)

Land use is a key factor in determining water demand. Changing land use conditions and irrigation practices are also factors that affect water demand from year to year.

2.3.1 Current and Historical Land Use

General land use conditions based on DWR survey data for CCC are illustrated in **Figures 2-9** through **2-11** and summarized in **Table 2-3** and **Figure 2-12**. The 2015 land use in the Subbasin is mainly agricultural (41%), followed by urban (about 23%), then by water and native vegetation (both about 14%) (source: DWR Crop Mapping Delta 2015 geospatial dataset[6]). The crop types with the highest land use coverage in the Subbasin are pasture (14%) and field crops (12%). Outside of the Subbasin, the existing land use is mainly field crops, truck crops and pasture **(Figure 2-9**) in the delta area.

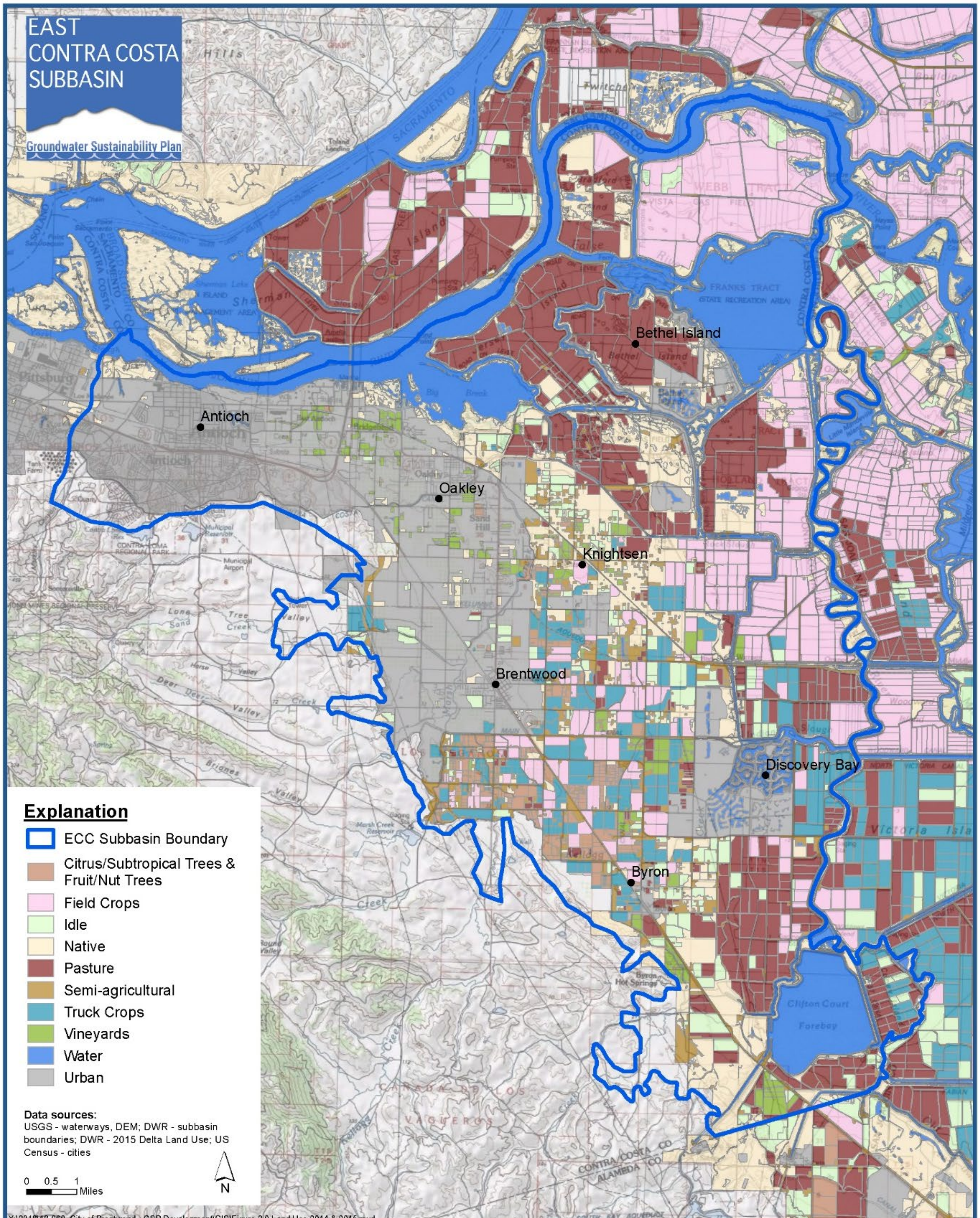
Table 2-3. Land Use Summary

Land Use Designation	1976		1995		2015	
	acres	%	acres	%	acres	%
Field Crops Total[1]	23,153	22%	18,195	17%	13,467	13%
Idle	916	1%	5,754	5%	3,527	3%
Native[2]	25,040	23%	23,400	22%	15,581	15%
Fruit/Nut Trees & Citrus/Subtropical Trees	12,057	11%	6,398	6%	1,947	2%
Pasture	12,979	12%	11,087	10%	14,809	15%
Semi-agricultural[3]	797	1%	868	1%	6,276	6%
Truck Crops	7,747	7%	6,800	6%	5,428	5%
Urban[4]	9,726	9%	19,231	18%	23,523	23%
Vineyards	848	1%	876	1%	1,980	2%
Water	14,368	13%	14,868	14%	14,926	15%
Total[5]	**107,632**	**100%**	**107,477**	**100%**	**101,462**	**100%**

Source and Abbreviations:
California Open Data Portal, https://data.ca.gov/dataset/crop-mapping-delta-2015, accessed June 2019. Also used 2014 data for areas not covered by 2015 mapping.
California Department of Water Resources, https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Land-Use-Surveys, accessed June 2019

1- Includes land designated as Grain and Hay in 1976.
2- Includes land designated as Native, Native Riparian, Native Vegetation.
3-Includes incidental to agricultural, farmsteads, feed lots, dairies, lawns, cemeteries.
4- Includes land designated as Recreation in 1976.
5-Total area differs due to different survey areas monitored. Total about 107,000 acres (168 square miles).
6-1995 and 2015 Surveys have land that was not surveyed and was given "Not Designated" description.

[6] California Open Data Portal, https://data.ca.gov/dataset/crop-mapping-delta-2015, accessed June, 2019.

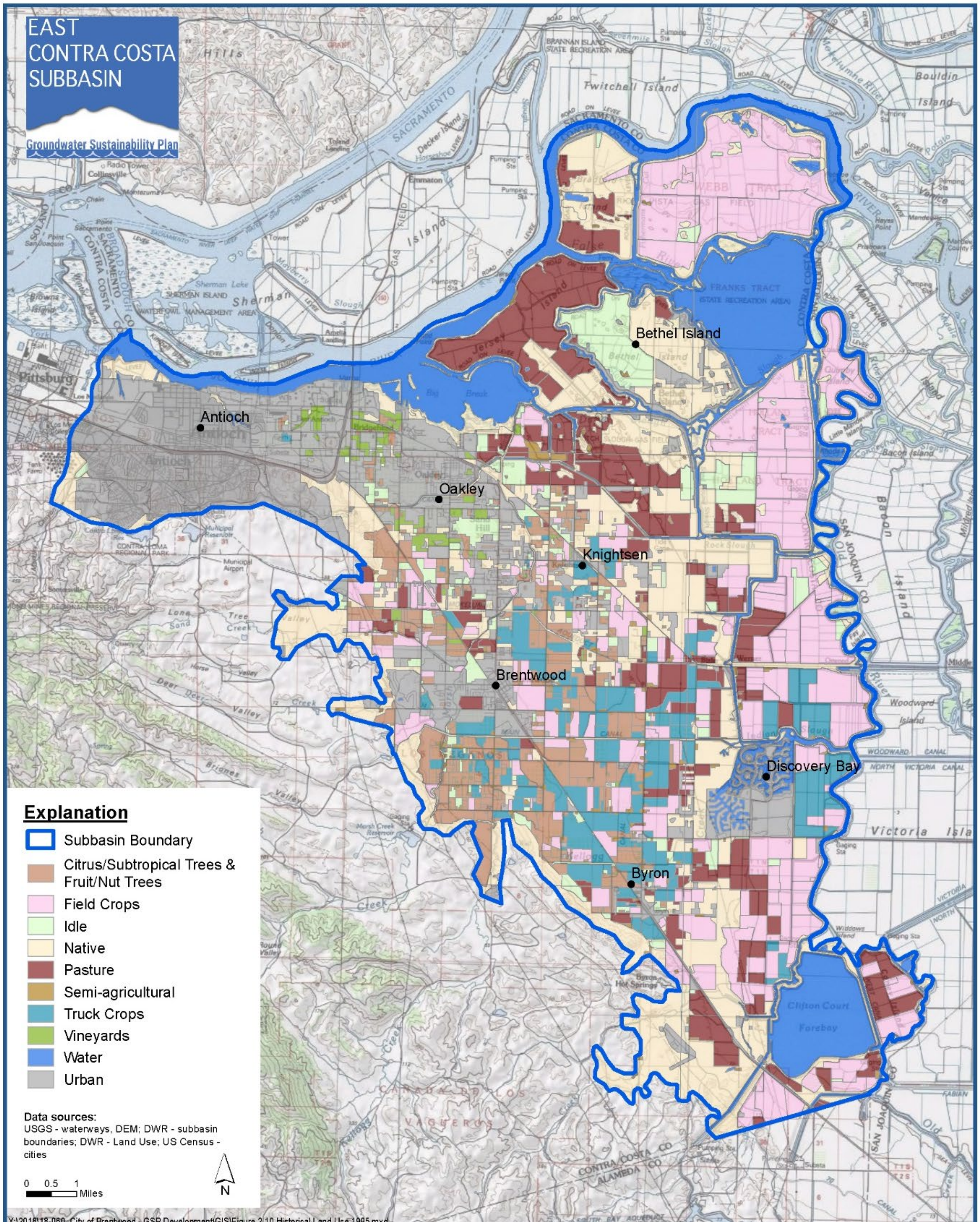


Luhdorff & Scalmanini Consulting Engineers

Land Use- 2014 & 2015

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-9

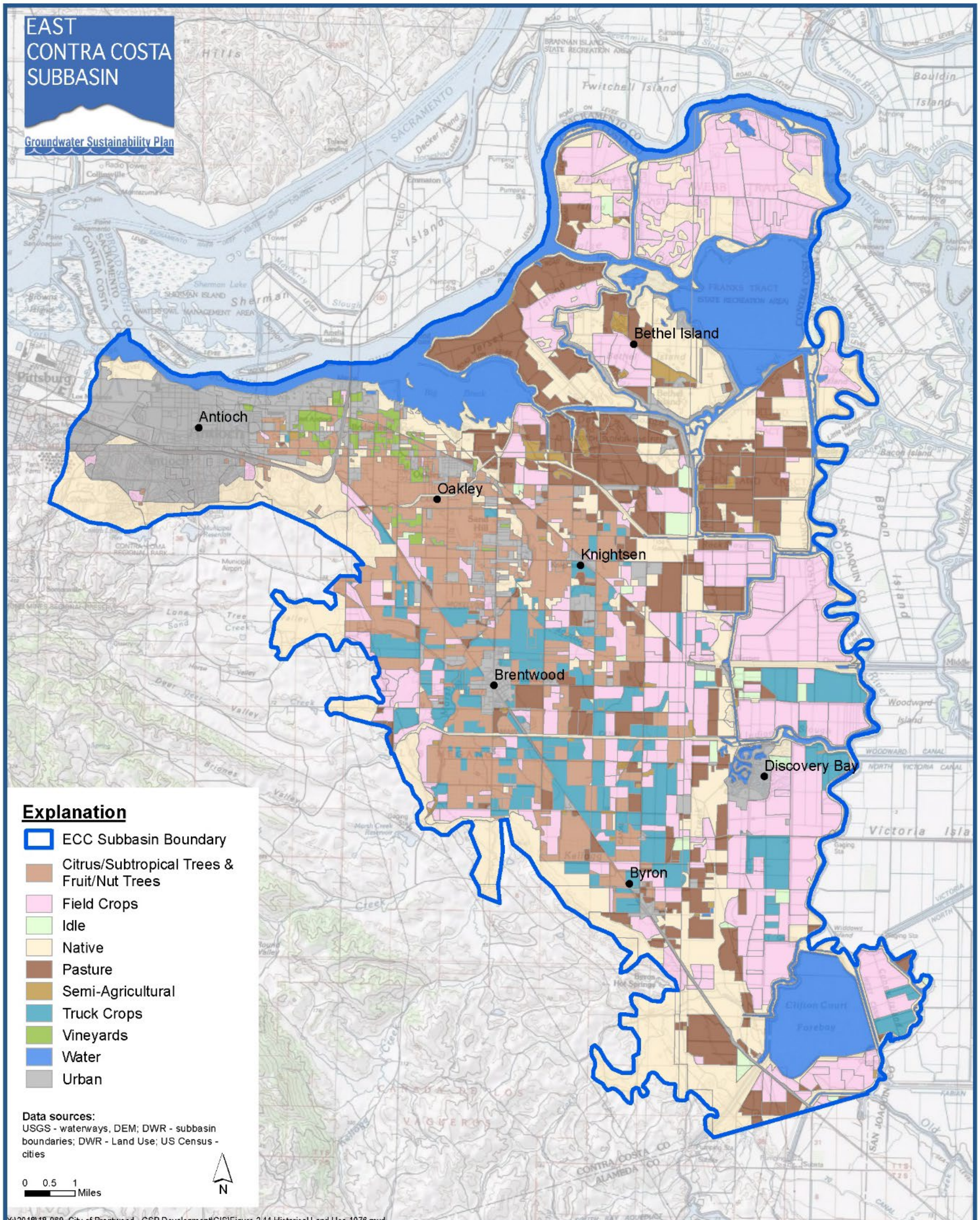


Luhdorff & Scalmanini Consulting Engineers

Historical Land Use-1995

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-10

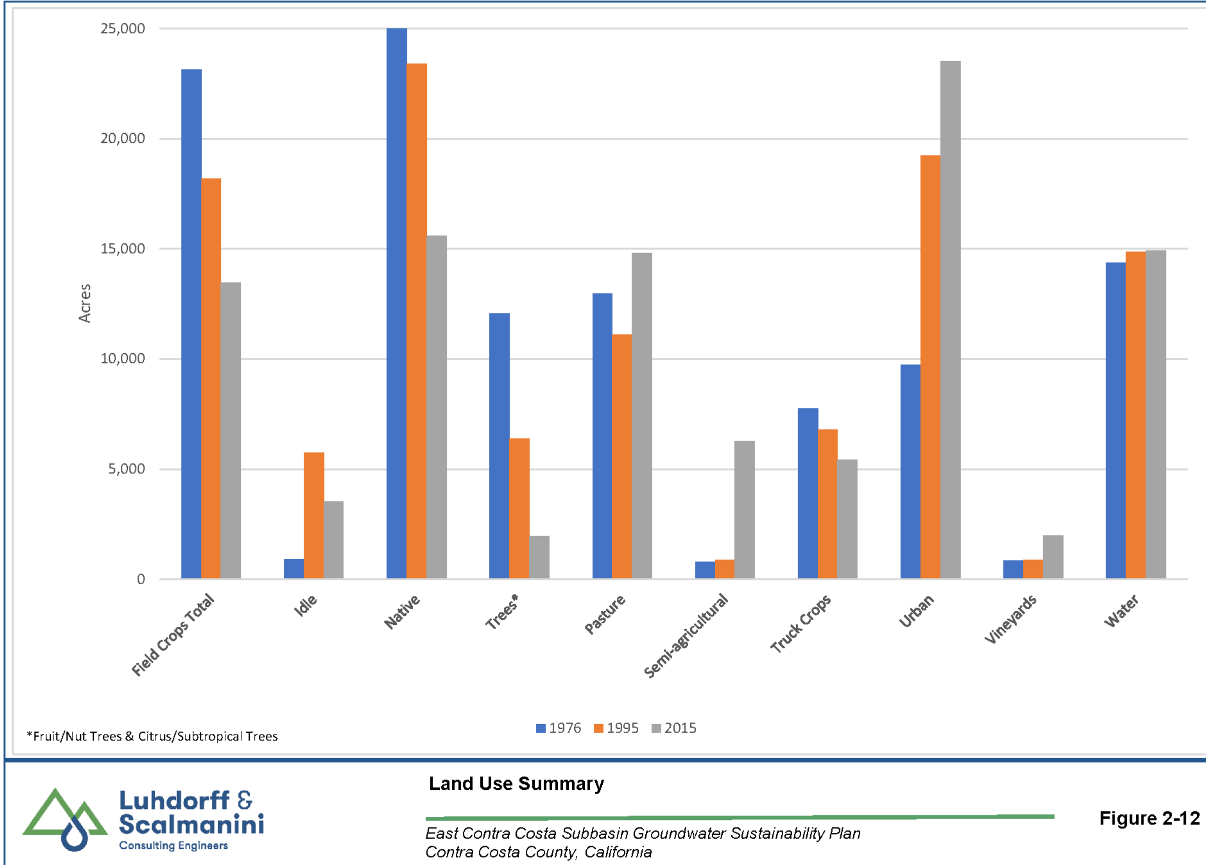


Historical Land Use-1976

Figure 2-11

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Luhdorff & Scalmanini Consulting Engineers



Land Use Summary

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-12

Figures 2-10 and **2-11** illustrate historical land use for the years 1995 and 1976, respectively. **Table 2-3** and **Figure 2-12** summarize land use trends over a 40-year span (1976 to 2015) that shows increasing urban lands and decreasing agricultural (field crops and fruit trees) and native lands. Chapter 4.1 provides additional detail on current and historical land uses.

2.3.2 Disadvantaged Area: DAC, SDAC and EDA

Nearly 35% of the ECC Subbasin is considered a Disadvantaged Area and (**Table 2-4** and **Figure 2-13a**), which accounts for almost 20% of the population of the Subbasin (**Table 2-5** and **Figure 2-13b)**. The term "Disadvantaged Area" includes the severely disadvantaged communities (SDAC), disadvantaged communities (DAC), and economically distressed areas (EDA), (collectively referred to as Disadvantaged Area [DA]).

There are 15,253 people in 5,610 acres of land in the ECC Subbasin that are categorized as a DAC, an additional 17,689 people in 5,095 acres are designated as SDACs, making approximately 18% of the 178,618 population and 10% of the 107,600 acres of the ECC Subbasin covered by DACs and SDACs. DACs are areas identified as having a median household income (MHI) of less than 80% of the California statewide annual MHI, and SDACs have an MHI of less than 60% of the statewide MHI. The DAC/SDAC acreage is based on the Median Household Income ($63,783) for 2012-2016 US Census American Community Survey (ACS) and in accordance with data from DWR's DAC Mapping Tools. The areas within the Subbasin identified as DACs and SDACs are displayed on **Figure 2-13**. A summary of DAC area by Census geography type (e.g., Census Block Groups, Census Place, and Census Tracts) is included in **Table 2-4**.

There are 2,645 people in 26,389 acres of land in the ECC Subbasin that are categorized as an EDA. The areas within the Subbasin identified as EDAs are displayed on **Figure 2-13a**, and **2-13b**. A summary of EDA areas by Census geography type (i.e., by Tracts and Blocks) is included in **Table 2-4 (by area)** and **Table 2-5 (by population)**. The EDAs by Tract and Block fulfill three criterion: EDA Criterion 1 and 2 municipality with MHI of less than 85% of the Statewide MHI and a population of less than 20,000; and EDA Criterion 3 has a low population density (less than or equal to 100 persons/square mile). The total percentage of people in the Subbasin comprising EDAs is about 2% and 24.5% percent of land are considered EDAs.

Table 2-4. Summary of Disadvantaged Areas by Area

Area Description	Acres[1]	Percent of Subbasin	Cumulative Acres[1]	Cumulative Percent of Subbasin
East Contra Costa Subbasin	**107,596**	**100%**	**107,596**	**100%**
Disadvantaged Communities[2]				
Census Block Groups				
SDAC	1,512	1.41%	1,512	1.41%
DAC	3,218	2.99%	4,730	4.40%
Census Place				
SDAC	3,583	3.33%	8,313	7.73%
Census Tracts				
DAC	2,392	2.22%	10,705	9.95%
Total Census Block Group and Tract DACs & SDACs			**10,705**	**9.95%**
Economically Distressed Areas[3]				
Census Tract and Block				
Total EDA	26,389	24.53%	26,389	24.53%
Total DACs, SDACs, and EDAs for All Census Geographies			**37,095**	**34.5%**

[1] Areas calculated using geographic projection NAD 1983 California Teale Albers.

[2] DAC = Disadvantaged Community: $38,270 < median household income [MHI] < $51,026.
SDAC = Severely Disadvantaged Community: MHI < $38,270 (60% of statewide MHI).

[3] EDA=Economically Distressed Area: a municipality with a population of 20,000 persons or less, a rural county, or a reasonably isolated and divisible segment of a larger municipality where the segment of the population is 20,000 persons or less, with an annual median household income that is less than 85% of the Statewide median household income, and with one or more of the following conditions as determined by the department: (1) financial hardship, (2) unemployment rate at least 2% higher than the Statewide average, or (3) low population density. (Water Code §79702(k)).

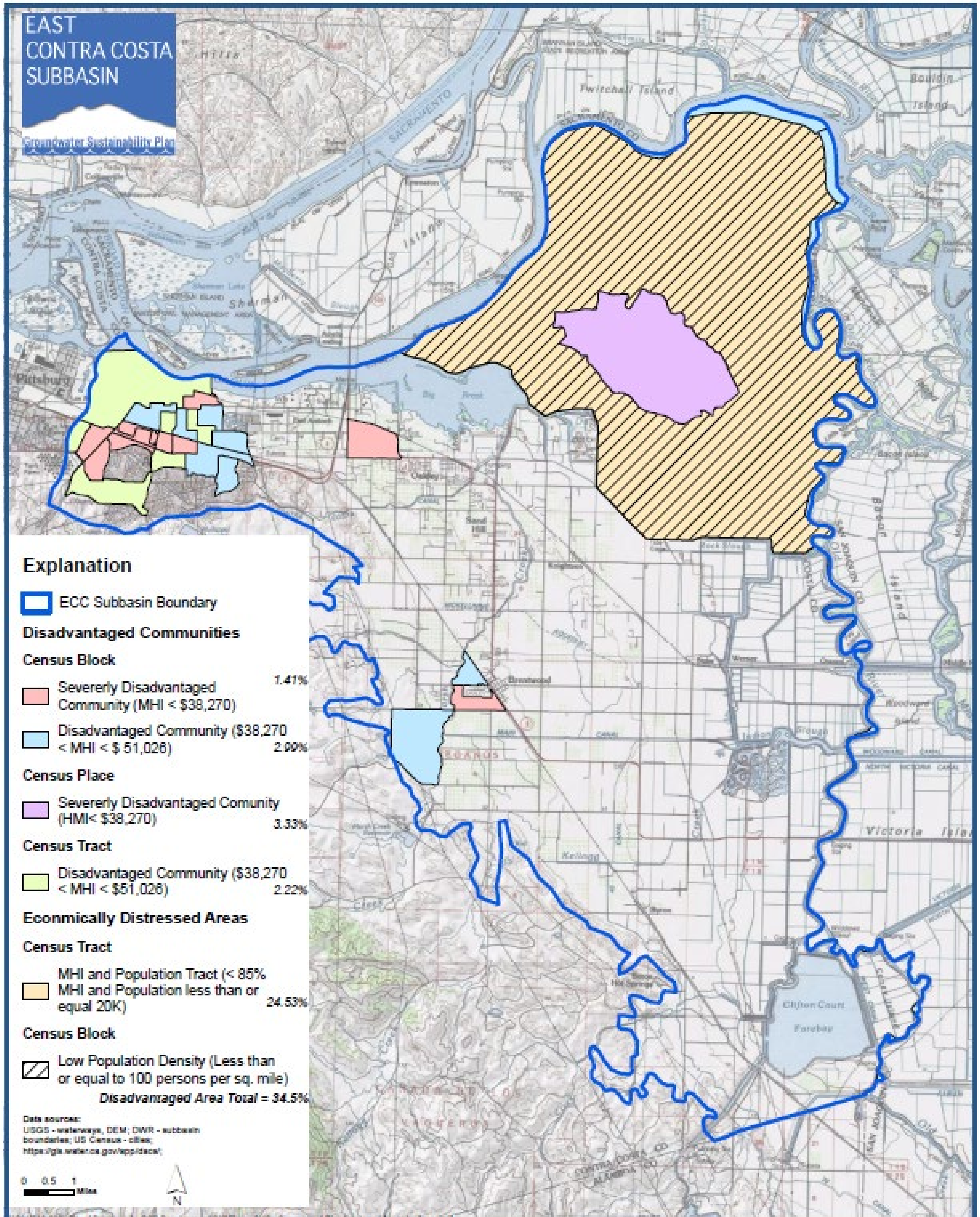
Table 2-5. Summary of Disadvantaged Areas by Population

Area Description	Population[1]	Percent of Subbasin	Cumulative Population[1]	Cumulative Percent of Subbasin
East Contra Costa Subbasin	**178,618**	**100%**	**178,618**	**100%**
Disadvantaged Communities[2]				
Census Block Groups				
SDAC	15,490	8.67%	15,490	8.67%
DAC	13,684	7.66%	29,174	16.33%
Census Place				
SDAC	2,199	1.23%	41,373	17.56%
Census Tracts				
DAC	1,569	0.88%	32,942	18.44%
Total Census Block Group and Tract DACs & SDACs			**32,942**	**18.44%**
Economically Distressed Areas[3]				
Census Tract and Block				
Total EDA	**2,645**	**1.48%**	**2,645**	**1.48%**
Total DACs, SDACs, and EDAs for All Census Geographies			**35,587**	**19.9%**

[1] Population calculated using Census Tract data.

[2] DAC = Disadvantaged Community: $38,270 < median household income [MHI] < $51,026.
SDAC = Severely Disadvantaged Community: MHI < $38,270 (60% of statewide MHI).

[3] EDA=Economically Distressed Area: a municipality with a population of 20,000 persons or less, a rural county, or a reasonably isolated and divisible segment of a larger municipality where the segment of the population is 20,000 persons or less, with an annual median household income that is less than 85% of the Statewide median household income, and with one or more of the following conditions as determined by the department: (1) financial hardship, (2) unemployment rate at least 2% higher than the Statewide average, or (3) low population density. (Water Code §79702(k)).

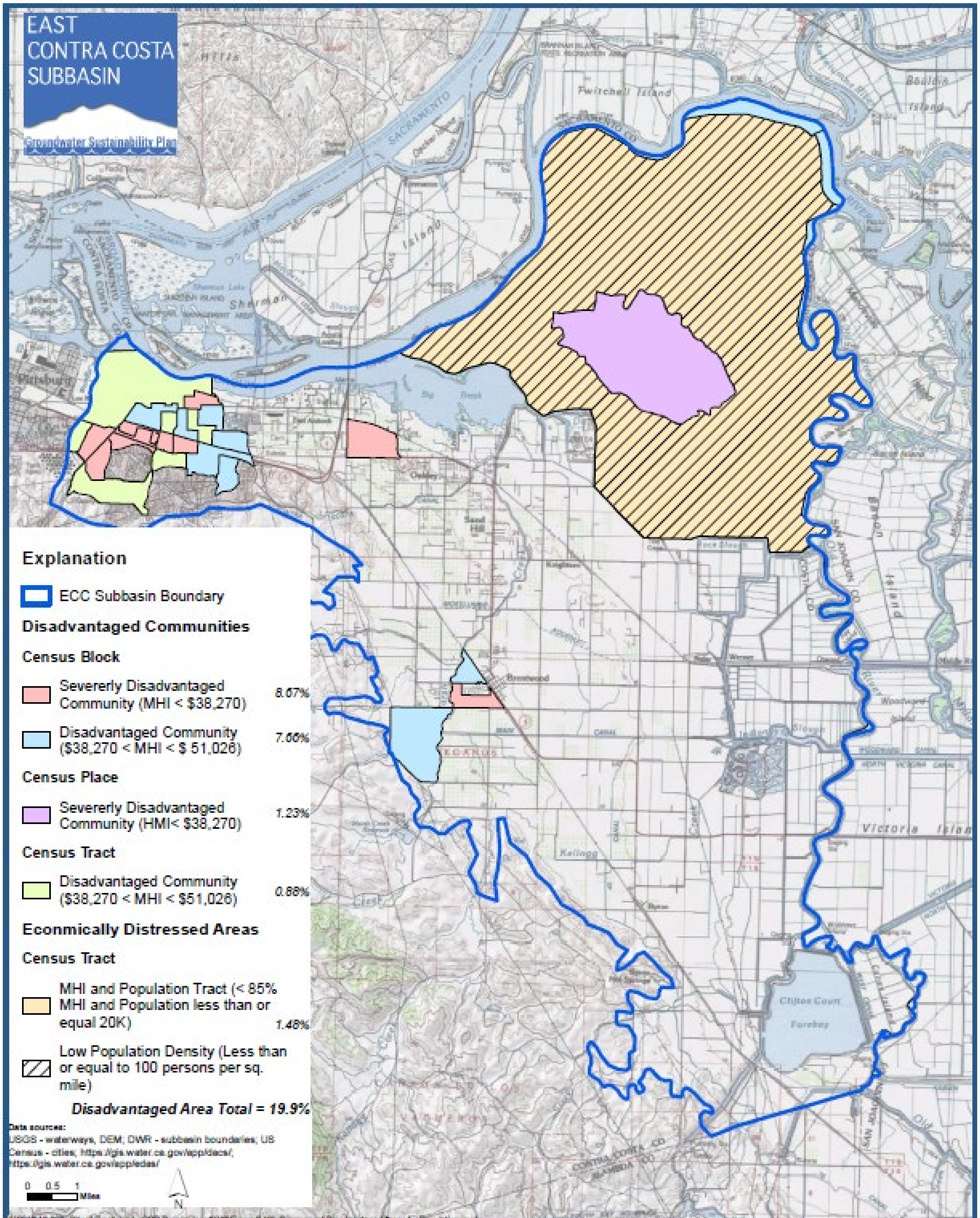


Luhdorff & Scalmanini
Consulting Engineers

Summary of Disadvantaged Areas by Area

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-13a



Luhdorff & Scalmanini
Consulting Engineers

Summary of Disadvantaged Areas by Population

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-13b

2.3.3 Water Use Sector and Water Source Type

SGMA regulations define "water use sector" as "categories of water demand based on the general land uses to which the water is applied, including urban, industrial, agricultural, managed wetlands, managed recharge, and native vegetation[7]." **Figure 2-14** shows the distribution of the water use sectors in the Subbasin. Agriculture is the predominant water use sector followed by urban (Cities of Antioch, Oakley, Brentwood, and Discovery Bay) and native vegetation.

The Subbasin has three water source types: surface water (primary source about 80,000 AFY); groundwater (secondary source about 8,000 AFY); and recycled water (about 2,700 AFY) (IRWMP, 2019, based on 2010 Urban Water Management Plans). Land use by water source in the ECC Subbasin is shown in **Figure 2-15.** Conjunctive use of surface water and groundwater is practiced throughout much of the Subbasin. Urban centers water sources vary The City of Antioch uses surface water exclusively, while the Cities of Brentwood and Oakley (water provided by DWD) use a combination of surface water and groundwater, and the Town of Discovery Bay uses only groundwater. ECCID and BBID hold water rights to divert surface water from Old River and meet remaining demand with groundwater. The unincorporated portions of the Subbasin generally have surface water as the water source however, these amounts are not quantified. The exceptions to this are domestic users and small community water systems which rely on groundwater. The Ironhouse Sanitary District uses recycled water to irrigate crops for animal feed on Jersey Island (2,700 AF in 2010).

2.3.4 General Plans

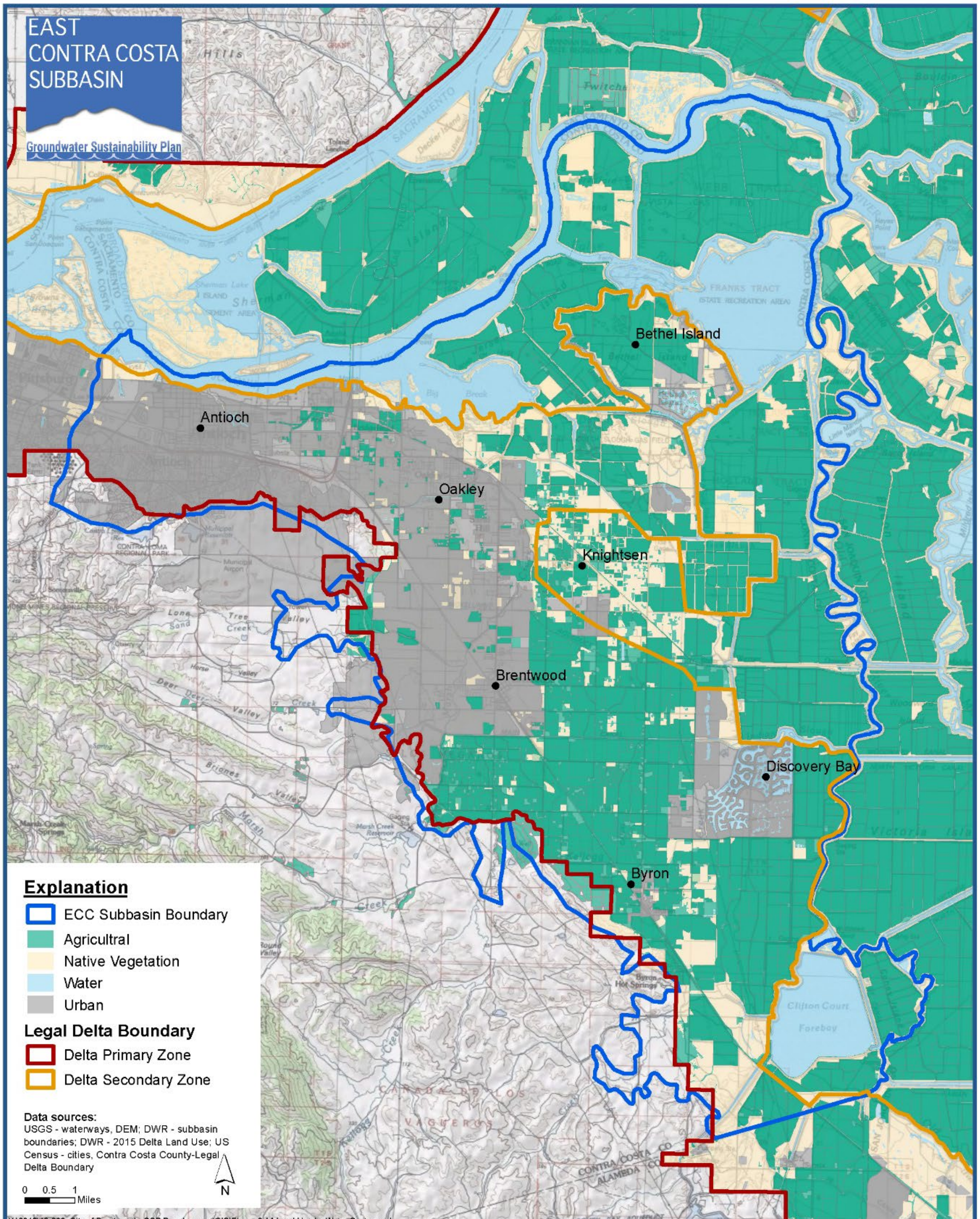
Four entities in the ECC Subbasin have land use authority[8] (**Figure 2-16**), which is an important factor in water management. Below is a description of the plans and how they may affect implementing the GSP. The Town of Discovery Bay does not have land use authority; however, the Town can advise the County on decisions affecting land use. The following section describes policies in the Plans related to water resources management in the ECC Subbasin. General Plans in the ECC Subbasin include:

- Contra Costa County General Plan (CCCDCD,2005)
- City of Antioch General Plan (LSA, 2003)
- City of Brentwood General Plan (DNPG, 2014)
- City of Oakley General Plan (CoO, 2016)

---

[7] California Code of Regulations, Title 23. Waters, Division 2. Department of Water Resources, Chapter 1.5. Groundwater Management, Subchapter 2. Groundwater Sustainability Plans, Article 2. Definitions

[8] CC County -Title 8, Zoning
https://library.municode.com/ca/contra_costa_county/codes/ordinance_code?nodeId=TIT8ZO
City of Brentwood – Title 17, Zoning
http://qcode.us/codes//brentwood/?view=desktop&topic=17-viii-17_467-17_467_002
City of Antioch – Title 9, Planning and Zoning
https://codelibrary.amlegal.com/codes/antioch/latest/overview
City of Oakley – Title 9 Land Use Regulation
https://www.codepublishing.com/CA/Oakley/

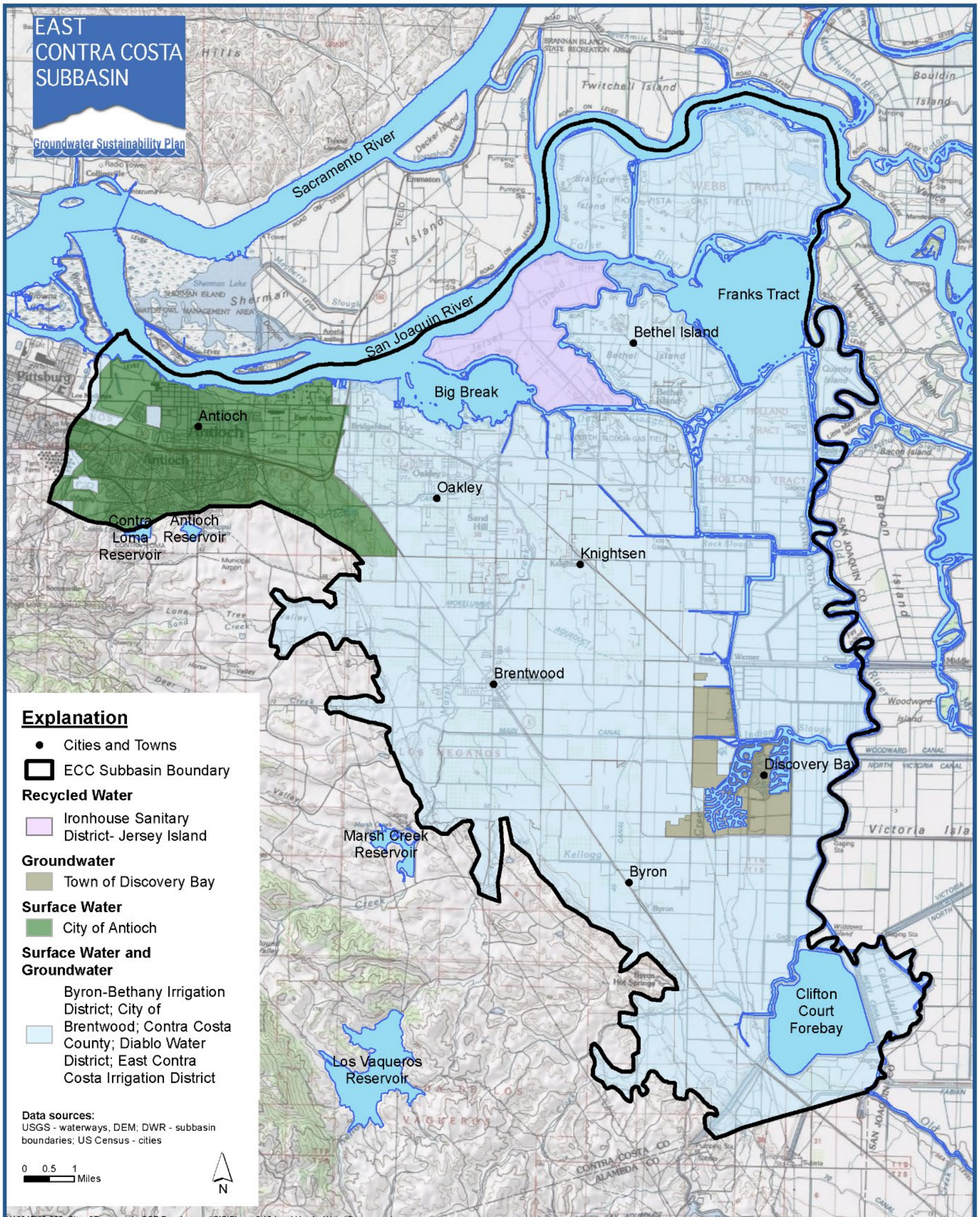


Luhdorff & Scalmanini Consulting Engineers

Land Use by Water Sector

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-14

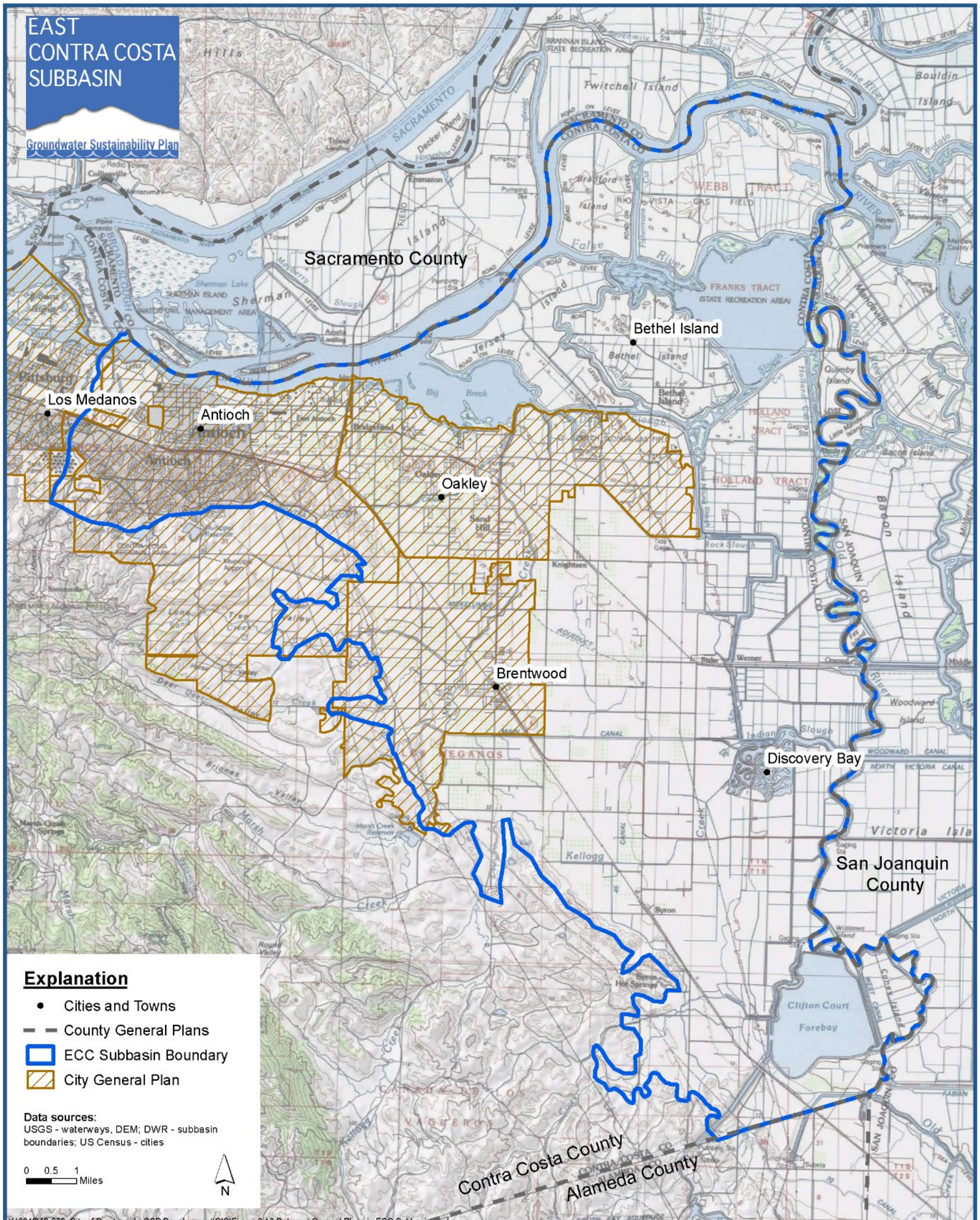


Luhdorff & Scalmanini Consulting Engineers

Land Use by Water Source (2010)

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 2-15



Luhdorff & Scalmanini Consulting Engineers

Relevant General Plans in ECC Subbasin

Figure 2-16

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

2.3.4.1 Contra Costa General Plan

The planned land use for the Subbasin is outlined in the Contra Costa County General Plan (CCCGP). The CCCGP was developed for 2005 to 2020 (CCC, 2005). Currently the county is working on a comprehensive update to the General Plan; a draft is anticipated to be ready for review in 2021. The county is mandated by California Government Code (§65350-65362) to prepare a General Plan to help and guide future development in the county as related to land use, development, and conservation. It describes that much of the county's future growth (2000 to 2010) was planned along the Pittsburg-Antioch corridor.

In regard to conservation the CCCGP developed five overall policies:

- 8-1. Resource utilization and development shall be planned within a framework of maintaining a healthy and attractive environment.
- 8-2. Areas that are highly suited to prime agricultural production shall be protected and preserved for agriculture and standards for protecting the viability of agricultural land shall be established.
- 8-3. Watersheds, natural waterways, and areas important for the maintenance of natural vegetation and wildlife populations shall be preserved and enhanced.
- 8-4. Areas designated for open space/agricultural uses shall not be considered as a reserve for urban uses and the 65 percent standard for non-urban uses must not be violated.
- 8-5. In order to reduce adverse impacts on agricultural and environmental values, and to reduce urban costs to taxpayers, scattered urban development in outlying areas shall be precluded outside the urban limit line.

2.3.4.2 City of Antioch General Plan

The City of Antioch prefers that development not outpace infrastructure. The City foresees that a lot of development will occur in the area and requires developers to pay for infrastructure improvements so current infrastructure will not be overly stressed. The City also wants the infrastructure to be outlined prior to completing development to avoid want temporary work arounds. The City anticipates more growth, and its goal is to continue water conservation efforts. The City presents several options to meet water demands besides conservation. These include (LSA, 2003):

- Confirm new developments can be supported with a reliable water source
- New development landscaping must be drought tolerant
- Work to make recycled water a viable option
- Protect potential groundwater recharge areas
- Fight policies that would reduce river rights (i.e., increase salinity)

2.3.4.3 City of Brentwood General Plan

The City of Brentwood General Plan was updated in 2014 (DNPG) and provides the framework to guide growth and conserve open space. The City's goal with regard to water requirements is to provide safe and reliable water to its citizens. The General Plan outlines three ways it plans to achieve this goal. The City plans to continually assess water saving strategies and water demands. The City also plans to discuss the possibility of receiving additional water from East Bay Municipal Utility District (EBMUD), CCWD, and ECCID. In 2006, voters approved an Urban Limit Line (ULL); the line would limit the development of urban infrastructure. Current land use maps show small areas are planned for future development (DNPG, 2014).

2.3.4.4 City of Oakley General Plan

The City of Oakley also has a ULL and a desire to "preserve quality of life for residents". The City's goal to meet current and future water requirements is to require new development to detail how water supplies will be met, request that water agencies meet quality standards, and protect water sources from pollution by working with regulatory agencies. The City also will urge water agencies to have written plans in case of drought (CoO, 2016).

2.3.4.5 Land Use Plans and the GSP Water Supply Assumptions

In general, land use and water supply assumptions included in the General Plans in the ECC Subbasin are consistent with current and future land use and water demand projections used in the GSP. The county and cities' policies include water conservation and sustainable management of groundwater resources. GSP implementation is expected to be consistent with future water use and land use as projected in the General Plans, urban water management plans, and agricultural water management plans. These documents were used to project future land use and resulting water demand for the future water budgets used in the GSP.

2.3.5 Water Management Plans

Many water management plans cover the Subbasin. These are described below.:

2.3.5.1 Urban Water Management Plan

Urban Water Management Plans (UWMP) are required by the Urban Water Management Plan Act for any water supplier distributing more than 3,000 AFY or that has more than 3,000 connections. A UWMP must be prepared and submitted to DWR every 5 years. Each UWMP should asses the reliability of water for the next 20 years, how demands are met including shortages, conservation efforts with the goal being a 20% reduction in water use per person, and finally a goal for recycled water use in the agency's sphere of influence. The following UWMPs have been developed in the Subbasin:

- City of Antioch Urban Water Management Plan (WYA, 2015)
- City of Brentwood Urban Water Management Plan (B&C, 2016)
- Diablo Water District 2015 Urban Water Management Plan (CDM, 2015)
- Town of Discovery Bay Community Services District 2015 Urban Water Management Plan (LSCE, 2017)
- Contra Costa Water District Urban Water Management Plan (CCWD, 2015)

2.3.5.2 Agricultural Water Management Plan

Agricultural Water Management Plans (AWMP) are required by the Water Conservation Act of 2009 (SB X7-7) for any water supplier distributing more than 25,000 AFY (excluding recycled water deliveries) to prepare a plan and submit it to DWR. The Act requires that each agency/region develop a water budget for a water year identifying inflow and outflow components, ways to improve water efficiency, quantify water use, and outline a plan for droughts. In addition, the AWMP must include the status of Efficient Water Management Practices (EWMP). EWMP must be followed for delivery point measurements and volumetric pricing; the remaining EWMPs are to be implemented if they are technically feasible or funding is available. The following AWMP was developed in the Subbasin:

- Byron Bethany Irrigation District Agricultural Water Management Plan (CH2M, 2017)

2.3.5.3 Integrated Regional Water Management Plan

In an effort to address California's water supply and management practices, DWR created policies that encourage Integrated Regional Water Management Plans (IRWMP) and grant funding to implement the program. The goal of the IRWMP is to evaluate all aspects of water management. In 2015, CCC updated their IRWMP (ECCWMA, 2015). Their plan has 25 objectives that are used by the ECCWMA members to address their water management issues:

- Protect/improve source water quality
- Maintain/improve regional treated drinking water quality
- Maintain/improve regional recycled water quality
- Increase understanding of groundwater quality and potential threats to groundwater quality
- Meet current and future water quality requirements for discharges to the Delta
- Limit quantity and improve quality of stormwater discharges to the Delta
- Manage local stormwater
- Improve regional flood risk management
- Enhance understanding of how groundwater fits into the water portfolio and investigate groundwater as a regional source (e.g., conjunctive use)
- Protect, restore and enhance habitat in the Delta and connected waterways
- Protect, restore and enhance the watersheds that feed and contribute to the Delta ecosystem
- Minimize impacts to the Delta ecosystem and other environmental resources
- Reduce greenhouse gas emissions
- Protect Delta ecosystem against habitat disruption due to emergencies, such as levee failure
- Increase shoreline access for subsistence fishing and recreation
- Increase regional cost efficiencies in treatment and delivery of water, wastewater, and recycled water
- Develop projects with regional benefits that are implementable and competitive for grant funding
- Use financial resources strategically to maximize return on investment on grant applications for project development/implementation
- Develop a funding pool to self-fund regional efforts such as grant applications, outreach, website development, and other planning activities
- Increase public awareness of project importance to pass ballot measures or obtain matching funds through other means that require public support
- Ensure projects with existing matching funds are prioritized to maximize regional funding opportunities
- Identify and engage DACs
- Collaborate with and involve DACs in the IRWM process
- Promote equitable distribution of proposed projects across the region
- Increase awareness of water resource management issues and projects with the general public

2.3.5.4 Additional Water Plans in Subbasin

The City of Brentwood developed and updated a Water Master Plan in 2003 and 2017 (Ennis, 2017). The plan has two main goals: 1) identify limitations of the current water system and whether current infrastructure could be modified to resolve any deficiencies, and 2) identify what infrastructure will need to be modified to serve new development.

In 2012, the TODB developed a Water Master Plan (LSCE, 2012). The plan has two main objectives 1) evaluate system efficiency, and 2) outline any capital improvement projects that would enable TODB to meet the current and future water demands of the service area.

CCWD prepares a Water Management Plan to be submitted to the USBR as part of their contract for CVP water. CCWD prepares a Water Management Plan (Plan) every five years (the last one was submitted in 2017) and also periodically prepares a Future Water Supply Study. The intent of the Plan is for CCWD to demonstrate federal water "is put to reusable and beneficial use." CCWD demonstrates this to USBR by outlining water conservation efforts, providing information on water-related infrastructure, and description of the district which includes district demographics, topography, climate, natural and cultural resources, district rules and regulations, and billing and pricing.

As a result of Assembly Bill (AB) 3030, the California Water Code (CWC), Section 10750, DWD board of directors agreed to prepare a groundwater management plan. DWD's goal was "to provide a management framework for maintaining a high quality, reliable, and sustainable supply of groundwater within the District's sphere of influence." In 2007, DWD implemented the Diablo Water District Groundwater Management Plan for AB 3030 (LSCE, 2007).

2.4 County Well Construction, Destruction and Permitting

2.4.1 Wellhead Protection and Well Permitting

Wellhead protection is governed by county, state and federal regulations within the Subbasin.

Well permitting in the Subbasin is overseen by the CCC Health Services, Environmental Health Division. The Environmental Health Division requires a Well Permit Application to be completed prior to any ground surface breaking that includes well construction, reconstruction, or destruction, including water wells, dewatering wells, monitoring wells, cathodic protection wells, geothermal wells, piezometers, inclinometers, soil vapor probes, Cone Penetrating Testing (CPTs), soil borings, and geotechnical borings. Environmental Health Division reviews the well permit and either approves, denies, or requests modification. CCC also has well regulations to meet water supply demands for new housing construction (CCC, 1981).

2.4.1.1 Well Installations

A county official reviews permits for new well construction, and the application will be approved, dismissed, or more information will be requested. The well must be installed by a licensed C-57 Driller that maintains current registration with the county. Well installation requirements follow the standards outlined in the California Well Standards, Bulletin 74-81 and 74-90. The bulletin discusses the proper well locations (i.e. distance from property line, septic tanks, streams, livestock) for water supply wells, proper approaches for sealing the annulus (materials, methods, conditions and placement), casing material, and the material/construction of the completion monument (flush or stick up, with respect to the ground surface). A county official is required to inspect the grout mixture prior to well completion, and it is the responsibility of the driller to schedule the inspection. A pump test might be required if the county determines the need for one in the area.

2.4.1.2 Well Abandonment

As per Section 21 of Bulletin 74-81:

A well is considered 'abandoned' or permanently inactive if it has not been used for one year, unless the owner demonstrates intention to use the well again. In accordance with Section 24400 of the California Health and Safety Code, the well owner shall properly maintain an inactive well as evidence of intention for future use in such a way that the following requirements are met:

(1) The well shall not allow impairment of the quality of water within the well and groundwater encountered by the well.
(2) The top of the well or well casing shall be provided with a cover that is secured by a lock or by other means to prevent its removal without the use of equipment or tools, prevent unauthorized access, prevent a safety hazard to humans and animals, and prevent illegal disposal of wastes in the well. The cover shall be watertight where the top of the well casing or other surface openings to the well are below ground level, such as in a vault or below known levels of flooding. The cover shall be watertight if the well is inactive for more than five consecutive years. A pump motor, angle drive, or other surface feature of a well, when in compliance with the above provisions, shall suffice as a cover.
(3) The well shall be marked so as to be easily visible and located and labeled so as to be easily identified as a well.
(4) The area surrounding the well shall be kept clear of brush, debris, and waste materials."

2.4.1.3 Well Destruction

A permit must be submitted to the agency for approval of well destruction. The county states its requirements are as follows:

(1) Remove any obstructions from the well.
(2) Perforate or remove the well casing to the bottom of the well.
(3) Excavate around the casing to a depth of 6 ft.
(4) Place approved sealing material in the well extending from the bottom to the surface. Environmental Health staff will inspect this stage of the work. The well contractor is responsible for contacting Contra Costa Environmental Health to schedule inspection appointments. The greater the advance notice, the more likely a mutually convenient inspection appointment can be arranged.

2.5 Additional Plan Elements (WCS 10727.4)

Table 2-6 lists the additional Plan Elements listed in Water Code Section 10727.4 that should be included in a GSP, where appropriate, and the location in the GSP where these are addressed.

Table 2-6. Additional Plan Elements

Section Number	Code Description	Section in GSP with More Detail
10727.4 (a)	Control of saline water intrusion.	3.3.4
10727.4 (b)	Wellhead protection areas and recharge areas.	2.4.1 and 3
10727.4 (c)	Migration of contaminated groundwater.	3.3.6
10727.4 (d)	A well abandonment and well destruction program.	2.4
10727.4 (e)	Replenishment of groundwater extractions.	3
10727.4 (f)	Activities implementing, opportunities for, and removing impediments to, conjunctive use or underground storage.	2.2
10727.4 (g)	Well construction policies.	2.4
10727.4 (h)	Measures addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects.	3 and 4
10727.4 (i)	Efficient water management practices, as defined in Section 10902, for the delivery of water and water conservation methods to improve the efficiency of water use.	4 and 8
10727.4 (j)	Efforts to develop relationships with state and federal regulatory agencies.	8
10727.4 (k)	Processes to review land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity.	8
10727.4 (l)	Impacts on groundwater dependent ecosystems.	3.3.9

2.6 References

Brown and Caldwell (B&C). 2016. Final 2015 2015 Urban Water Management Plan. Prepared for City of Brentwood. June 2016.

Bradford Island Reclamation District 2059. https://bradfordisland.com/. Accessed January 2020

California Department of Water Resources (DWR). 1981. Water Well Standards: State of California. Bulletin 74-81.

California Department of Water Resources (DWR). 1991. California Well Standards, Bulletin 74-90.

California Department of Water Resources (DWR) Well Completion Report Map Application. 2019. https://www.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37. Accessed May 2019.

California Department of Water Resources (DWR). 2019 https://gis.water.ca.gov/app/edas/. Accessed May 2019.

California Department of Water Resources (DWR). 2019. https://gis.water.ca.gov/app/dacs/. Accessed May 2019.

California Department of Water Resources (DWR). December 2016. Guidance Document for the Sustainable Management of Groundwater: Groundwater Sustainability Plan (GSP) Annotated Outline. https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/GD_GSP_Outline_Final_2016-12-23.pdf. Accessed on March 26, 2020.

CDM Smith (CDM). 2015. Final 2015 Diablo Water District Urban Water Management Plan. June 2016.

CH2M. 2017. Byron Bethany Irrigation District Agricultural Water Management Plan. Prepared for Byron Bethany Irrigation District. October 2017.

Contra Costa County (CCC). 1981. Ordinance Code of Contra Costa County, California, Approved Water Supply Systems.

Contra Costa County Department of Conservation and Development (CCCDCD). 2005. Contra Costa County General Plan 2005-2020. January 18,2005

Contra Costa County Environmental Health Division (CCCEHD). 1994. Well Destruction Guidelines. https://cchealth.org/eh/land-use/#Wells. Accessed May, 2019

Contra Costa County Environmental Health Division (CCCEHD). 2000. The Well Permit Process. https://cchealth.org/eh/land-use/#Wells. Accessed May, 2019

Contra Costa County Environmental Health Division (CCCEHD). 2018. Underground Storage Tanks Program. https://cchealth.org/hazmat/ust/. Accessed January 2020.

Contra Costa Water District. 2015. 2015 Urban Water Management Plan for the Contra Costa Water District. June 2016.

Contra Costa Water District. 2017. Water Management Plan Report to the United States Bureau of Reclamation on Contra Costa Water District's Water Conservation Program and Activities.

City of Oakley (CoO). 2010. City of Oakley 2020 General Plan. February 2, 2016.

De Novo Planning Group (DNPG). 2014. City of Brentwood General Plan. July 22, 2014.

East Contra Costa County Water Management Association (ECCWMA). 2015. East Contra Costa County Integrated Regional Water Management Plan (IRWMP). March 2019.

Ennis Consulting. 2017. City of Brentwood Water Master Plan. June 1, 2017

Hotchkiss Tract Reclamation District 799. https://www.rd799.com/. Accessed January 2020

Jersey Island Reclamation District 830. http://www.ironhousesanitarydistrict.com/211/RD-830. Accessed January 2020

Luhdorff and Scalmanini, Consulting Engineers. 1999. Investigation of Ground-Water Resources in the East Contra Costa Area. Prepared for East County water entities. March 1999.

Luhdorff and Scalmanini, Consulting Engineers. 2007. Diablo Water District Groundwater Management Plan for AB3030. Prepared for Diablo Water District. May 2007.

Luhdorff and Scalmanini, Consulting Engineers. 2011. Groundwater Monitoring Report. Prepared for Diablo Water District. August 2011.

Luhdorff and Scalmanini, Consulting Engineers. 2012. Discovery Bay Community Services District Water Master Plan Final Report. January 2012.

Luhdorff and Scalmanini, Consulting Engineers. 2014. California Groundwater Elevation Monitoring (CASGEM) Network Plan. Prepared for East Contra Costa Agencies. July 2014.

Luhdorff and Scalmanini, Consulting Engineers. 2017. 2015 Urban Water Management Plan Town of Discovery Bay Community Services District. June 21, 2017.

Luhdorff and Scalmanini, Consulting Engineers. 2018. Groundwater Conditions Update Tracy Subbasin. Prepared for Contra Costa County Agencies. May 2018.

LSA Associates (LSA). 2003. City of Antioch General Plan. November 24,2003.
West Yost Associates (WYA). 2016. Final 2015 Urban Water Management Plan, prepared for City of Antioch. May 2016.

SECTION 3 CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

3. BASIN SETTING

3.1 Overview

This Basin Setting section of the East Contra Costa (ECC) Groundwater Sustainability Plan (GSP) describes the Hydrogeologic Conceptual Model (HCM) (Section 3.2) and historical and current Groundwater Conditions (Section 3.3). The sections were developed using best available science and serve as the basis upon which ECC GSAs will select management criteria to maintain sustainable groundwater conditions in the ECC Subbasin. Groundwater Sustainability Agencies (GSAs) "have the responsibility for adopting a Plan that defines the basin setting and establishes criteria that will maintain or achieve sustainable groundwater management" as detailed by DWR in the GSP regulations (Title 23 California Code of Regulations [CCR] Section 350.4e). The two main topics covered in this section include:

- **Hydrogeologic Conceptual Model (HCM):** Section 3.2 describes the physical components of the Subbasin including the regional geology, structural properties, boundaries of the Subbasin, principal aquifer descriptions with cross sections, topographic and soil characteristics, recharge areas, and significant surface water bodies.
- **Groundwater Conditions:** Section 3.3 provides current and historical groundwater conditions including discussions of groundwater level maps and time-series graphs, groundwater storage, seawater intrusion, groundwater quality, land subsidence, interconnected surface water systems, and groundwater dependent ecosystems.

3.2 Hydrogeologic Conceptual Model

The HCM describes the geologic and hydrologic framework that governs how water moves through the ECC Subbasin. This description provides the basis to develop water budgets, monitoring networks, and ultimately a surface water/groundwater mathematical model (**Section 5** of this GSP). This section includes information about the regional geologic and structural setting, lateral and vertical basin boundaries, and principal aquifers. This section is based on technical studies and maps that characterize the physical components and interaction of the surface water and groundwater systems, pursuant to Section 354.14 Hydrogeologic Conceptual Model. Information was compiled for this section from two main references: *Investigation of Ground-Water Resources in the East Contra Costa Area* (LSCE, 1999) and *An Evaluation of Geological Conditions, East Contra Costa County* (LSCE, 2016). Both reports are included in this document as **Appendices 3a and 3b**.

3.2.1 Regional Geological and Structural Setting

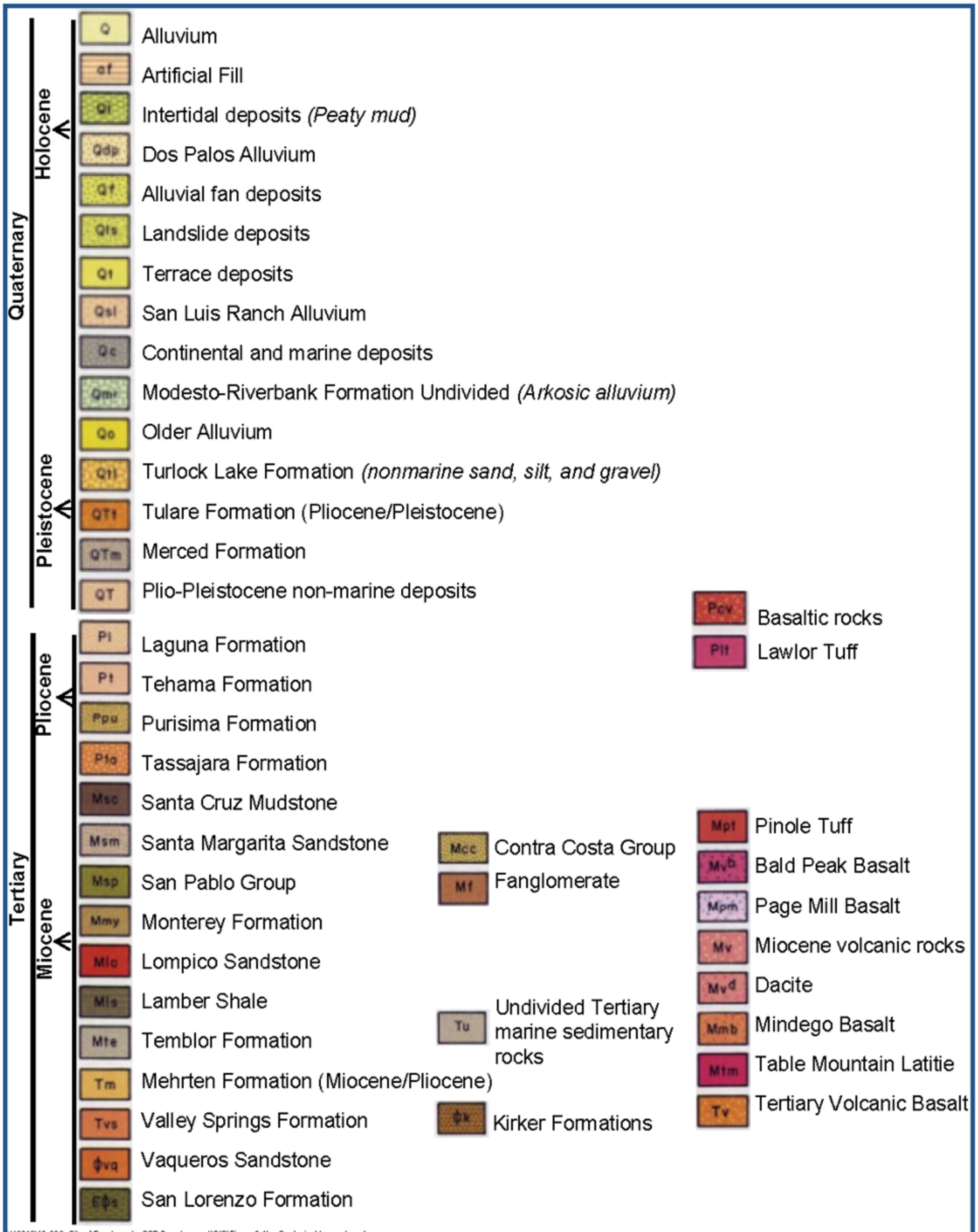
The San Joaquin Valley formed between two mountain ranges (Coast Ranges and the Sierras). The ECC Subbasin lies on the western side of the northern San Joaquin Valley portion of the Great Valley province of California. The western boundary of the Subbasin is a no flow boundary with respect to groundwater and is delineated by exposed bedrock of highly deformed Tertiary age and older marine sediments of the Coast Range Diablo Mountains. Most of the Subbasin is filled with freshwater-bearing alluvium, eroded continental sediments from the Coast Ranges, that are Quaternary in age. Surficial geology from multiple sources is provided in **Figure 3-1a** and a detailed legend is in **Figure 3-1b and c**.

Luhdorff & Scalmanini
Consulting Engineers

Surficial Geology and Faults

Figure 3-1a

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

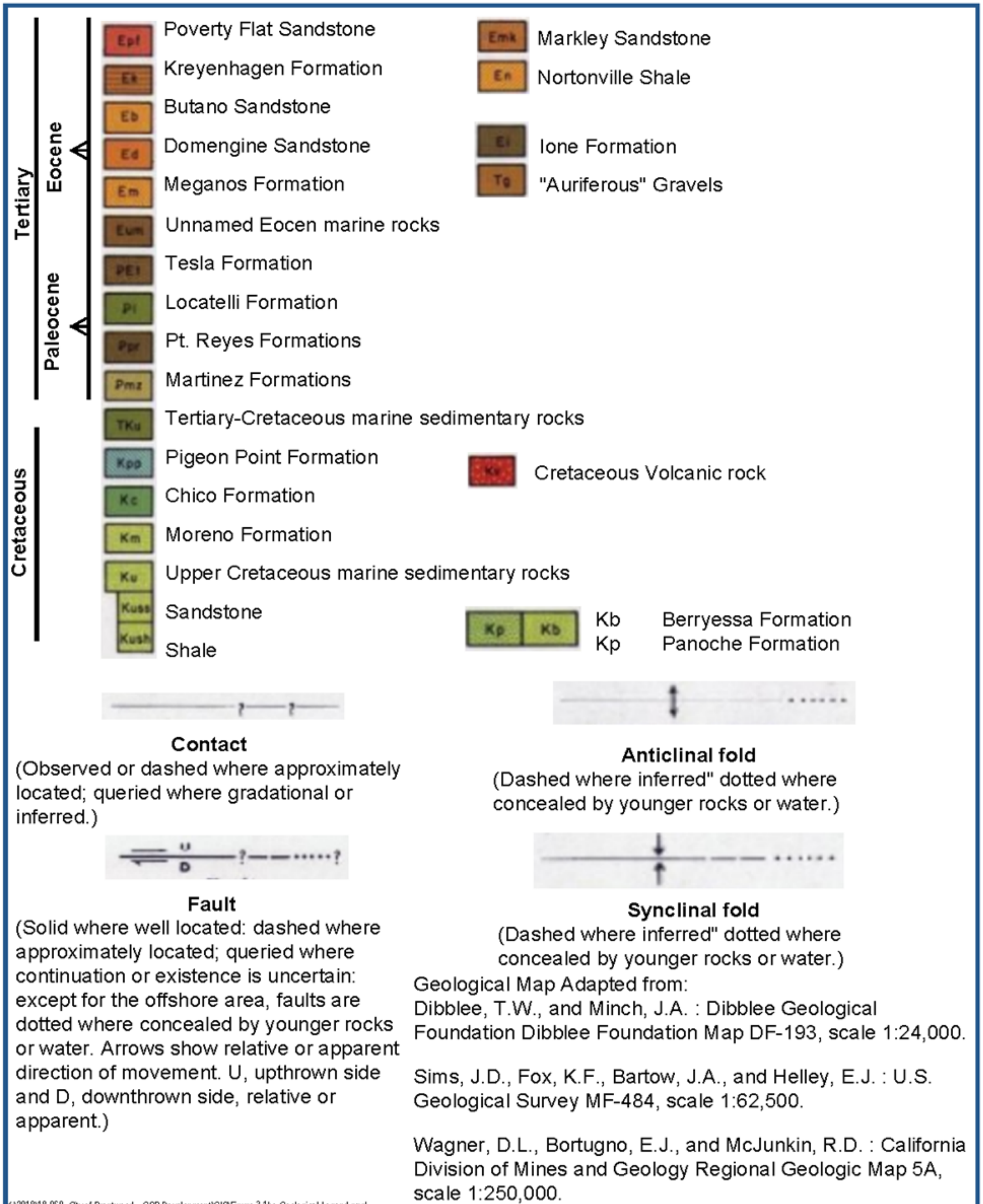


Luhdorff & Scalmanini
Consulting Engineers

Surficial Geology Legend

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-1b



Luhdorff & Scalmanini Consulting Engineers

Surficial Geology Legend

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-1c

3.2.1.1 Topographic Information

The topography of the Subbasin is generally flat with land surface elevations that slope gently downward to the east. Topographic elevations vary from about 200 feet above mean sea level (msl) in the west to less than 10 feet from msl in the delta area over a distance of about 10 miles (**Figure 3-2**). There are portions of the Subbasin (e.g., Delta islands) in the northeast and southeast that are below sea level.

3.2.1.2 Depositional Model

Regional geologic studies (Bartow, 1991; and Bertoldi and others, 1991) reported that Miocene marine deposition occurred in the area as shown by the Tertiary marine rocks exposed in the Coast Ranges. During the following Pliocene epoch, the San Joaquin Valley drained south to the ocean via the Salinas Valley. The Sacramento Valley drained westward through the Delta area, and the Coast Range locally had not yet been uplifted. Deposition may have been confined to distal fluvial plains sourced from the Sierra Nevada area, such that little sand was carried into the area. Similar aged fine-grained deposits are seen in southern Sacramento County, near Vacaville, and around Rio Vista reaching thicknesses of 2,000 to 2,500 feet.

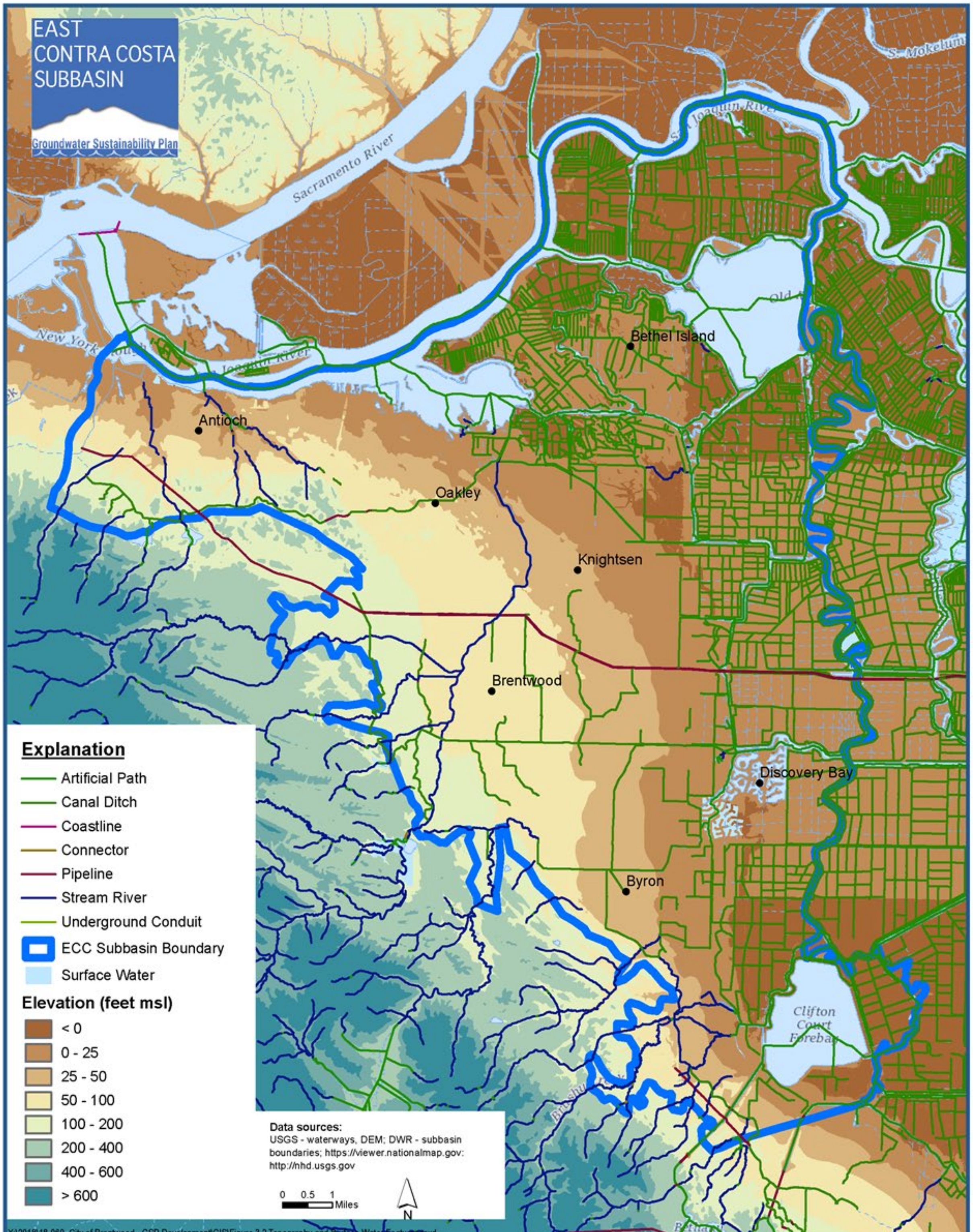
In the Quaternary (mid-Pleistocene) period, the San Joaquin Valley south of Tracy was occupied by a large freshwater lake known as Corcoran Lake. Associated with the lake was deposition of the Corcoran Clay, also termed E-Clay unit. Neither the lake nor the Corcoran Clay unit extended as far north as the ECC Subbasin distinguishing the Subbasin from other parts of the San Joaquin Valley Groundwater Basin to the south and east. At about 600,000 years ago, northern San Joaquin River drainage and local Coast Range uplift began. It is suspected that this activity marked the beginning of the alluvium deposition where coarse-grained deposits were formed and carried into the area by the San Joaquin River and from erosion of the uplifting Coast Ranges.

3.2.1.3 Surficial Geology and Geological Formations

Bedrock formations observed in outcrops along the western boundary of the ECC Subbasin consist of strongly deformed marine sedimentary rocks that range in age from over 63 million years (my) to 5my. The Tertiary marine rocks of sandstones, shales and mudstones dip east beneath the San Joaquin Valley with increasing depths. Because of their marine origin, well consolidated nature, and saline water, the Mesozoic and Tertiary marine rocks are not a source of fresh groundwater in the Subbasin (LSCE, 1999; 2016). Additional information about these units can be found in **Appendix 3a**.

Overlying the Tertiary marine rocks are a sequence of Tertiary-Quaternary non-marine sedimentary deposits (Pliocene to Pleistocene). These older sediments have limited areas of exposure along the edge of the Coast Range. These deposits are not well understood in the study area, but they are believed to consist of fine-grained clays, silts, and mudstones with a few sand beds. They dip moderately to the east and northeast under the San Joaquin Valley. Limited information from a few deep water well boreholes indicate they occur from 400 feet to depths of over 1,500 feet below the San Joaquin River. The lower portion of these deposits may be equivalent to the Mehrten Formation on the east side of the San Joaquin Valley. The upper portion of these older non-marine sediments may be equivalent to the Tulare Formation to the south of the Subbasin and the Tehama Formation to the north. Water quality appears to become brackish with depth (LSCE, 1999 and 2016).

Overlying the Tertiary/Quaternary non-marine sediments are the primary groundwater-bearing units in the ECC Subbasin.



X:\2018\18-060 City of Brentwood - GSP Development\GIS\Figure 3.2 Topography and Surface Water Features.mxd

Luhdorff & Scalmanini Consulting Engineers

Topography and Surface Water Features

Figure 3-2

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

These Quaternary alluvium deposits are unconsolidated beds of gravel, sand, silts, and clays becoming weakly consolidated with increasing age and burial depth. The alluvium thickens eastward to over 300 feet beneath Brentwood and about 400 feet below Old River. As discussed in Section 3.2.4, the units around Brentwood are believed to have been deposited by streams forming alluvial fans of silts and clays off the uplifted Diablo Mountains. Units around Discovery Bay are believed to be stream channel deposits of coarser sands and gravels. Separation of the alluvium into distinct units is difficult using well drillers' reports. The sand and gravel can be correlated locally, but the fine-grained sand and clays are so massive, a greater spatial correlation is not possible (LSCE, 1999). Sand and gravel beds and their distribution are discussed further in this chapter.

About 600,000 years before present, Corcoran Lake formed in nearly the entire San Joaquin Valley northward to the Stockton-Tracy area. A blue lake clay was deposited across the San Joaquin Valley and is known as the Corcoran Clay or E-clay. However, as cited above, this clay unit has not been identified north of the Stockton-Tracy area into the Delta area of Contra Costa County or in the Sacramento Valley (LSCE, 2016).

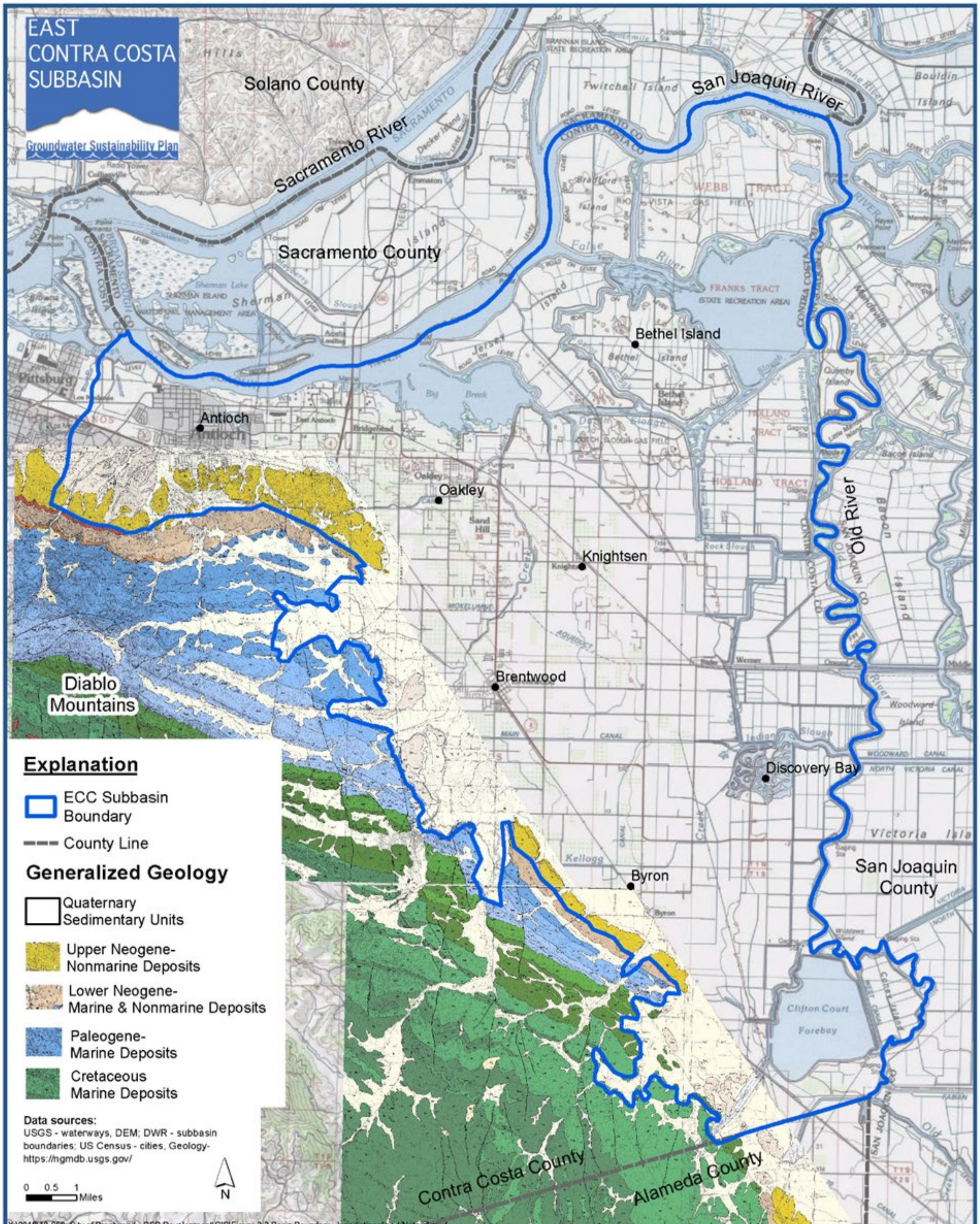
3.2.2 Faults and Structural Features

Three inactive faults (Midland, Sherman, and Antioch) trend in a north-south direction across the Subbasin (**Figure 3-1,** dashed lines). They are not known to inhibit groundwater flow or to impact water conveyance infrastructure. The Vernalis Fault is located southeast of Clifton Court Forebay (off of the geology map, **Figure 3-1**). Uplift or deformation along this fault may have caused a ridge that may influence groundwater flow as discussed below. No surface expression has been noted of this fault (LSCE, 2016).

3.2.3 Basin Boundaries

The lateral extent of the ECC Subbasin is defined primarily by jurisdictional and surface water boundaries (**Figure 3-3**). ECC Subbasin is bounded on the north, east, and south by the Contra Costa County line, which is contiguous with the San Joaquin River (north) and Old River (east). In the west, a non-jurisdictional Subbasin boundary corresponds to the non-water bearing geologic units which form a bedrock barrier to groundwater flow. **Figure 3-3** is a diagrammatic illustration of the western ECC Subbasin boundary in relation to the bedrock outcrop of older consolidated marine sediments (green, blue, and tan colors).

The base of the ECC Subbasin is defined by the vertical extent of available and extractable freshwater. The base of freshwater has been mapped previously in the general area by Page (1973) and Berkstressser (1973), and in a detailed map of the ECC Subbasin constructed by LSCE (2016). The base of freshwater map prepared by LSCE (**Figure 3-4**) updates the delineation of freshwater resources through additional oil and gas well electric logs in Montezuma Hills, Rio Vista, and the northwestern hills of Mount Diablo (Davis et al., 2018). The base of freshwater aquifers was determined from electric log responses in thick sand beds that had high resistivity values, and the character of the spontaneous-potential (S-P). This approach distinguished zones of poor water quality within sand beds, though it did not quantify salinity. Nevertheless, the geophysical characteristics of sand beds from electric logs provide a sound estimate of the vertical extent of freshwater in the Subbasin. Deeper sandy units with low resistivity values and indeterminable S-P characteristics were considered to be non-viable as aquifers. The examination by LSCE (2016) showed the deepest base of freshwater is to the northeast and east near the Subbasin boundary (-1,000 to -1,200 feet from msl) and rising to the west to elevations of 200 feet msl. In the Clifton Court Forebay area a subsurface ridge-like feature, possibly caused by the Vernalis Fault, extends eastward from the valley edge and may influence groundwater flow around the ridge or impede any northwest flow from the south at depths below -400 feet elevation.

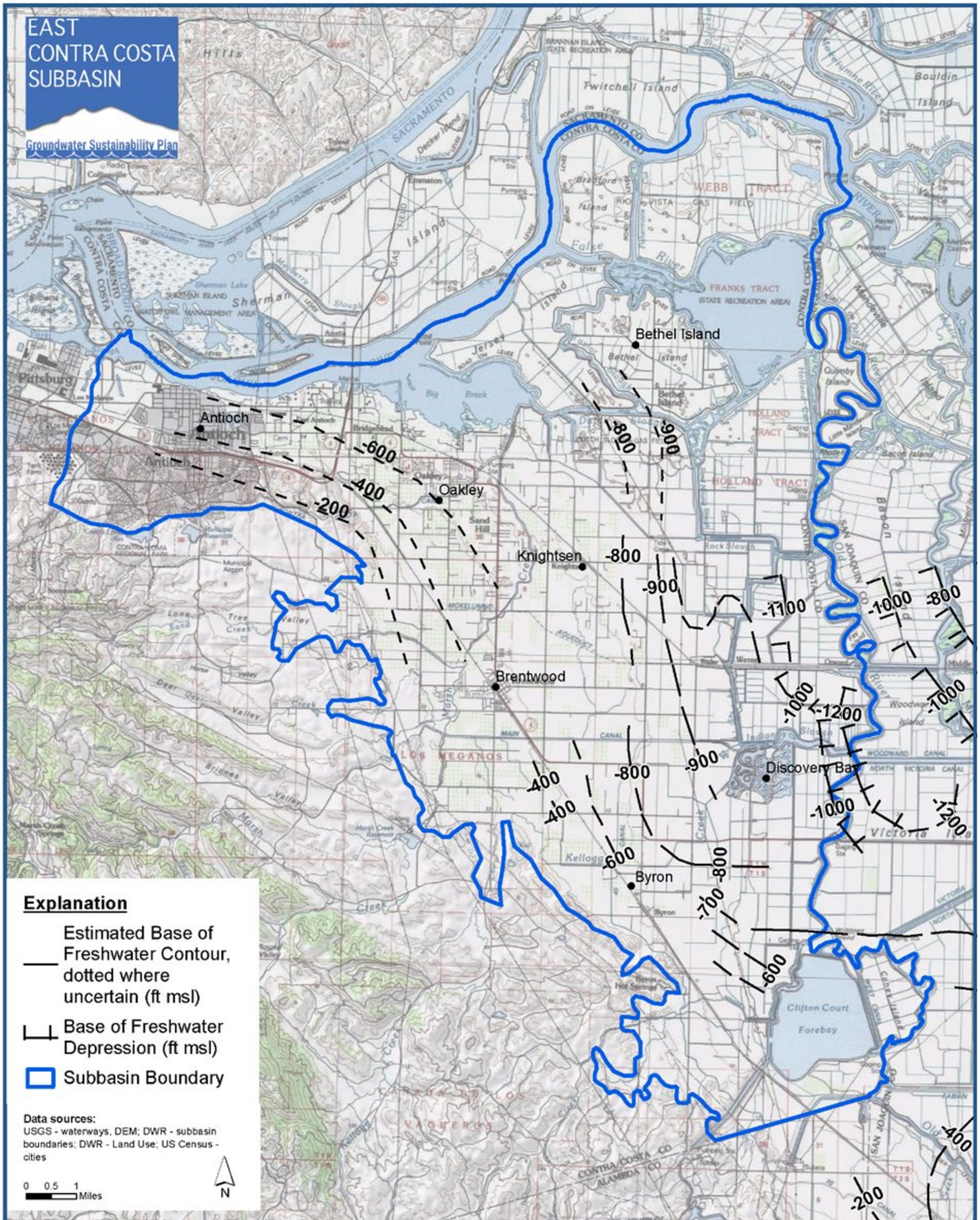


Luhdorff & Scalmanini Consulting Engineers

Basin Boundary- Jurisdictional and Natural

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-3



Luhdorff & Scalmanini
Consulting Engineers

Base of Freshwater

Figure 3-4

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

3.2.4 Geologic Cross Sections and Depositional Facies Model

In 1999, LSCE performed a detailed hydrogeologic study of eastern Contra Costa County groundwater. The focus of the study was the uppermost 500 feet where most water wells are completed in the region. This study included construction of cross sections from drillers' logs and oil and gas logs to assess sand bed characteristics and their extent. Five cross sections were constructed in an east-west direction perpendicular to the Coast Range and three were drawn in a north-south direction (**Figure 3-5**). Two cross sections (4-4' and C-C', **Figures 3-6a and 3-6b**) are included in this report and all eight cross sections are included in **Appendix 3a**. These sections illustrate the ground surface, lithology associated with each well log, and the base of fresh water (LSCE, 2016).

The geologic cross-sections show the interbedded and variable nature of fine- and coarse-grained sediments both laterally and vertically and throughout the study area. They illustrate in detail the primary water-bearing units for water supply purposes. Coarse-grained units were identified primarily in the upper 400 feet where the majority of public supply wells are perforated however, it was noted that the units are difficult to correlate laterally. Well information was lacking for depths below 400 feet below ground surface (bgs) but consistent with the discussion in the previous section, it was expected that the units are fine grained and become brackish at depth.

From the vertical and lateral variability in sediments reflected in cross sections, general patterns in the occurrence and character of sand and gravel aquifers could be identified. These variations were explained by different depositional environments (e.g., stream and delta) as detailed below. In addition, these depositional environments were used to inform groundwater model calibration and for other quantitative purposes.

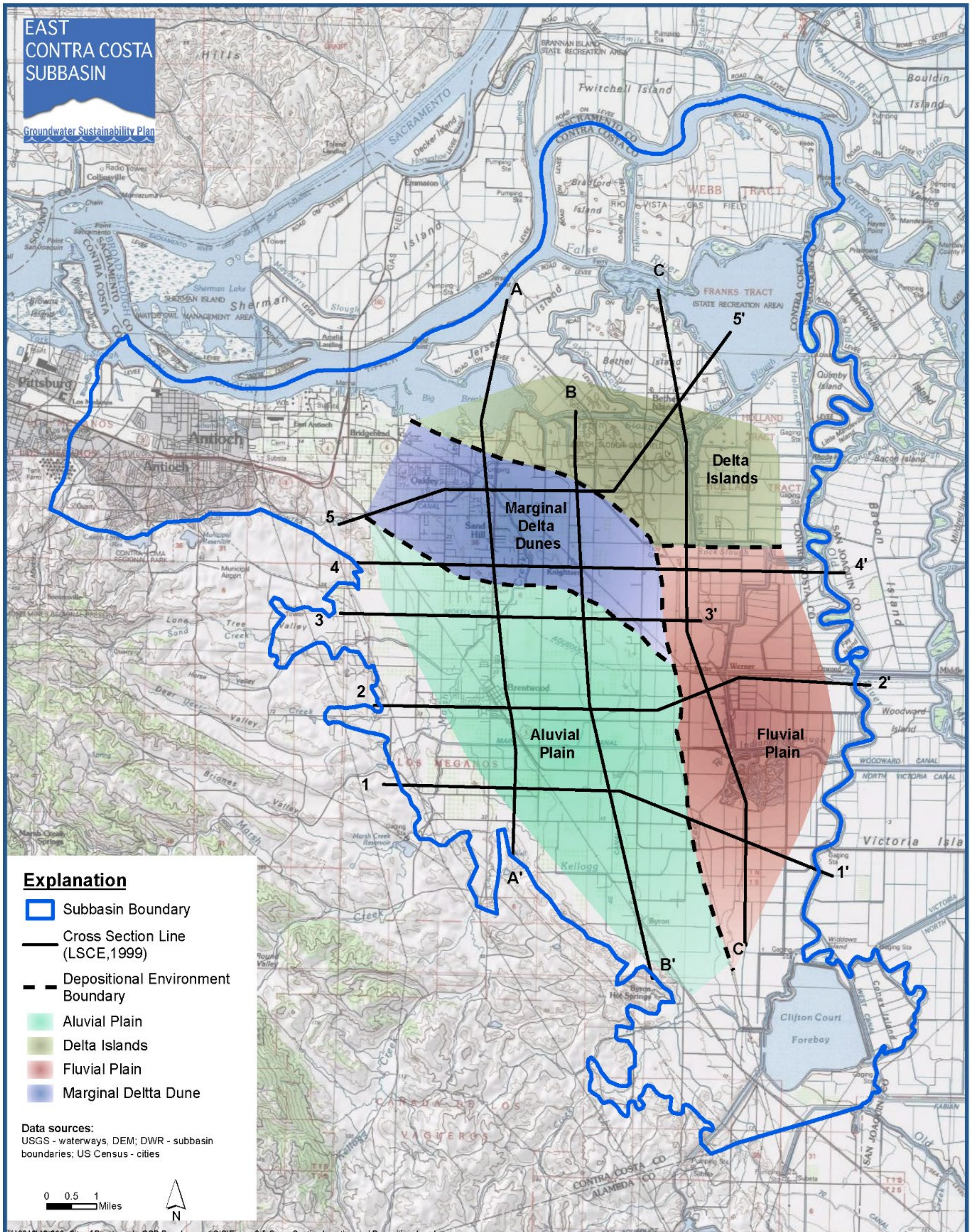
From the work described above, a facies model for four depositional regions in the Subbasin was developed as part of the Subbasin HCM (**Figure 3-5**). The depositional regions are detailed below:

Fluvial Plain

This is representative of the eastern portions of the Subbasin including Discovery Bay. It is defined by a zone of well-defined, thick-bedded sands and gravels with sand thickness of generally 30 feet or more per 100 feet. The depositional environment was probably similar to that which occurs in the present-day area with northward flowing river channels, distributaries, and sloughs across floodplains of overbank areas. Deposits extend to depths of about 350 feet, below which occur largely fine-grained silts and clays with poor to brackish water quality (TODB et al., 2017).

Delta Islands

This is representative of the northeastern portion of Subbasin (Diablo Water District GSA and encompasses Bethel Island and vicinity). Sand and gravel beds may correlate to the Fluvial Plain, but net sand thicknesses increase northward from about 30 to 60 feet per 100 feet below Bethel Island. Sand beds exist to depths of about 300 to 350 feet bgs. There is evidence of shallow saline or brackish water that may be present in shallow sand beds below the Delta Islands. The depositional environment is interpreted as multiple stream channels meandering between islands. Channels would be active with through-flowing waters, then abandoned as new channels developed. Possibly slower stream flow and tidal fluctuations allowed thicker, fine-grained sand deposits to form.

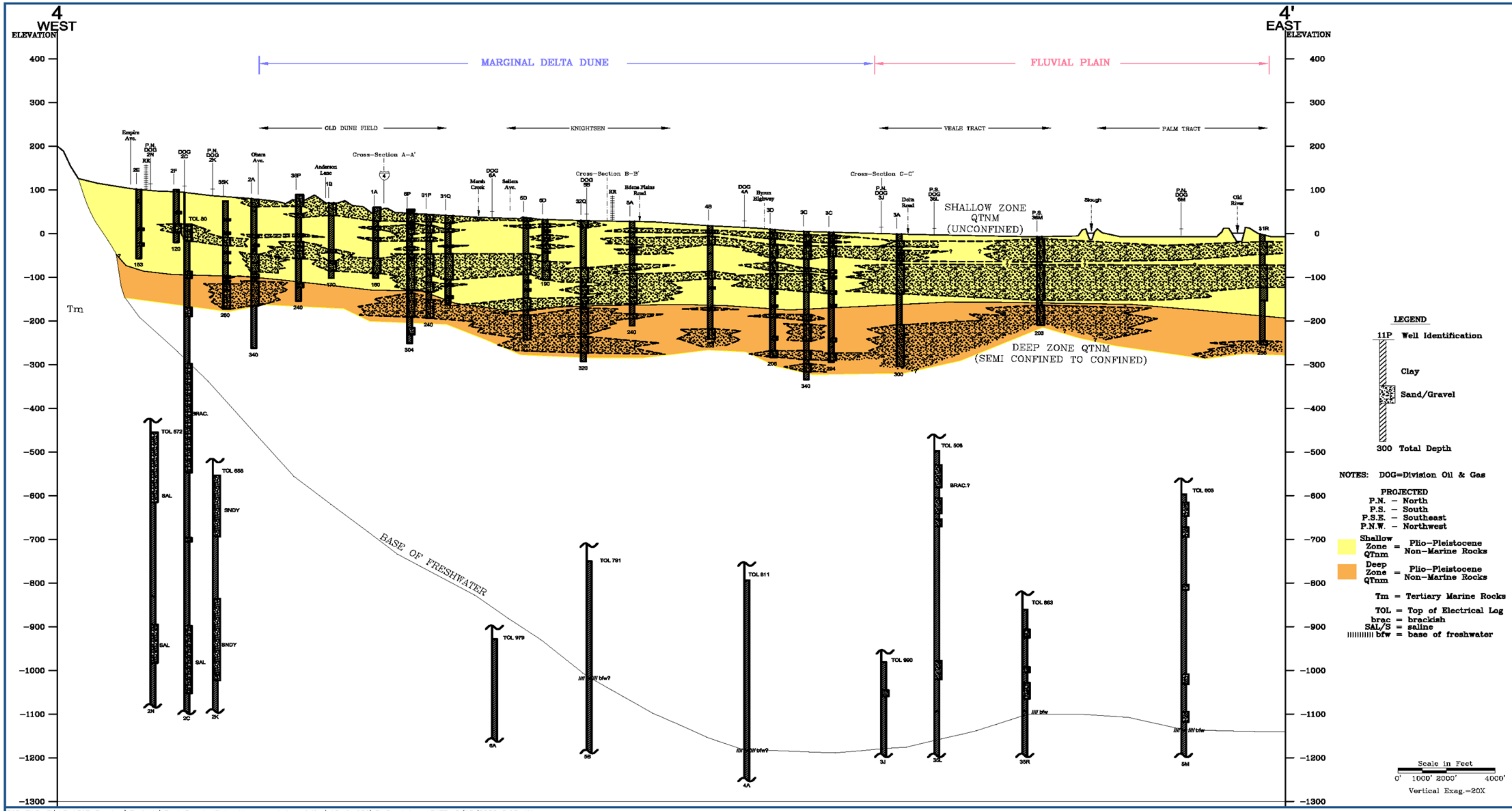


Luhdorff & Scalmanini Consulting Engineers

Cross Section Location and Depositional Environment

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-5

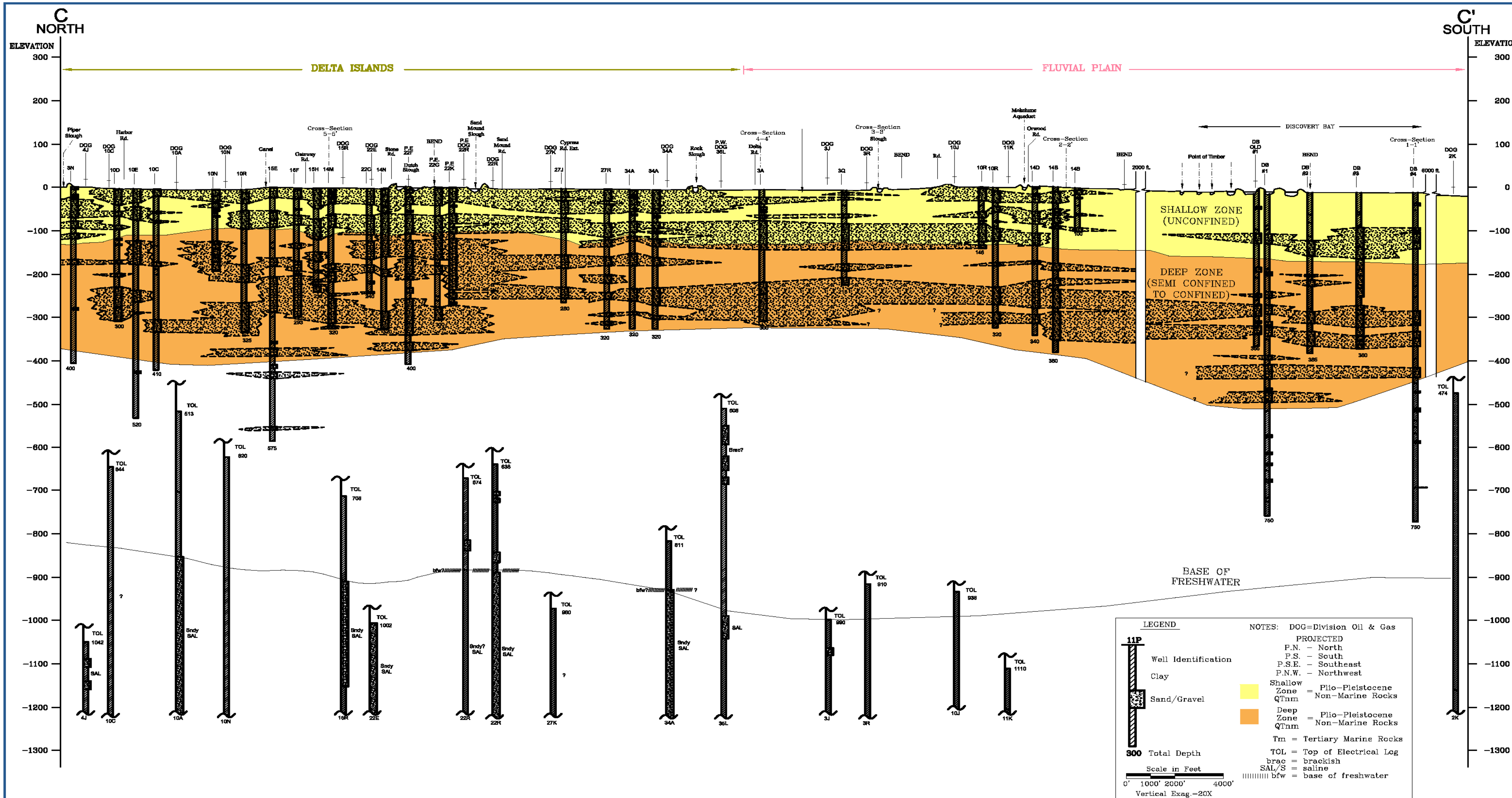


Luhdorff & Scalmanini Consulting Engineers

Geologic Cross Section 4-4'

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-6a



CAD FILE: D:\LS ACAD Dropbox\Projects\East County Water Managment Association\19-1-101\3-6b.r4.dwg DATE: 6/19/2020 8:47 AM

Luhdorff & Scalmanini Consulting Engineers

Geologic Cross Section C-C'

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-6b

Marginal Delta Dunes

This is representative of the Oakley area and defined by numerous thin to thick sand beds that are on the order of 30 to 60 feet thick per 100 feet. The depositional environment is a mixture of delta fluvial distributary channels and possibly aeolian dune fields. A surface deposit of rolling gentle hills of relic sand dunes occurs between Oakley and northern Brentwood. These sand dunes are believed to have been generated by strong winds blowing sand off the delta margins. Some deeper sand beds across the Marginal Delta Dunes area may be older dune fields.

Alluvial Plain

This is representative of greater Brentwood south of the Marginal Delta Dune and City of Oakley, and west of the Fluvial Plain and defined by thin sand and gravel beds with a lower sand thickness (less than 20 feet per 100 feet). The depositional environment is small streams draining eastward from the Coast Range foothills to the west. Flood flows of these streams spread out from the hills depositing fine-grained materials, possibly as mudflows with high sediment content. Stream flows deposited thicker sand and gravel beds that tended to stack upon each other causing the thicker bands of sand beds. The thicker stream deposited sand and gravel bands extend eastward until the sands either thin out or have not been reached by wells. In the north, the stream deposits appear to reach into the Marginal Delta Dunes area, blending into the sand units that are present there.

Antioch and Byron Areas

Due to lack of well control, these two areas could not be examined in detail. The Antioch area is poorly defined, but it appears to be a thin alluvial plain with thin sand beds overlying Plio-Pleistocene non-marine deposits. The Byron area appears to have only a few thin sand beds in a small alluvial plan area that is marginal to the Fluvial Plain region where fine-grained deposits dominate.

3.2.5 Principal Aquifers and Aquitards

Two primary aquifer zones are identified in the East Contra Costa Subbasin: an unconfined to semi- confined Shallow Zone and a semi-confined to confined Deep Zone, with clay layers separating the two. These aquifers are composed of alluvial deposits as illustrated on the representative cross sections (**Figures 3-6a** and **3-6b)**. The Shallow Zone extends from ground surface to a less permeable material (i.e., clay and silt) generally to a depth of less than 150 feet bgs. The Deep Zone directly underlies the shallow zone, is the primary production zone for public supply wells (generally 200-400 feet in depth, LSCE, 2011), and extends to the base of fresh water (a maximum of 1,200 feet from mean sea level).

As indicated previously, the Corcoran Clay does not extend into the ECC Subbasin nor does a similar feature occur that separates major aquifer units. However, in the Alluvial Plain (around the City of Brentwood) there appears to be local confinement by multiple clay layers which separates shallow and deep zones (LSCE, 1999). This separation is seen through distinctive water levels (see **Section 3.3.1**). The Fluvial Plain (around Discovery Bay, **Figure 3-6a**) and Marginal Delta Dune (around Oakley) both have a confined Deep Zone with an extensive layer of clay separating a shallow zone from the deep zone that serves as the primary production aquifer. The Delta Islands area does not have clay layers separating a deep confined zone from shallower aquifer materials nor water levels that reflect it. The primary use of the Shallow Zone is by domestic wells and small community water systems which may have poorer water quality due to Bay-Delta influences. The primary use of the Deep Zone is for municipal supply (City of Brentwood, Discovery Bay and DWD) and agricultural irrigation supply (ECCID and BBID).

Groundwater System Conceptualization

The ECC Subbasin aquifer system is subdivided into two zones: an upper unconfined Shallow Zone that sits above discontinuous to locally continuous clay layers and, a lower semi-confined to confined Deep Zone. As illustrated in the geologic cross-sections described above, the upper 400 feet of sediments is comprised of alluvial deposits with discontinuous clay layers interspersed with more permeable coarse-grained units. Most water wells are constructed within the upper 400 feet where coarse grained units are identified. Water well information is lacking for depths below 400 feet bgs to the base of fresh water but the units are likely fine grained and become brackish at and below that depth based on the current HCM.

3.2.6 Soil Characteristics

There are many soil types found throughout the Subbasin (**Figure 3-7a**). The soil data were gathered from the Natural Resource Conservation Service (NRCS) as part of the Soil Survey Geographic Database (SSURGO). The data are compiled from various maps, which are updated on a yearly basis. The predominate soil types in the Subbasin are the Brentwood, Capay, Delhi, Marcuse, and Rindge series. The Brentwood series is reported to be a well-drained silty clay loam found in valleys and valley floors near Brentwood. The Capay series is noted to be a moderately well-drained clay and is found throughout the Subbasin often near the Brentwood series. The Delhi series is noted to be a somewhat excessively drained sand found primarily in Oakley and Antioch and is derived from eolian deposits. The Marcuse series is noted to be a poorly drained clay and silty clay with a small amount of sand and is found throughout the center of the Subbasin. The Rindge is noted to be a very poorly drained silty clay loam to muck, and is found along the Delta Islands (i.e., Bethel Island) and near the Old River boundary.

3.2.6.1 Soil Properties

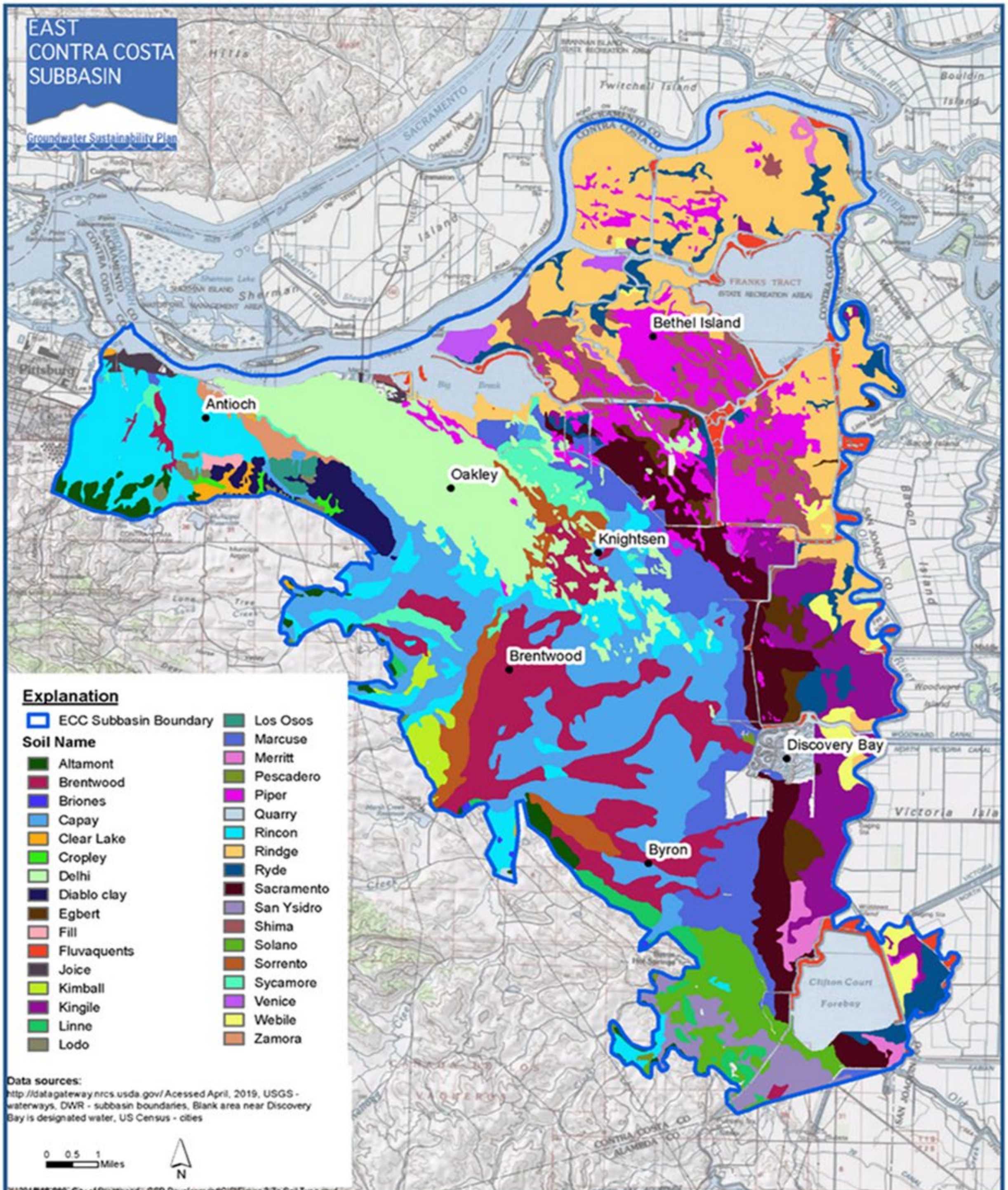
Soil properties are important to the HCM to the extent that they provide a pathway for groundwater infiltration through the soil and have high or low runoff potential. This information is used to calculate surface water recharge and to estimate deep percolation for surface water/ groundwater models. **Figure 3-7b** illustrates the soil texture of the surficial soils found in the Subbasin as outlined by NRCS. The dominant soil textures are clay, clay loam, sand, and muck. Clays and clay loams are found throughout the Subbasin. Sand is concentrated near Antioch and Oakley in the northwestern part of the Subbasin. Muck is found in the eastern portion of the Subbasin along the Old River and the Delta Islands. Muck is defined by the NRCS as "the most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic material".

Figure 3-7c presents the average hydraulic conductivity[1] for soils in the Subbasin. The hydraulic conductivity of soils ranges from less than 1 ft per day to more than 15 ft per day (ft/day). The highest conductivity areas are those with soil textures of muck, sand, or loamy sand. The areas around Oakley and on the northeastern and eastern border of the Subbasin have the highest hydraulic conductivity possibly due to the occurrence of dune sands.

Figure 3-7d shows the soil salinity for the Subbasin. Soil salinity is measured by electric conductivity (EC) and is measured by the amount of soluble salts in the soil. Almost the entire Subbasin has electric conductivity values of less than 2 deSiemens per meter (dS/m) which is low. Higher EC is noted in the center of the Subbasin, following a similar pattern as the distribution of the Marcuse soil, which was noted to be poorly

[1] Capacity for soil to transmit water with units of Length/Time. Units used in this report are feet/day.

drained clay. There is also a small area near Antioch that has ECs greater than 15 dS/m, in an area with a muck texture.

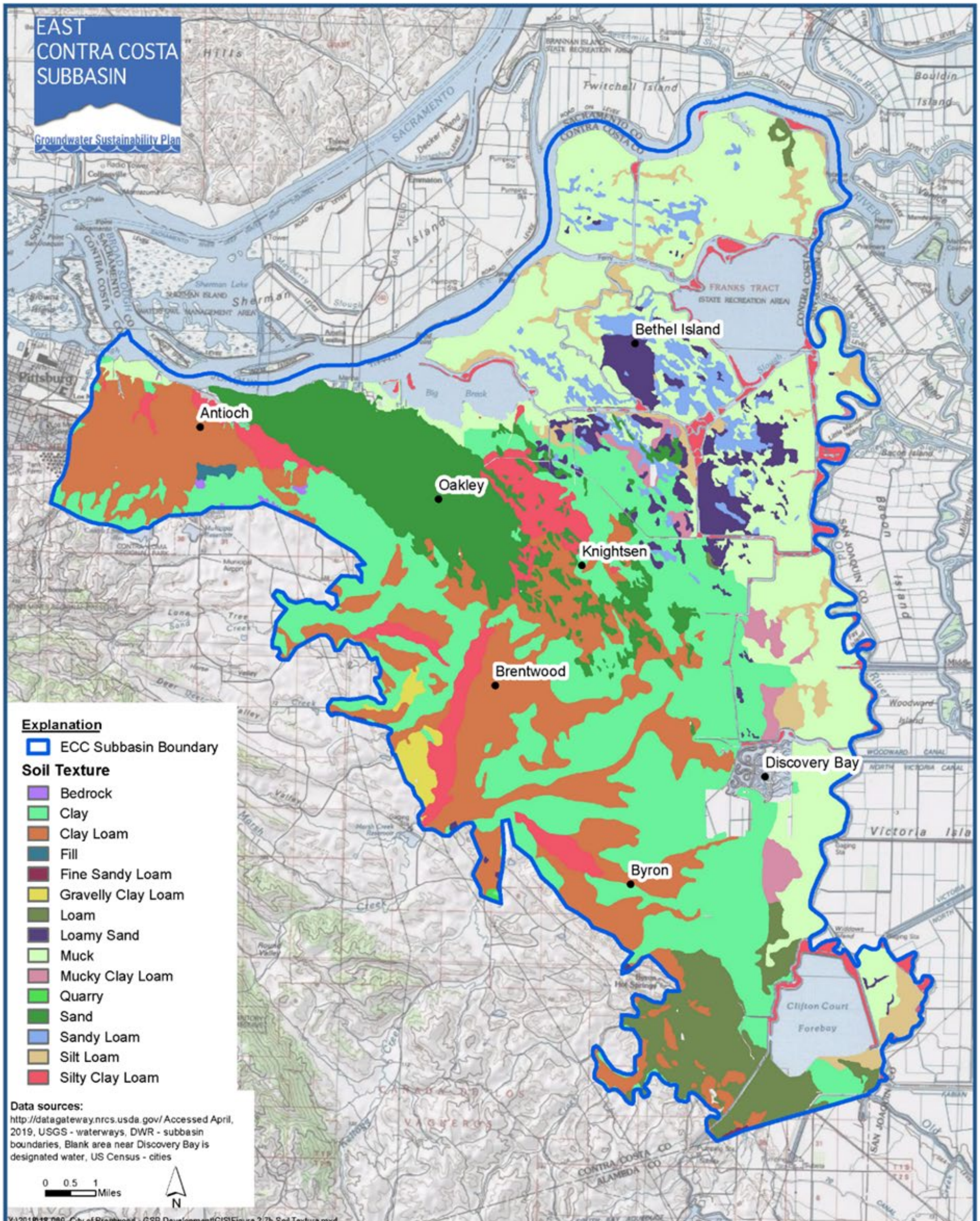


Luhdorff & Scalmanini Consulting Engineers

Soil - Type

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-7a

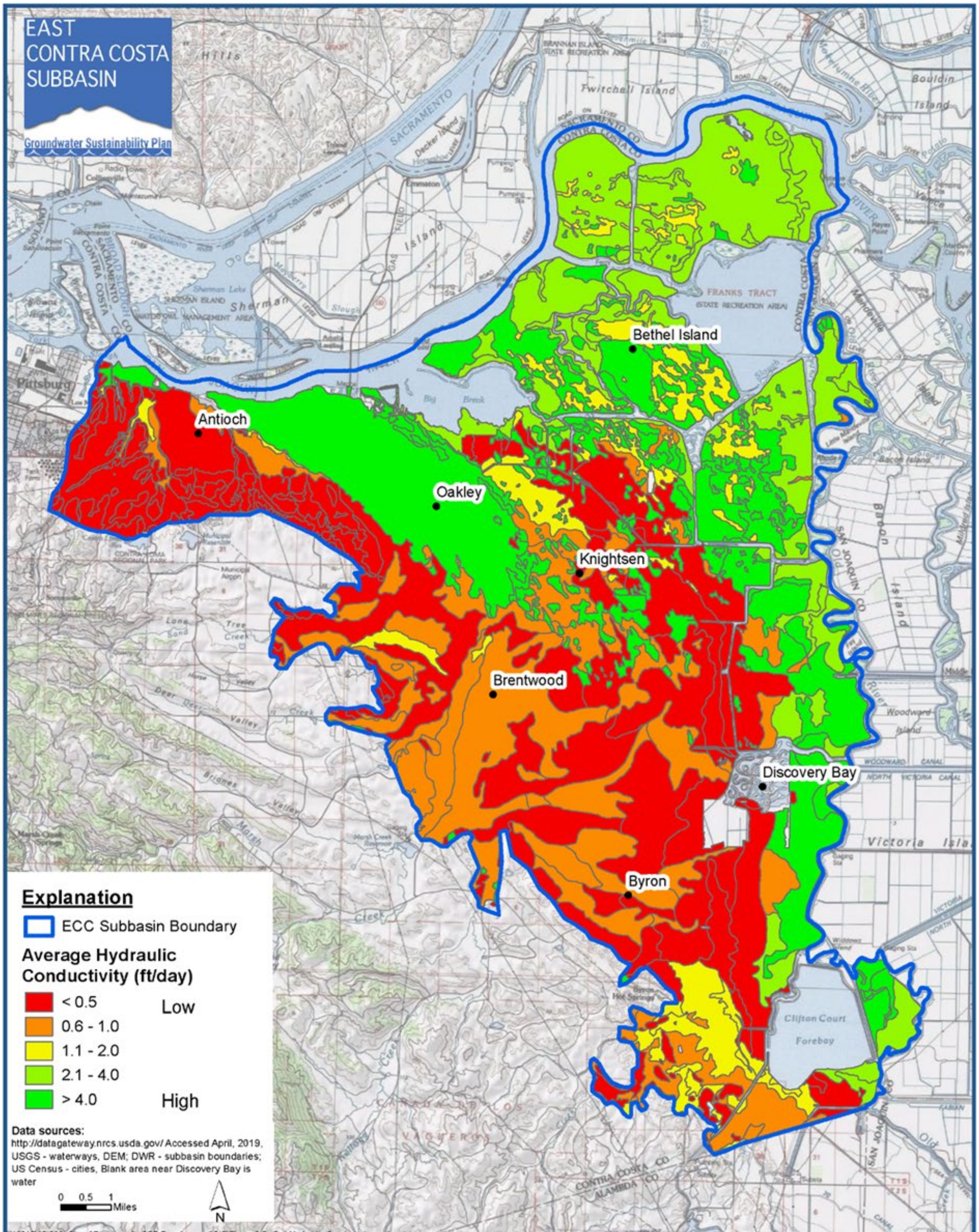


Luhdorff & Scalmanini Consulting Engineers

Soil - Texture

Figure 3-7b

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

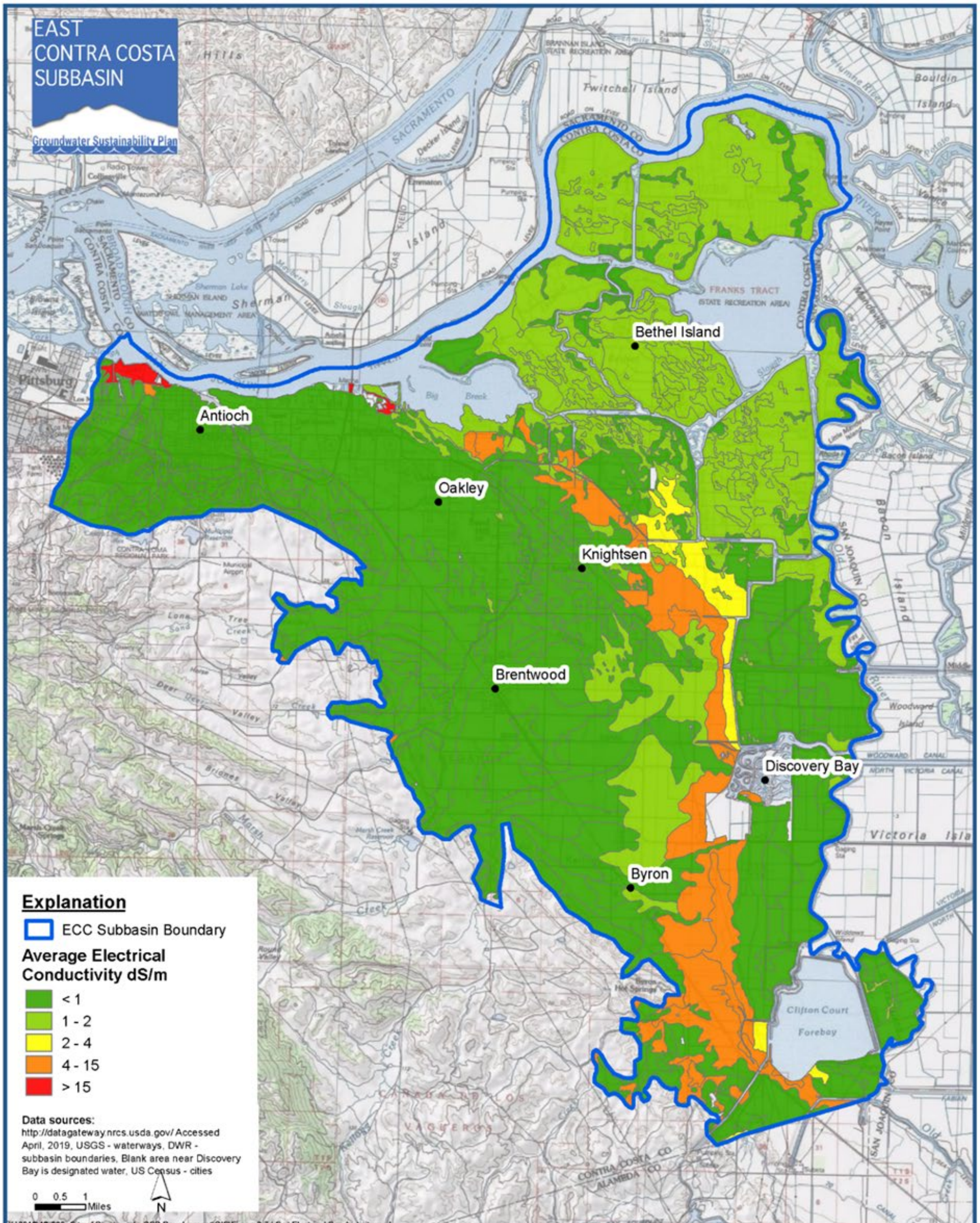


Luhdorff & Scalmanini
Consulting Engineers

Soil - Hydraulic Conductivity

Figure 3-7c

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California



Luhdorff & Scalmanini Consulting Engineers

Soil - Electrical Conductivity

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-7d

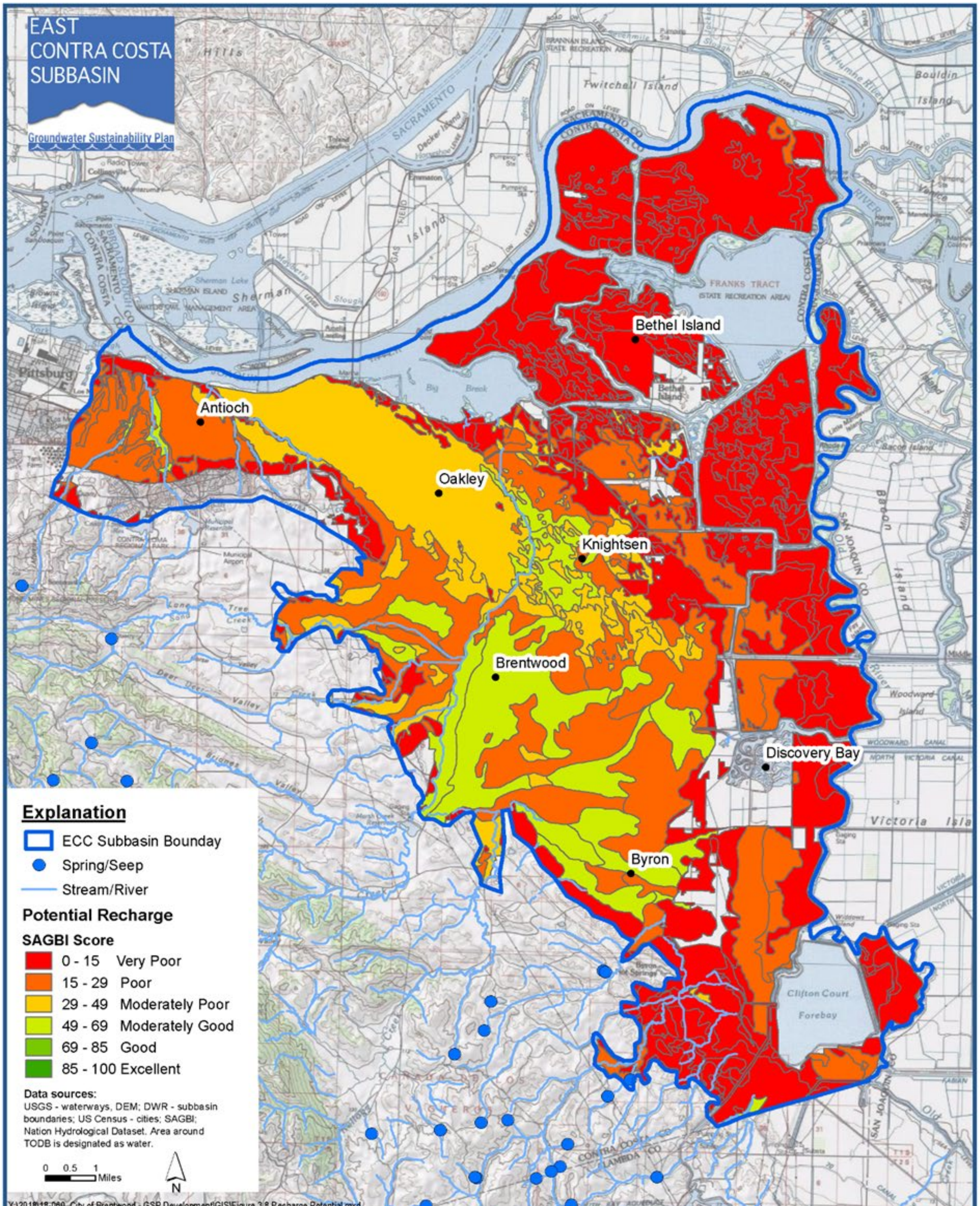
3.2.7 Groundwater Recharge and Discharge Areas

Groundwater recharge can occur from infiltration of precipitation and applied water (e.g., irrigation), surface water infiltration, subsurface inflows from outside the Subbasin, and unintentional recharge (e.g., leaky pipes). This section identifies the areas that may provide greater potential for future managed surficial recharge under the GSP implementation. Surface areas with favorable recharge potential (**Figure 3-8**) were evaluated using soil mapping data and the Soil Agricultural Groundwater Banking Index (SAGBI). The SAGBI provides a characterization of potential for groundwater recharge on agricultural land. The SAGBI score is based on five elements: deep percolation, root zone residence time, topography, chemical limitations, and soil surface conditions. **Figure 3-8** illustrates the main areas of percolation; however, these are not the same areas as those with high hydraulic conductivity (**Figure 3-7c**) and high infiltration potential (**Figure 3-7d**). The areas with highest recharge potential are along Marsh Creek near Brentwood and Kellogg Creek in the Byron area (moderately good), and the dune sands in the Oakley area (moderately poor). However, as discussed below, water levels indicate very little space, if any, available in the aquifer for additional recharge.

Due to the different depositional environments that occur in the Subbasin, there are a variety of natural recharge sources. The Alluvial Plain area is recharged from the Coast Range Foothills and groundwater moves through the Alluvial Plain and the Marginal Delta Dunes' area. The Fluvial Plain area likely has a different recharge source from the south as a function of its fluvial setting (LSCE, 1999). Recharge for the Delta Islands may be a combination of different sources, including fluvial influence from the Delta.

Groundwater discharge from the Subbasin can occur from discharge to surface water and springs, subsurface outflow from the Subbasin, and groundwater extraction by wells. Groundwater discharge from the Subbasin is from groundwater pumping (agricultural, municipal, domestic, and industrial uses). Maps of general locations of wells are provided in **Figures 2-6a** to **2-6d**. These maps indicate that the majority of domestic wells are located in the western portion of the Subbasin, public supply wells are mostly concentrated in urban centers of Discovery Bay, Brentwood, and Oakley, and agricultural wells are located on the western side of the Subbasin. Maps of the average depths (in feet) of domestic, agricultural, and public supply wells by section are provided in **Figures 3-9a** to **3-9c**. Domestic well depths are generally less than 200 feet bgs (**Figure 3-9d**). Agricultural well depths vary across the Subbasin with ranges from 60 to 800 feet bgs. Public supply wells are most commonly in the 200 to 400-foot bgs range.

The USGS's National Hydrography Dataset (NHD) maps one spring in the Subbasin located along the southwestern boundary. There are multiple springs that could be sources of recharge, in addition to streams, located in the foothills west of the Subbasin boundary (**Figure 3-8**).

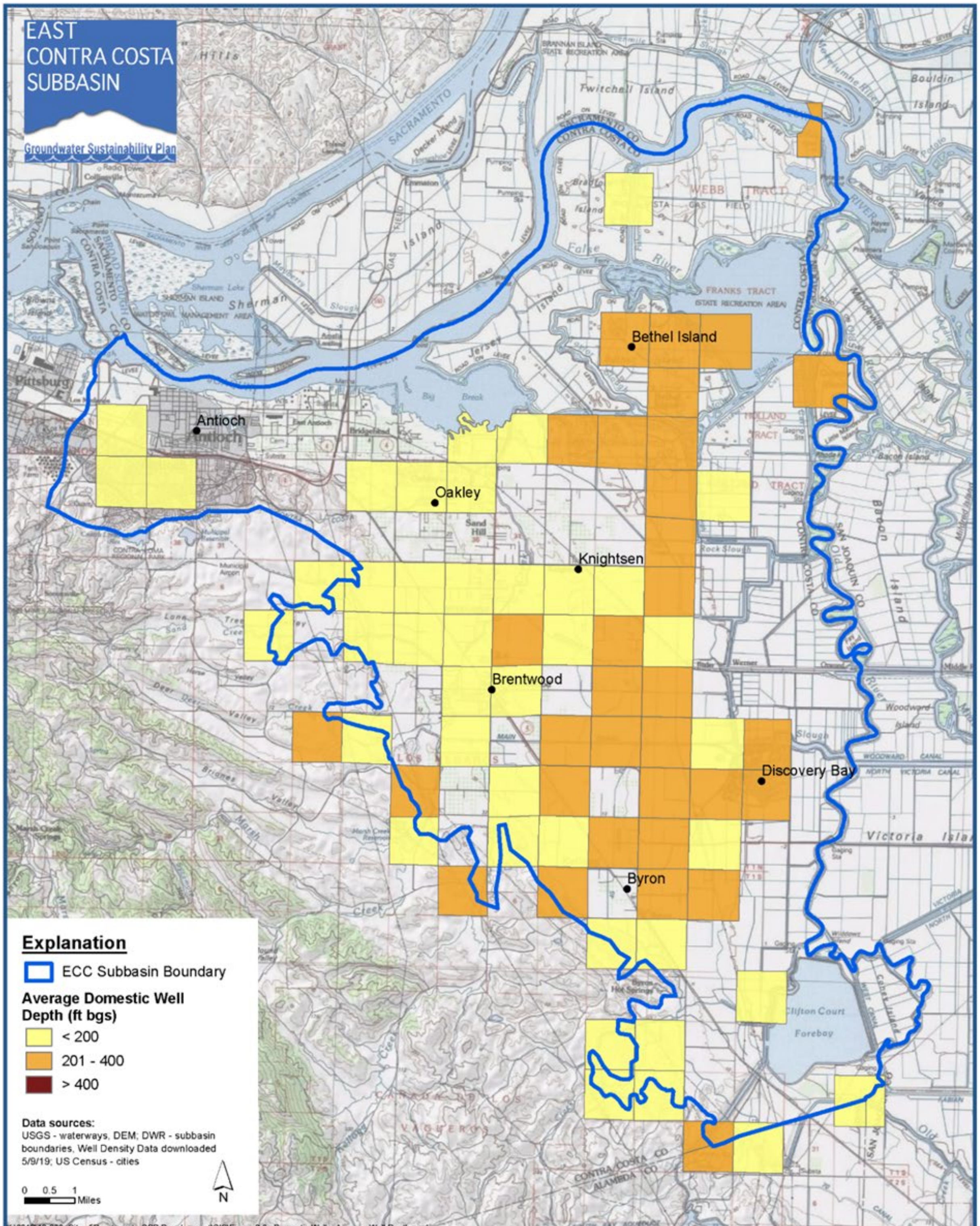


Luhdorff & Scalmanini Consulting Engineers

Soil - Potential Recharge

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-8

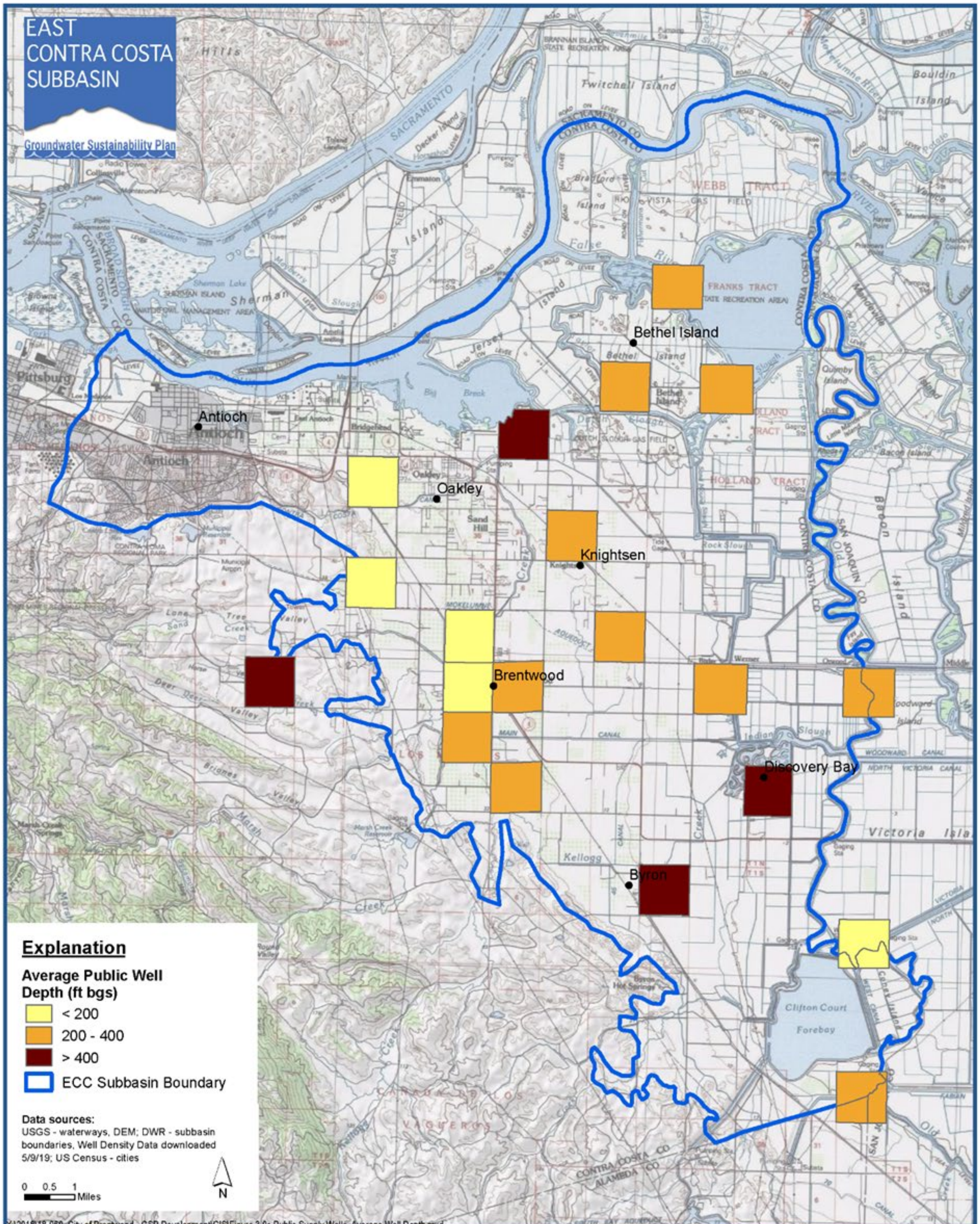


Luhdorff & Scalmanini Consulting Engineers

Domestic Wells - Average Depth

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-9a

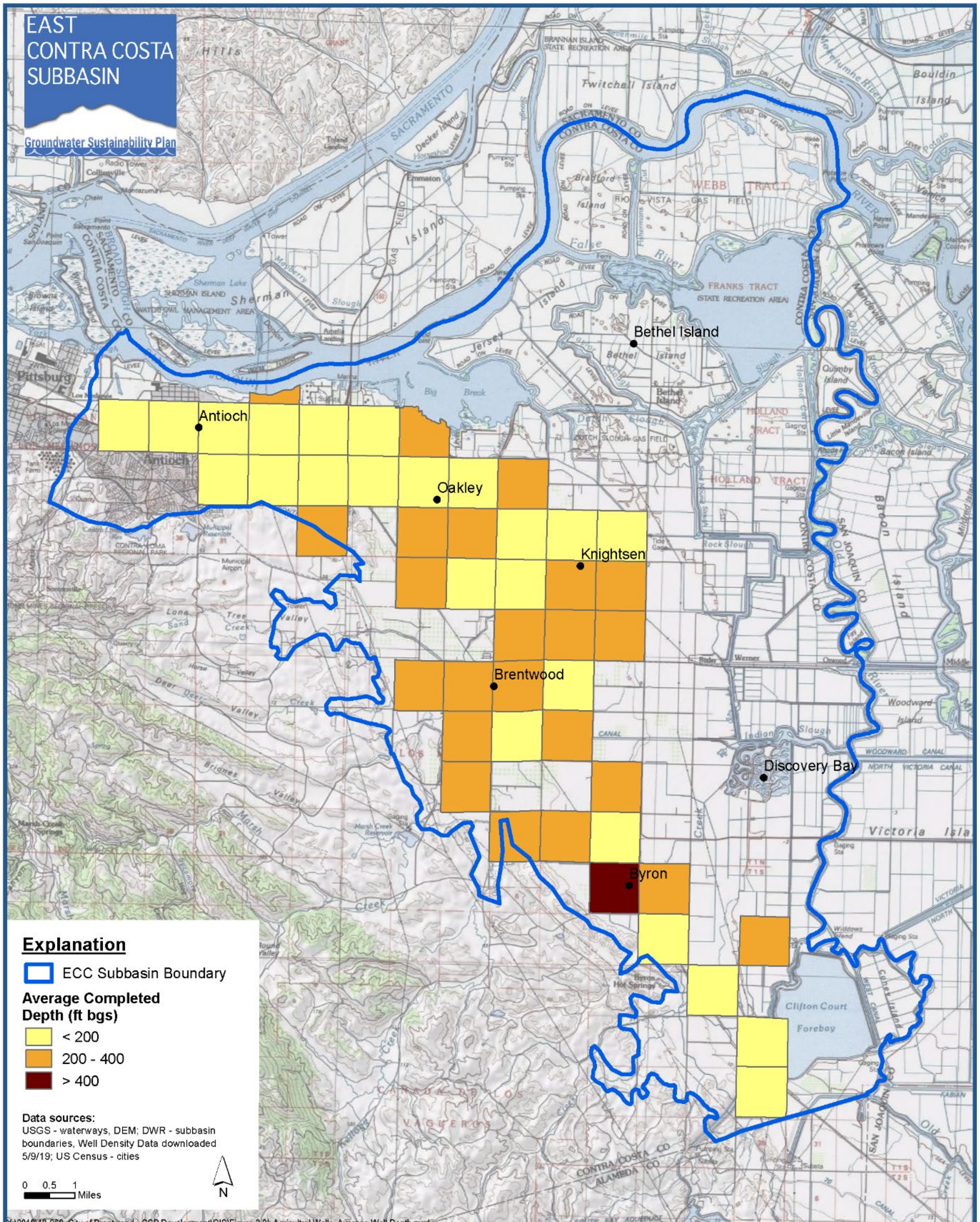


Luhdorff & Scalmanini Consulting Engineers

Public Supply Wells - Average Depth

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-9b

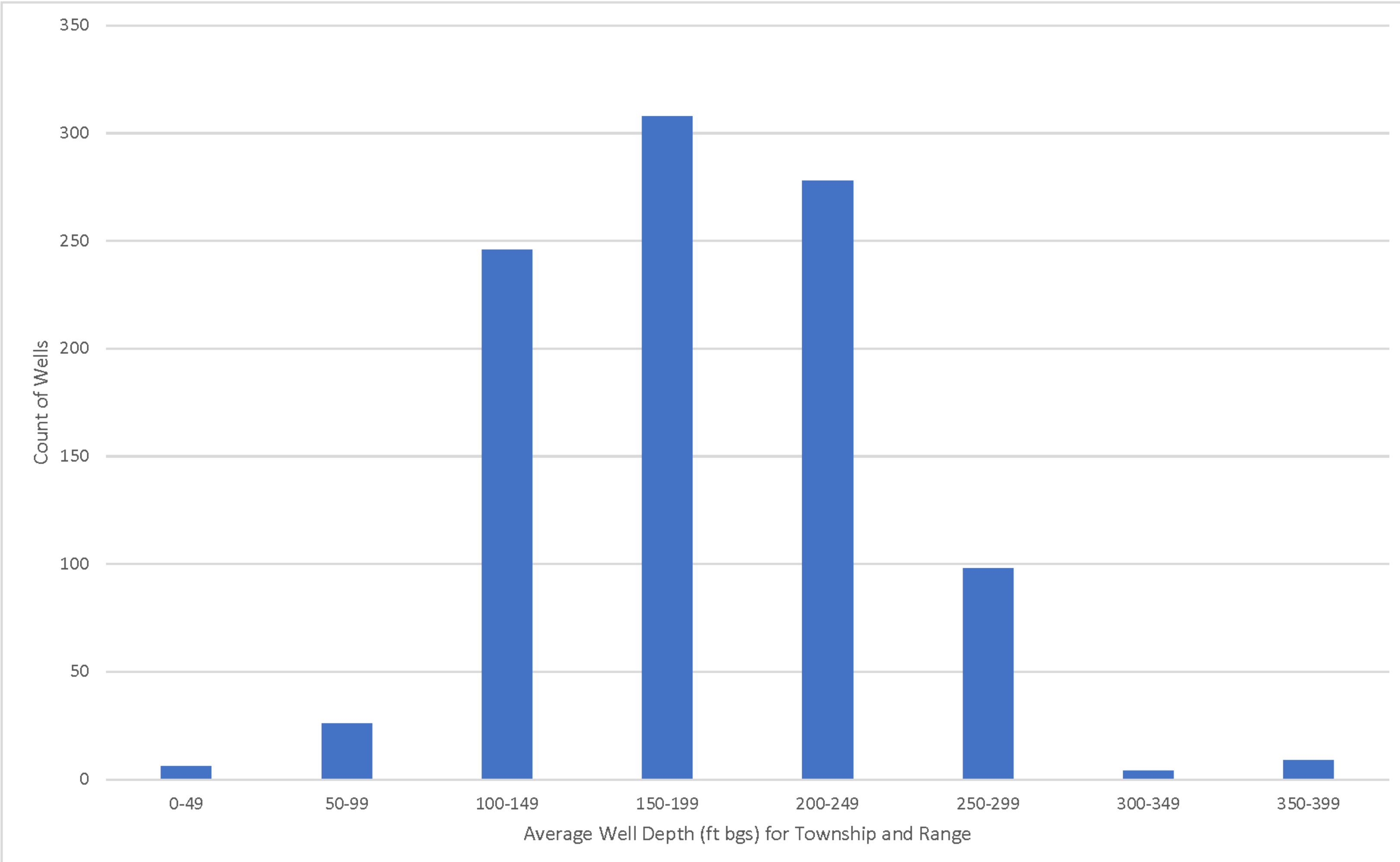


Luhdorff & Scalmanini Consulting Engineers

Agricultural Wells - Average Depth

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-9c



Luhdorff & Scalmanini
Consulting Engineers

Domestic Well Depths

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-9d

3.2.8 Imported Supplies

Contra Costa Water District draws water from the Delta primarily under a contract with the federal Central Valley Project (CVP). Surface water is diverted at two intake locations within the Subbasin: Rock Slough and Old River (**Figure 2-4**). Two entities in the Subbasin purchase water from CCWD: City of Antioch and Diablo Water District. In addition, CCWD diverts and conveys ECCID surface water for the City of Brentwood.

3.2.9 Surface Water Bodies

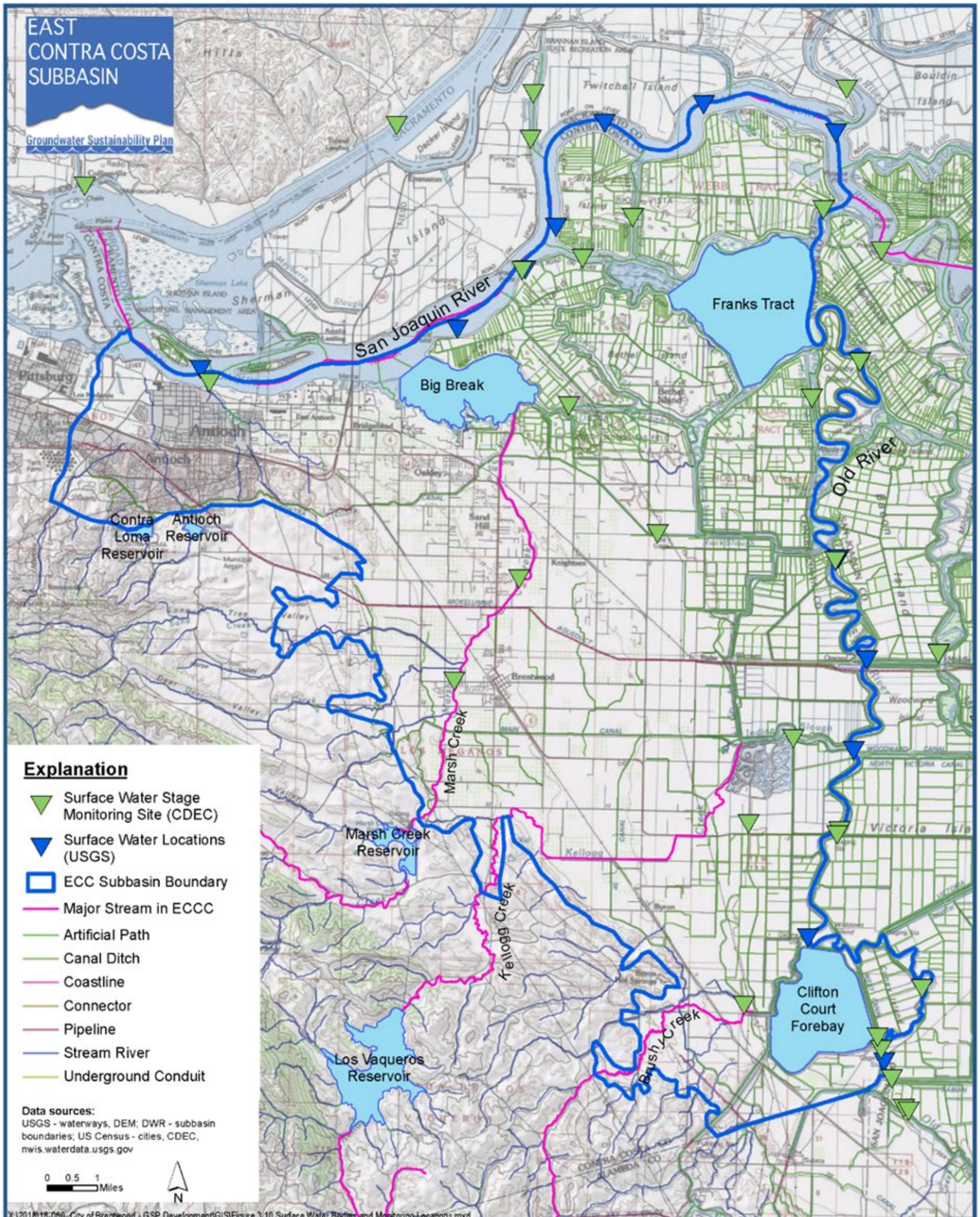
There are a number of surface water bodies that are significant to the management of the Subbasin (**Figure 3-10**). The Clifton Court Forebay, Franks Tract, and Big Break are large surface water bodies in the Subbasin. Two rivers are the primary natural surface water features in the ECC Subbasin. The San Joaquin River flows from east to west along the northern edge of the Subbasin and Old River flows from north to south on the eastern edge of the Subbasin. Numerous streams from the Coast Range enter the Subbasin from the west and discharge into the Delta (ECC IRWM, 2019). Marsh Creek drains parts of Mt. Diablo and has flows impounded (stored/captured) by the Marsh Creek Reservoir. Flow and water quality information is available for 2012 to 2013[2] in connection to the Dutch Slough Project. Similar to groundwater quality, March Creek water quality analyses showed TDS and chloride that exceeded the recommended secondary MCL (500 mg/L and 250 mg/l, respectively). Kellogg Creek drains the watershed south of Marsh Creek and includes the CCWD operated Los Vaqueros Reservoir. Brushy Creek is south of Kellogg Creek and drains into Old River and Clifton Court Forebay.

3.2.10 Hydrogeologic Conceptual Model Data Gaps and Uncertainty

This section identifies the data gaps and levels of uncertainty of the information for the physical setting and characteristics of the basin and current conditions.

Lithologic, water quality, and water level measurement controls exist for purposes of developing the hydrogeologic conceptual model mostly in the urban areas of Brentwood, Discovery Bay and Oakley. There are large areas in the north near Antioch and Bethel Island and in the south, west of Clifford Court Forebay, that have low well density as a result of a more rural setting. Many wells used for municipal purposes were also primarily screened to less than 500 feet bgs, which leads to uncertainty in the nature of the deeper subsurface materials. Many lithological descriptions come from drillers' logs which are limited in quality as a function of driller's experience and attention to detail. Geophysical logs provide the most consistent and quantitative information, but well control is highly variable as a function of current and historic groundwater use patterns. Expanded monitoring by aquifer for groundwater quality and level measurements and additional lithologic descriptions outside the urban areas would benefit development of the hydrogeologic conceptual model.

[2] Hydrofocus Inc. 2014. Dutch Slough Restoration Area Surface Water Quality Monitoring Report, September 2012 to August 2013. April 11, 2014. 228 pages.



Luhdorff & Scalmanini
Consulting Engineers

Surface Water Bodies and Monitoring Locations

Figure 3-10

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

3.3 Groundwater Conditions

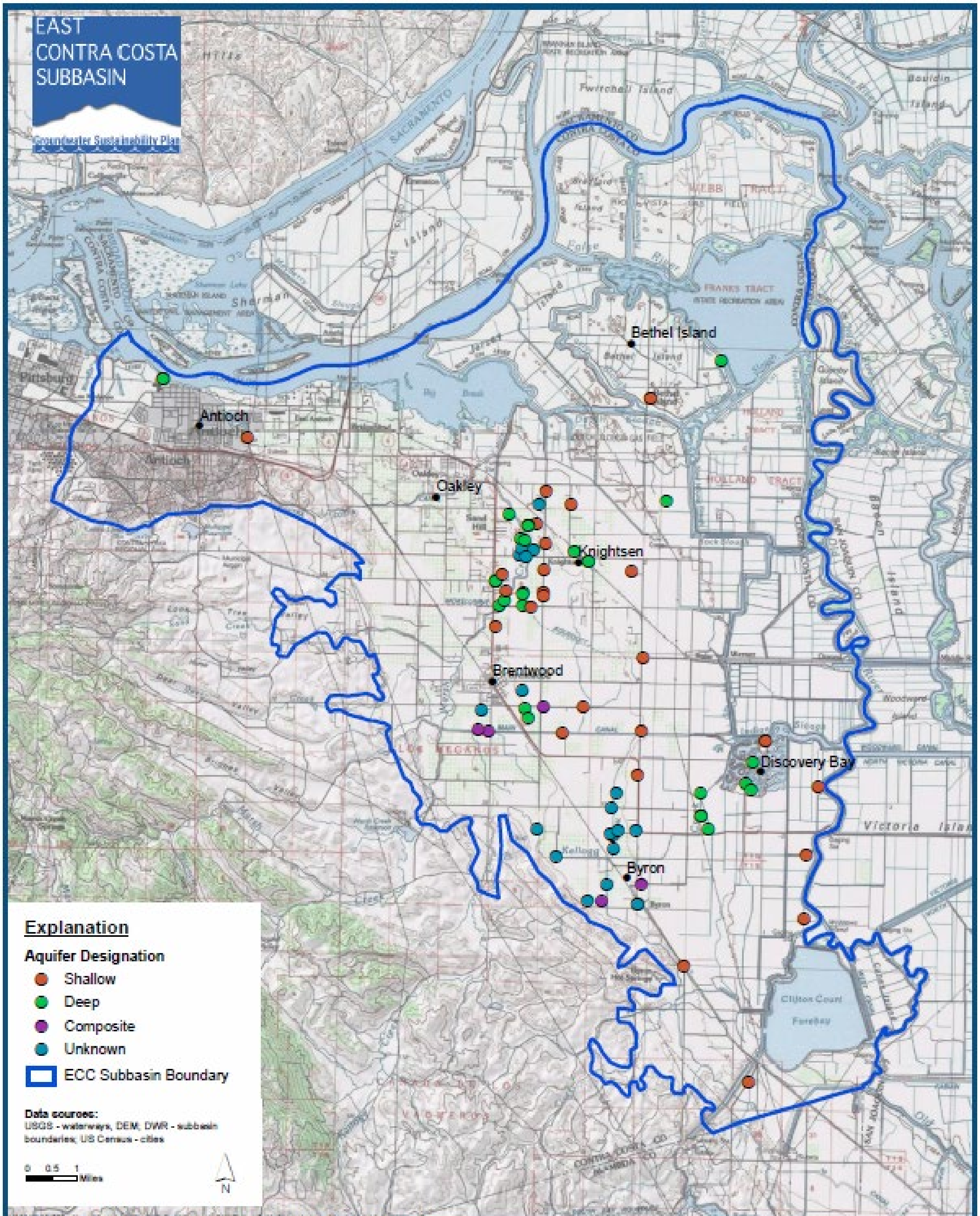
This Groundwater Conditions section describes historical groundwater conditions in the ECC Subbasin through present day. Groundwater levels and storage, seawater intrusion, groundwater and surface water quality, land subsidence, interconnected surface water, and groundwater dependent ecosystems are presented in this section.

3.3.1 Groundwater Levels

Groundwater levels provide useful data for understanding groundwater conditions and trends over time. Groundwater levels are affected by natural recharge and discharge which are in turn governed by variations in climate conditions. Groundwater pumping and water usage such as in agriculture also affect groundwater levels. Groundwater movement, as governed by regional and local gradients and aquifer properties are also reflected in groundwater levels. All factors play a role in changes in groundwater storage over time which is a primary consideration in the HCM.

Groundwater level records were compiled from the various entities in the Subbasin in addition to data from Geotracker, USGS, and DWR. A small subset of wells has a long period of record for water level monitoring, but most data are relatively recent, within the last 15 years. The wells with the longest period of record have over 50 years of data and are primarily concentrated in the ECCID area (**Figure 2-1**). All data were reviewed and compiled in a Data Management System (DMS). Data of similar type was converted to the same units and, if applicable, the method used to gather data was noted (e.g., surveyed reference point elevations versus estimated elevations). A well was assigned an aquifer zone designation (Shallow Zone, Deep Zone, Composite, or Unknown) based on the well screen interval and/or total well depth. This well construction information is presented in **Appendix 3c** for over 1,100 wells in the ECC Subbasin. The contact between the Shallow Zone and Deep Zone ranges in depth from 100 and 150 ft bgs throughout the Subbasin but is generally about 120 ft bgs. Wells with screen intervals in both zones were given the designation Composite. Wells with missing well construction information were designated Unknown. **Figure 3-11** illustrates the groundwater level monitoring well locations in the Subbasin and their assigned aquifer designations (Shallow Zone, Deep Zone, Composite, or Unknown) based on well construction. Selected groundwater level hydrographs are presented for Shallow Zone wells in **Figure 3-12a**, for Deep and Composite Zone wells in **Figure 3-12b,** and all hydrographs are presented in **Appendix 3d**. Overall, water levels are stable for the periods of record.

Figure 3-12a is a panel map with hydrographs from wells completed in the unconfined Shallow Zone. Shallow groundwater level information is concentrated in the Oakley, Brentwood, and Discovery Bay areas. These data indicate that basin-wide Shallow Zone water levels have remained fairly stable with no evidence of long-term declines. A minor shift in water level is seen in one well, 5 Binn in the southern portion of the Subbasin, that has dropped five feet over a 22-year period. This is not considered a significant factor to either groundwater quantity or quality in the Subbasin.

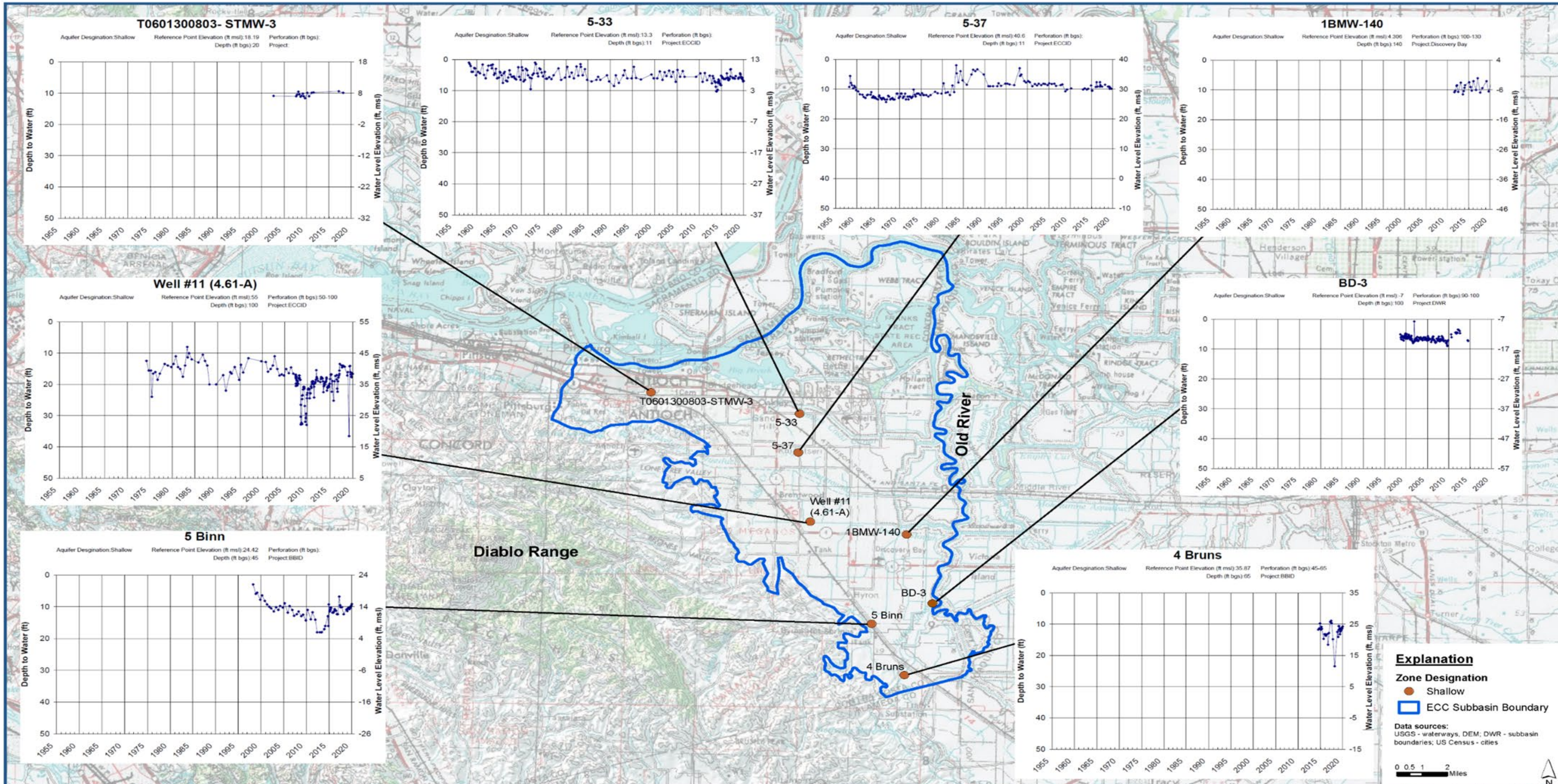


Groundwater Level Monitoring Locations

East Contra Costa Subbasin Groundwater Sustainability Plan
Contro Coasta County, California

Figure 3-11

Luhdorff & Scalmanini Consulting Engineers

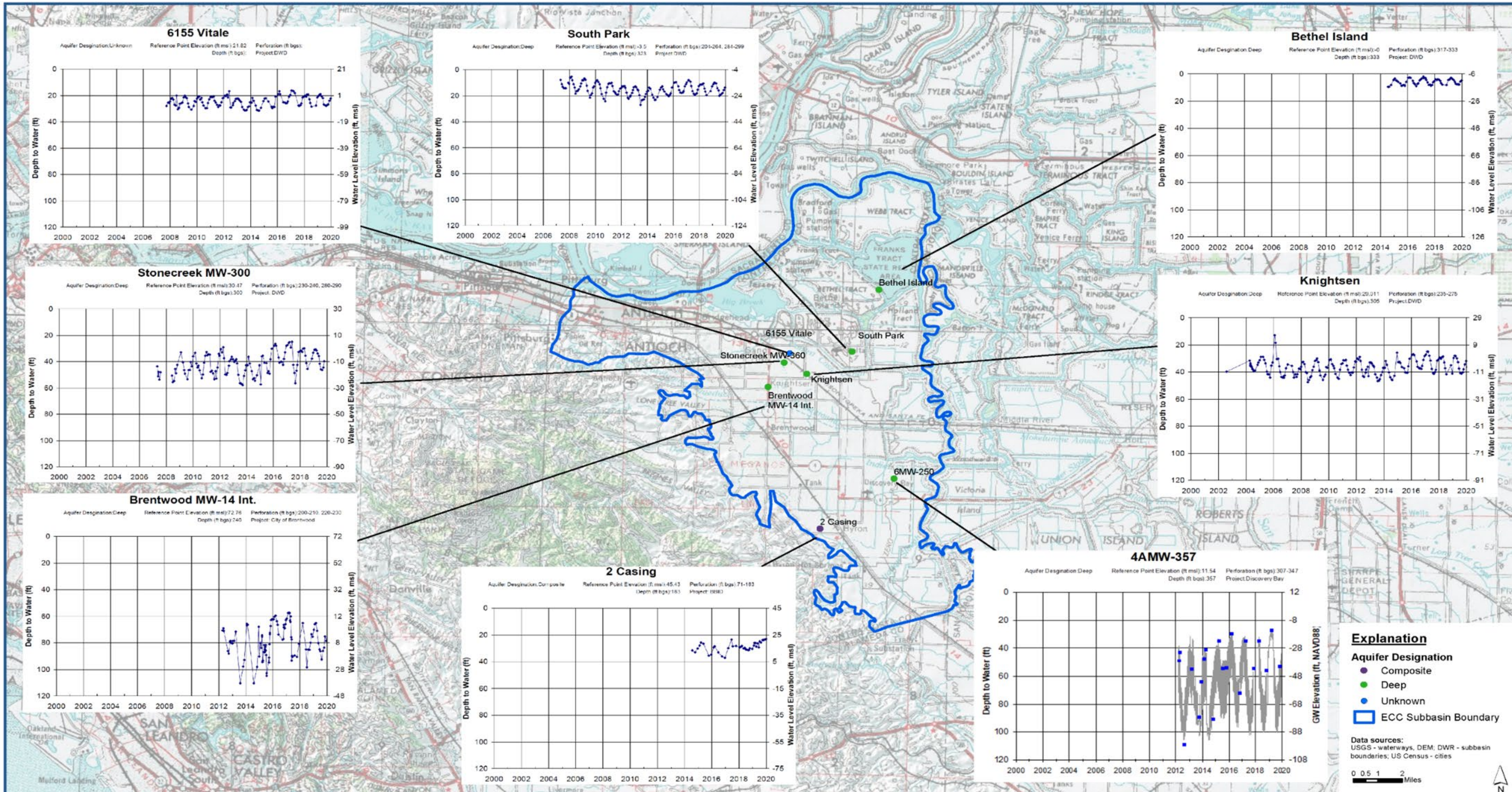


Luhdorff & Scalmanini
Consulting Engineers

Selected Graphs of Groundwater Elevations - Shallow Zone

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-12a



Luhdorff & Scalmanini Consulting Engineers

Selected Graphs of Groundwater Elevations - Deep and Composite Zone

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

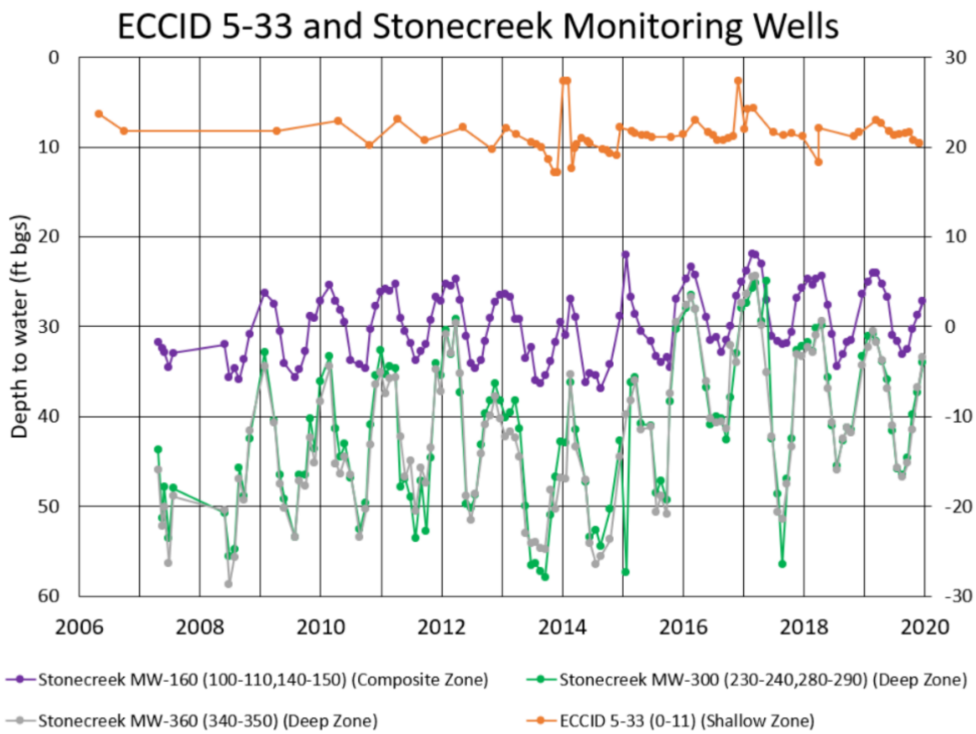
Figure 3-12b

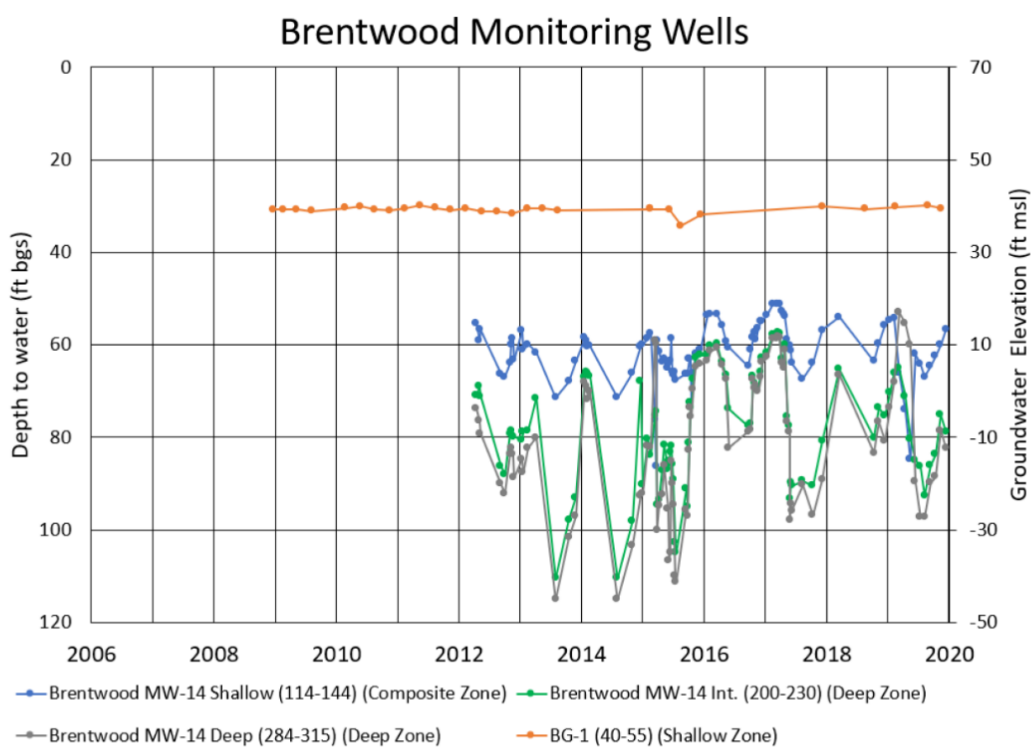
Shallow Zone seasonal variations in groundwater levels on a regional basis are very minor (one to three feet). In the Oakley and Brentwood areas, a few Shallow Zone wells with deeper completions (100 to 150 ft bgs) show more variable seasonal trends (10 to 15 feet annual fluctuation in water levels) that suggest a slight increase in confinement (semi-confined) with depth. Shallow monitoring wells in the Discovery Bay area and eastward along Old River (BD-1, 2, 3) do not have pronounced seasonal water level changes (less than five feet annually) that may be attributed to influence by and proximity to the Delta. Shallow wells located in the western portion of the Subbasin (e.g., Well #11 [4.61-A], **Appendix 3d**) have more pronounced seasonal water level changes (about 10 feet annually) that is likely influenced by boundary effects due to proximity to the edge of the groundwater basin (e.g., the Diablo Range). The Delta Islands have a unique shallow groundwater situation unlike the rest of the Subbasin. Depth to water in subsided Delta islands (described in more detail below) is controlled by drainage ditches that convey irrigation water and seepage water from adjacent channels that is then pumped back into Delta channels. Deverel et al. (2016) reports that, due to this drainage system, groundwater levels are generally maintained at about 2-1/2 to 4 feet bgs in the Delta islands area.

Figure 3-12b shows select hydrographs of the confined Deep and Composite Zone wells in the Subbasin. Regional large capacity supply wells target the Deep Zone and are generally over 200 feet in depth (LSCE, 2011). The hydrographs show generally stable conditions with seasonal water level fluctuation from 10 to 30 feet bgs with maximum decline during the summer months. This is followed by a full recovery of water levels during wet months (November to March). Some variation in annual peak water levels according to climatic trends is noted in the period between 2007 and 2010 and 2012 to 2015 when water levels appear to be affected by the state-wide droughts (**Appendix 3d**). There is no evidence of pumping-induced groundwater level declines.

Vertical groundwater gradients can be monitored with nested monitoring wells. When plotted together, the water levels show the variation of groundwater levels in an unconfined, semi-confined and confined aquifer system (**Figures 3-13a and b**). The ECC Subbasin has three locations with nested monitoring wells: Stonecreek Monitoring Wells, Brentwood MW-14 Monitoring Wells, and Discovery Bay (**Figure 3-13c**). The Stonecreek Monitoring Well cluster has three monitoring wells screened between 100 and 350 ft bgs with a local shallow well (ECCID 5-33) that has a well depth of 11 ft bgs. Brentwood MW 14 has three wells screened between 114 and 315 ft bgs and a shallower well (BG-1) screened between 40-55 ft bgs. Discovery Bay MW4A has two wells screened between 122 and 347 ft bgs. All three nested wells show similar trends. In Stonecreek and Brentwood wells, the two deeper screened wells exhibit similar groundwater levels with seasonal variations of up to 30 ft. The shallower wells have higher groundwater levels with less seasonal variation (less than five feet for the ECCID 5-33 well). The Discovery Bay Deep Zone monitoring well (4AMW-357) has up to 60 feet seasonal variation and the Shallow Zone monitoring well (4AMW-152) has less than 5 feet of seasonal variation.

These hydrographs demonstrate that groundwater levels in ECC Subbasin wells are stable and that groundwater conditions in the Subbasin are consistent with sustainable use. The water levels, by virtue of their consistent seasonal recoveries, also indicate that the Subbasin on the whole is full, with no room for additional groundwater recharge.





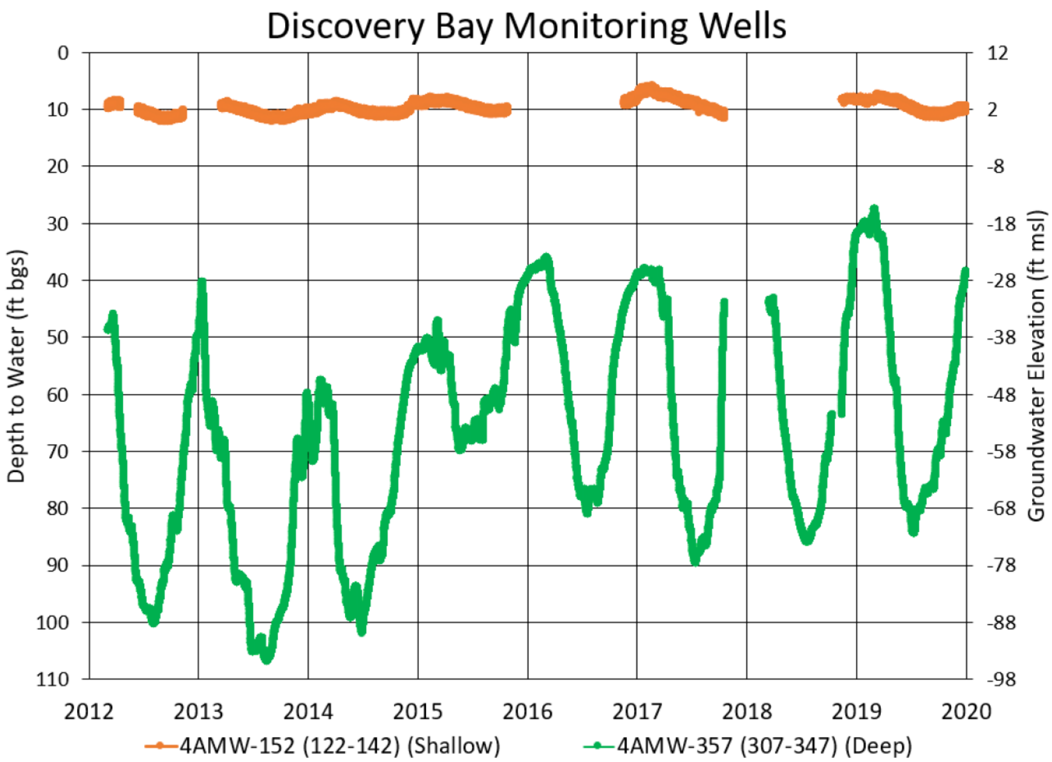
X:\2018\18-060 City of Brentwood - GSP Development\GIS\Figure 3.14a Vertical Groundwater Gradients.mxd

Luhdorff & Scalmanini
Consulting Engineers

Vertical Groundwater Gradients

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-13a



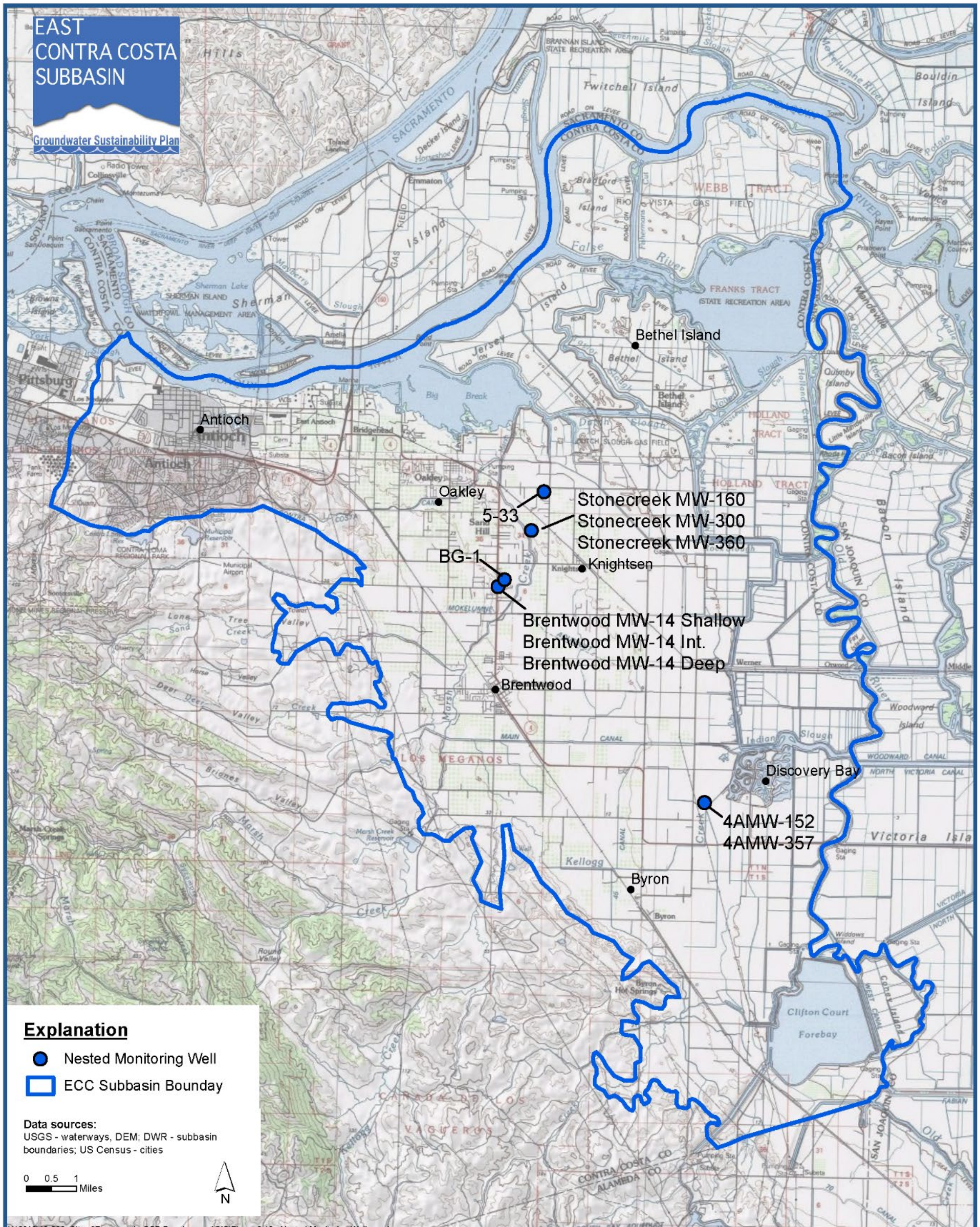
X:\2018\18-060 City of Brentwood - GSP Development\GIS\Figure 3.14b Vertical Groundwater Gradients.mxd

Luhdorff & Scalmanini Consulting Engineers

Vertical Groundwater Gradients

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-13b



Luhdorff & Scalmanini Consulting Engineers

Nested Monitoring Well Locations

East Contra Costa Subbasin Groundwater Sustainability Plan
Contro Coasta County, California

Figure 3-13c

3.3.2 Groundwater Elevation Contours

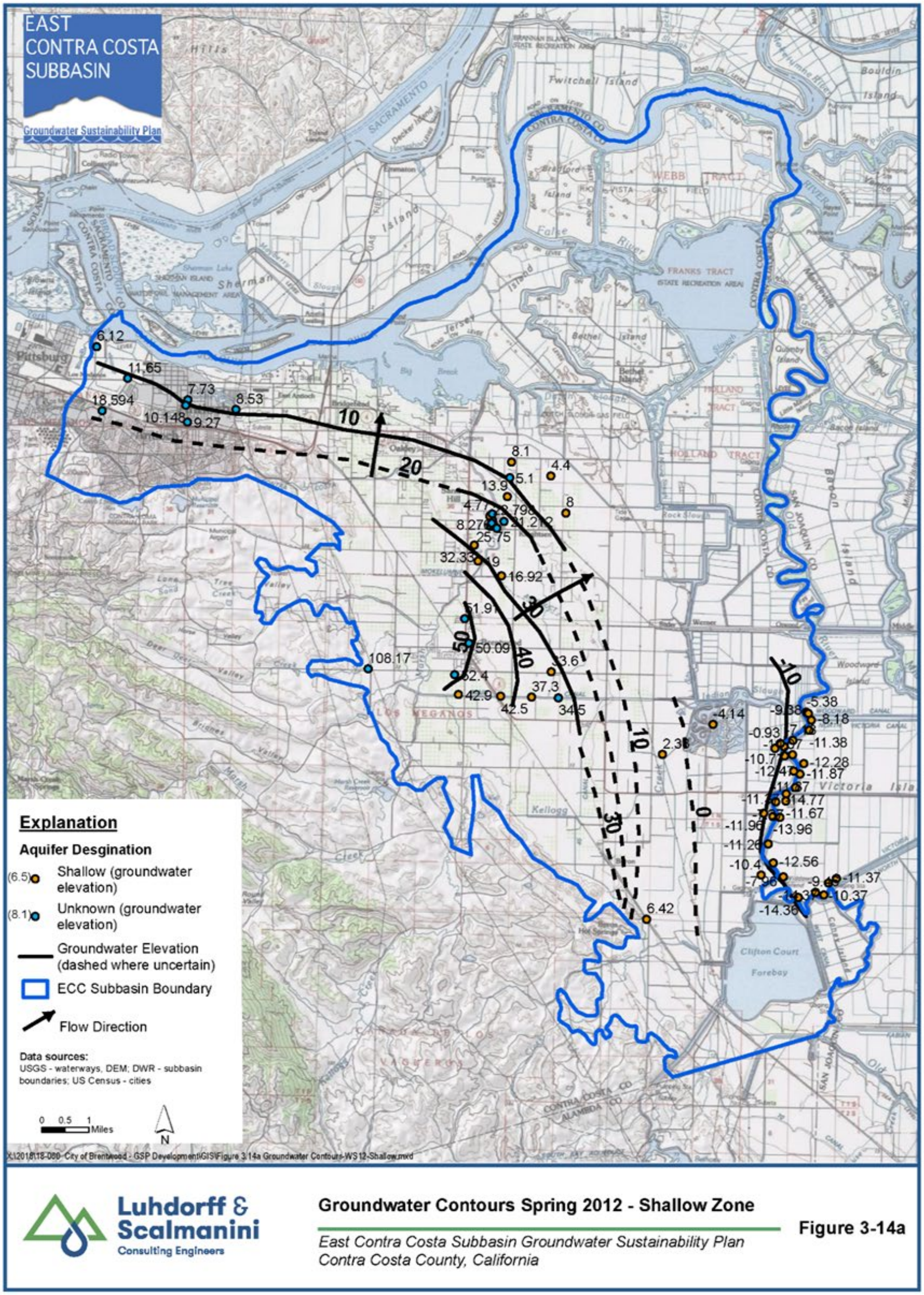
Maps of groundwater elevation from 1958 to present indicate groundwater flow direction is from the Diablo foothills towards the Delta, generally from the southwest to the northeast in the central East Contra Costa Subbasin. Groundwater elevation contour maps developed by LSCE (1999) are available for selected years between 1958 to 1996 (**Appendix 3e**). These maps were developed with water level measurements for wells mostly constructed in the Shallow Zone and are representative of the unconfined aquifer. To evaluate recent groundwater level conditions in the Subbasin, groundwater elevation contour maps were prepared for Spring 2012 and 2018 for both the Shallow and Deep Zones (**Figures 3-14a** to **Figure 3-14d)**.

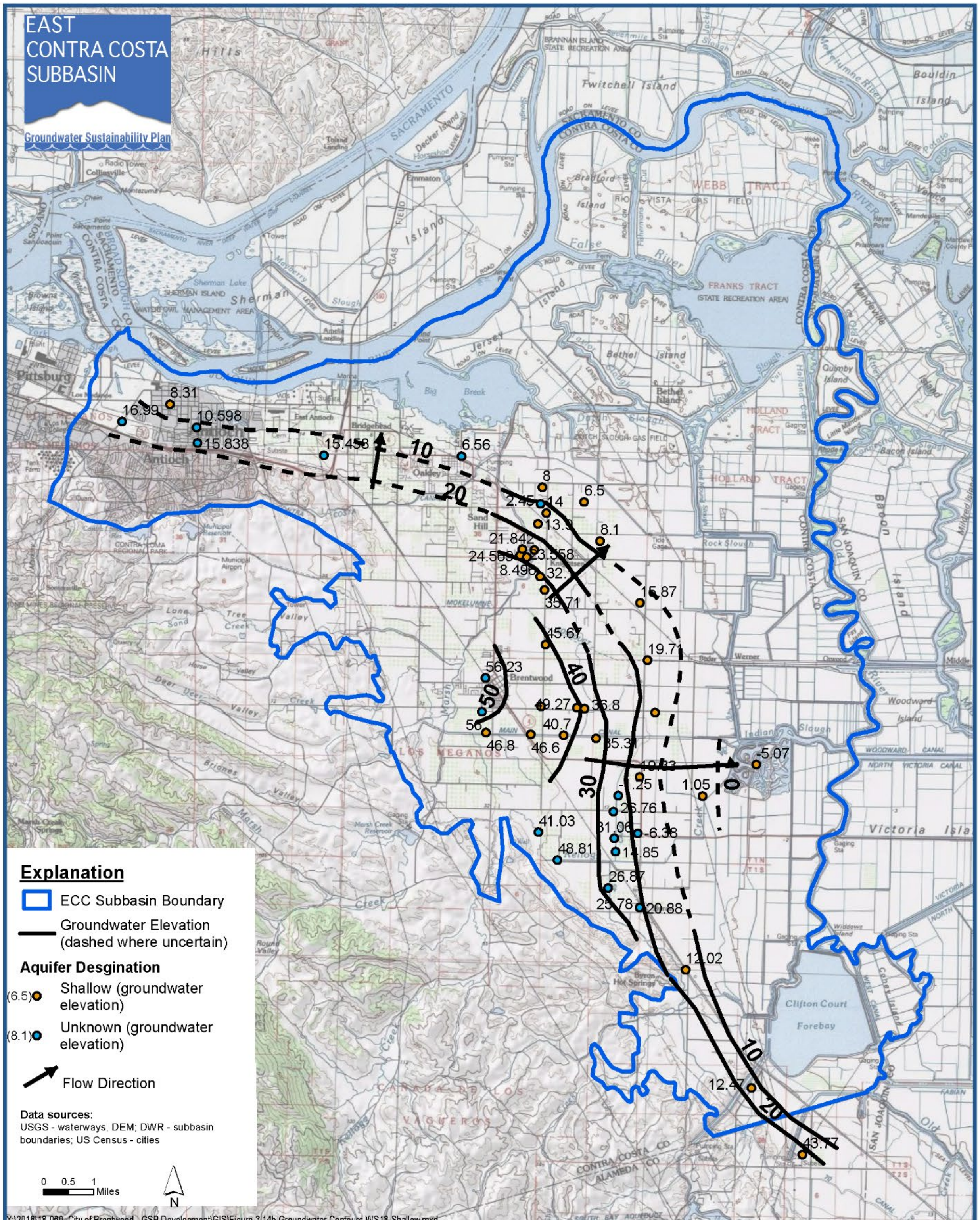
Shallow Zone

The spring 1958 through spring 2018 groundwater contours for the Shallow Zone exhibit a similar pattern of flow, generally from the southwest to the northeast. In 1958, groundwater elevations ranged from about 55 feet msl in Brentwood to about 5 feet msl near the Delta north of Oakley; however, data is only available in the vicinity of Brentwood and Oakley. In spring 1991 additional data were available for the area south of Brentwood on the basin boundary where the groundwater elevation was as high as 75 ft msl to -15 ft msl around Discovery Bay. In spring 2012 (**Figure 3-14a**), the highest groundwater elevations were south of Brentwood at about 45 ft msl to a low of about -10 ft msl along Old River. In spring 2018 (**Figure 3-14b**) the Shallow Zone high groundwater elevations were again located south of Brentwood at about 40 ft msl to a low of about -5 ft in Discovery Bay. The general groundwater flow directions remained the same (to the northeast) and elevations north of Oakley were still around 5 ft msl.

Deep Zone

Contouring groundwater elevations in the Deep Zone is difficult due to the lack of well control exclusively in the Deep Zone. In contouring groundwater levels in the Deep Zone, water levels were used from wells with known construction in the Deep Zone and composite wells (constructed in both the Deep and Shallow Zones). The composite wells are identified by a different colored symbol on the contour maps and allow contours to tentatively be extended outward. Deep Zone groundwater level data is not available until 2007 around Oakley and 2012 around Brentwood and Discovery Bay. Given the limited data points and spatial representation, two Deep Zone groundwater contour maps were constructed: spring 2012 and spring 2018 (**Figures 3-14c and d**). In spring 2012, the highest Deep Zone groundwater elevations were about 50 ft msl south of Brentwood to a low of less than -20 feet msl around Discovery Bay. The spring 2018 Deep Zone contour map illustrates similar groundwater elevations to spring 2012 with high levels of 52 ft msl south of Brentwood, less than -20 ft msl in Discovery Bay, and about 2 ft msl north of Oakley. The Deep Zone groundwater flow direction is to the northeast which is similar to the Shallow Zone flow direction. Due to the limited spatial coverage of Deep Zone wells, evaluating groundwater flow and gradients within the Subbasin are challenging.


EAST CONTRA COSTA SUBBASIN
Groundwater Sustainability Plan
Explanation
Aquifer Desgination
(6.5) Shallow (groundwater elevation)
(8.1) Unknown (groundwater elevation)
Groundwater Elevation (dashed where uncertain)
ECC Subbasin Boundary
Flow Direction
Data sources:
USGS - waterways, DEM; DWR - subbasin boundaries; US Census - cities
0 0.5 1 Miles
N
Luhdorff & Scalmanini Consulting Engineers
Groundwater Contours Spring 2012 - Shallow Zone
Figure 3-14a
East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

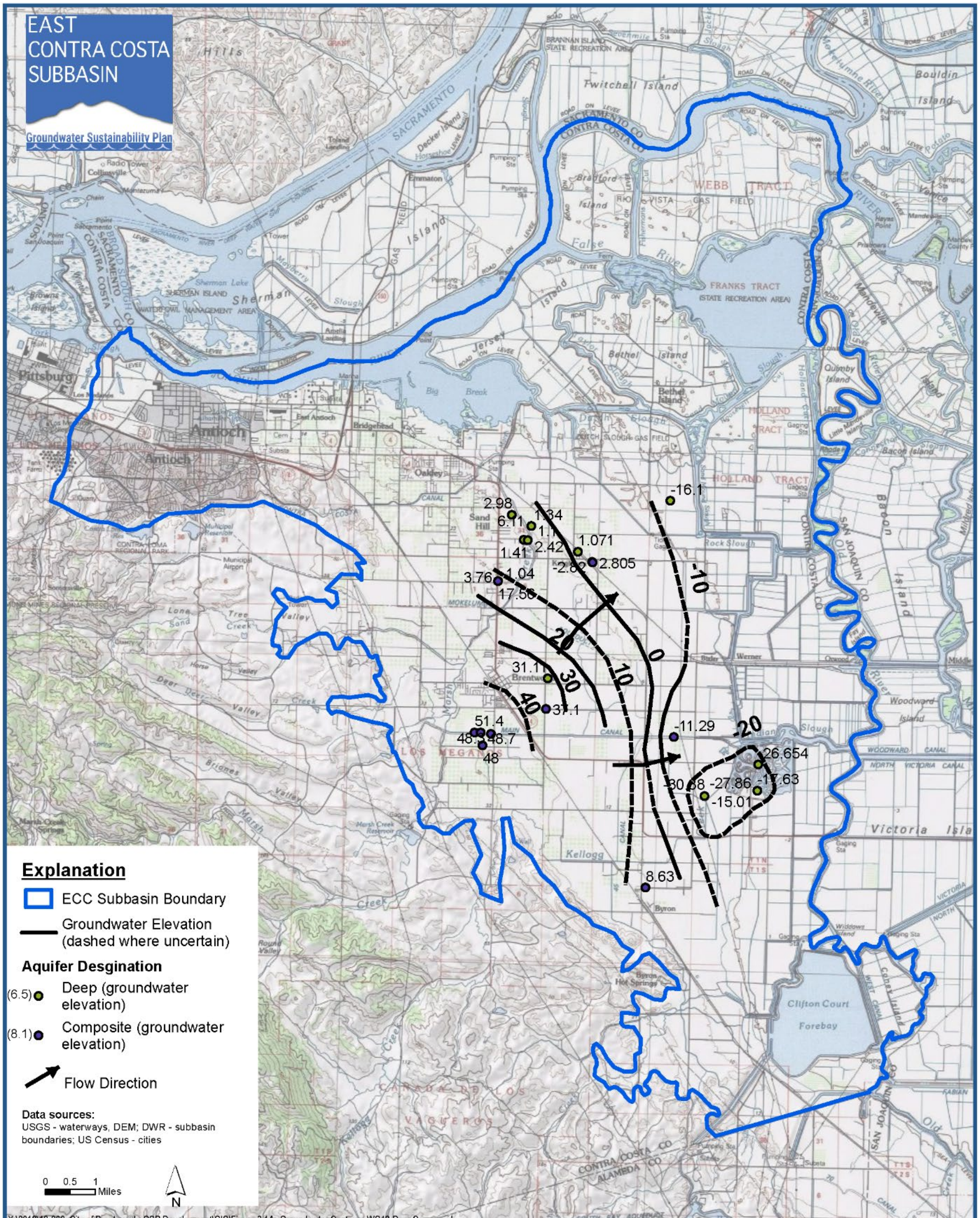


Luhdorff & Scalmanini Consulting Engineers

Groundwater Contours Spring 2018 - Shallow Zone

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-14b

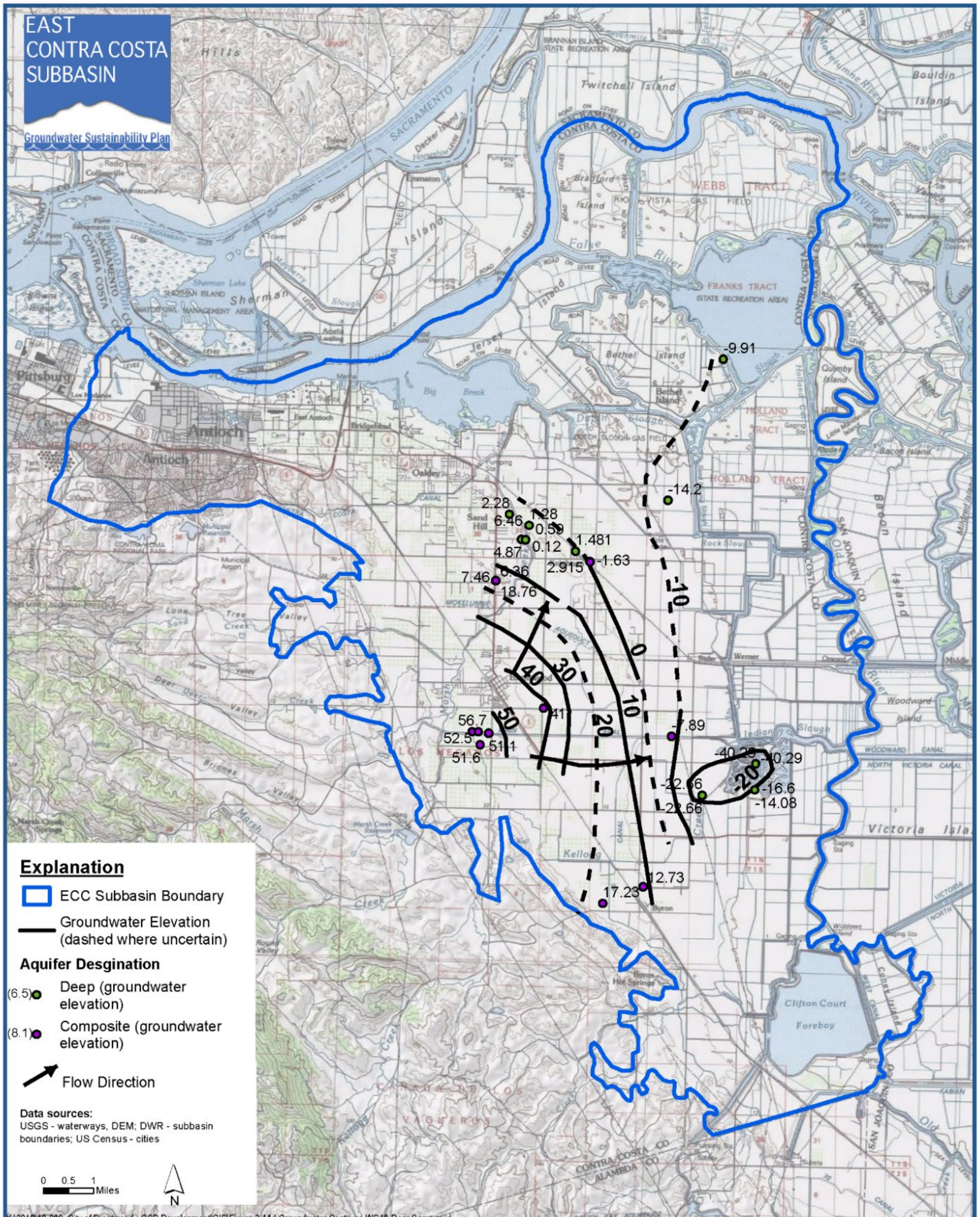


Luhdorff & Scalmanini
Consulting Engineers

Groundwater Contours Spring 2012 - Deep Zone and Composite Wells

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-14c



Luhdorff & Scalmanini
Consulting Engineers

Groundwater Contours Spring 2018 - Deep Zone and Composite Wells

Figure 3-14d

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

3.3.3 Storage

The total groundwater storage volume within the East Contra Costa Subbasin above the base of freshwater is estimated to be between 4.5 million AF (MAF) and 9.0 MAF based on the specific yield range of 5 to 10 percent and using spring 2018 groundwater level contours. DWR Bulletin 118 (2016 update), did not estimate total groundwater storage in the ECC Subbasin but did provide specific yield value ranges of 7 to 10 percent for the San Joaquin Subbasin and Delta for water bearing deposits. **Table 3-1** summarizes calculations of total groundwater storage in the Subbasin using the 7 and 10 percent specific yield values and a lower value of 5 percent as a sensitivity for lower computed storage. An additional analysis is included in **Table 3-1** ("To Base of Major Production Zone") that estimates groundwater storage for the saturated thickness in the Subbasin from the regional water table (spring 2018) to the base of the major production zone (about 300 feet bgs). The total groundwater storage volume for this subsurface unit is estimated to be between 1.5 MAF and 3.0 MAF. There has not been a change in groundwater storage over time because groundwater levels between 1993 to 2019 have been stable. Sustainable yield[3] refers to conditions under which extraction has not adversely impacted a variety of parameters including groundwater levels, storage, quality, etc. Historical conditions as reflected in the hydrographs and contour maps, where data is available, indicate that groundwater extraction has not impacted groundwater levels and storage and that the Subbasin is operating within its sustainable yield.

Table 3-1. Estimates of Total Groundwater Storage (2018)

Area	ECC Subbasin Volume (acre-feet)	Specific Yield (percent)	Total Groundwater Storage (acre-feet)	Notes on Specific Yield Basis
To Base of Major Production Zone	30,254,373	5%	1,513,000	
		7%	2,118,000	Range of 7 to 10% for water bearing deposits DWR Bull. 118 (2003) Tracy Subbasin
		10%	3,025,000	
To Base of Freshwater	89,839,409	5%	4,493,000	
		7%	6,290,000	Range of 7 to 10% for water bearing deposits DWR Bull. 118 (2003) Tracy Subbasin
		10%	8,986,000	

3.3.4 Seawater Intrusion

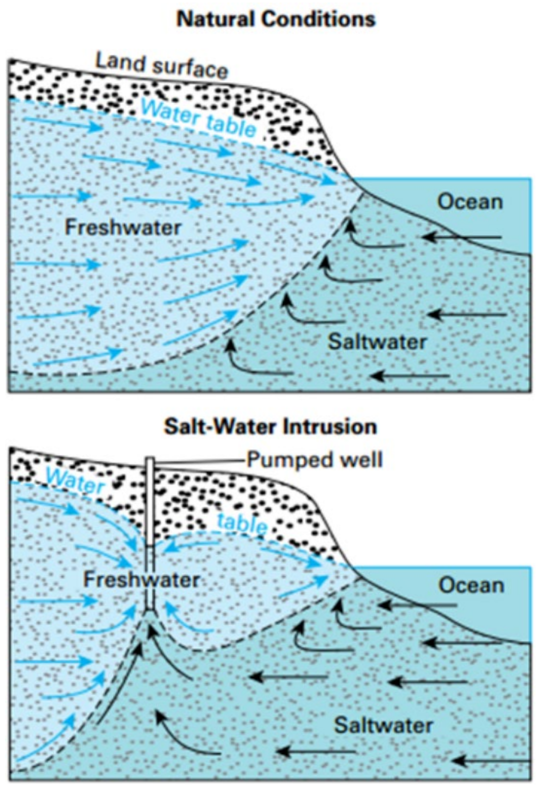
The East Contra Costa Subbasin has no coastline, is not bordered by the ocean, and direct seawater intrusion is not present. The Sacramento-San Joaquin River Delta has historically had brackish tidal water drawn in from the San Francisco Bay; however, levees installed around Delta islands to facilitate agriculture, and development of the Central Valley and State Water Projects, have altered the movement

[3] "In general, the sustainable yield of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results. Sustainable yield is referenced in SGMA as part of the estimated basinwide water budget and as the outcome of avoiding undesirable results." DWR, 2017.

of tidal water through the Delta to maximize freshwater flow. A surface water salinity interface of two parts per thousand near Chipps Island west of the ECC Subbasin, is the State Water Resources Control Board adopted[4] water quality objective to regulate Delta outflow. Though salinity in groundwater may occur naturally in parts of the Subbasin, it is not due to direct seawater intrusion into aquifers.

The mechanism for seawater intrusion is illustrated in **Figure 3-15.** When a direct connection exists such as along the coast, seawater may be drawn into aquifers when the gradient for freshwater outflow is reduced or reversed due to over-pumping. This causes the saltwater/freshwater aquifer interface to move inland. As mentioned above, this is not present in the ECC Subbasin.

Figure 3-15 The Process of Saltwater Intrusion from an Aquifer



Source: https://www.usgs.gov/media/images/process-saltwater-intrusion

In the Bay-Delta setting of the ECC Subbasin, there is no saltwater interface in the subsurface and the aquifers are freshwater. A potential source of saline water intrusion might be migration of baywater into the Shallow Zone aquifers. While fresh baywater outflow through the Delta is managed, increases in baywater salinity could potentially occur due to sea-level rise. This occurrence may potentially impact sustainability if intruded shallow groundwater migrated vertically downward into the Deep Zone aquifers used for water supply. This mechanism is illustrated by two cross-sections (A-A' and C-C') from the 1999 LSCE report (**Figure 3-16a, b, c**). **Figures 3-16b** and **3-16c** show the potential for interactions through hydraulic pathways between stream and delta channels and shallow aquifers. **Figure 3-16b** shows

[4] https://www.baydeltalive.com/maps/11634

substantial clay layers that impede vertical migration to the Deep Zone. Connection to the Deep Zone may be of concern for some areas where domestic and agricultural pumping occurs. One possible area is depicted on Section C-C’ (**Figure 3-16c**) where there are fewer hydraulic clay barriers present. **Figure 3-16d** presents the average chloride concentrations measured in the Shallow Zone and Deep Zone wells over the last ten years. Chloride concentrations are below 500 mg/L and are generally around the 250 mg/L Recommended MCL with a few isolated exceptions.

Seawater Intrusion (or baywater in the ECC Subbasin) will be evaluated with chloride concentration maps that include the new dedicated Shallow Zone monitoring wells (see **Section 6.2.4** for monitoring well list and well map). These wells will act as sentinels for intrusion-related degradation of water quality. There is currently no chloride concentration contour since the monitoring wells have not been installed. A chloride concentration map will be produced for the initial annual report and then for each 5-year update unless more frequent reporting is warranted through analysis of test results. Based on initial sampling and an assessment of basin-wide Shallow Zone water quality characteristics, a baseline for intrusion will be determined. A threshold is set at 250 mg/L, which is the Recommended Limit Secondary Maximum Contaminant Level (SMCL) for chloride as defined by the EPA and below which are the majority of chloride concentration is in the Subbasin.

Figure 3-16a Partial Cross Section Location

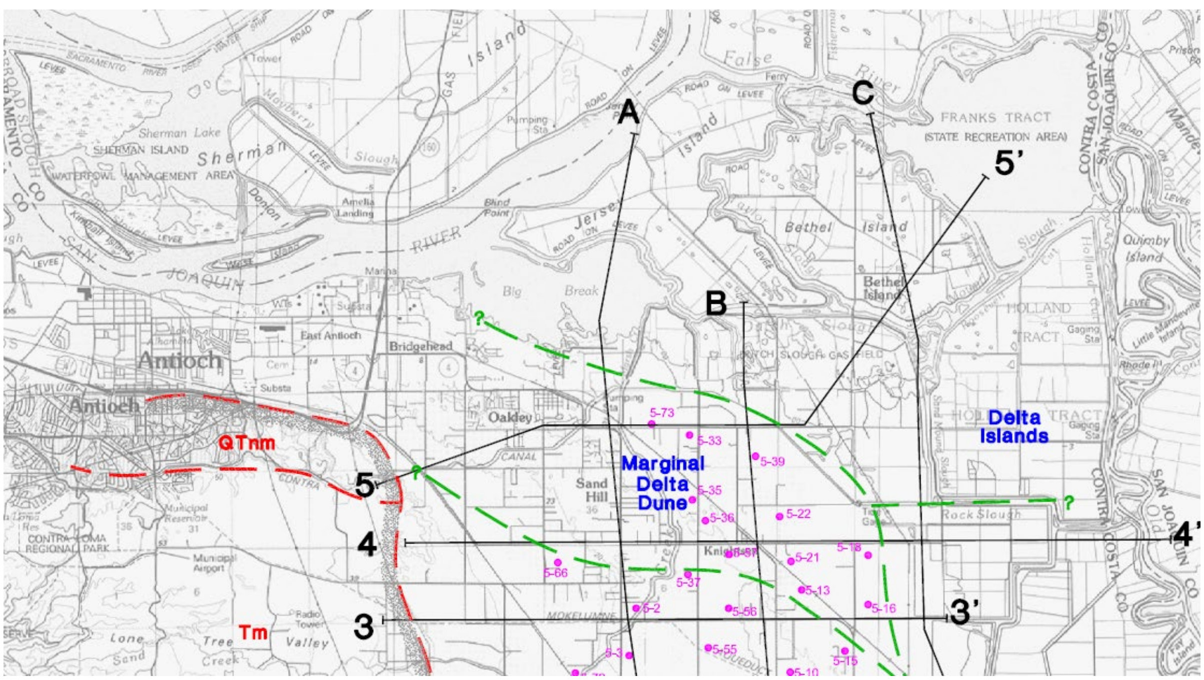


Figure 3-16b Partial of Cross Section A-A'-Clay Barriers Prevent Vertical Baywater Migration

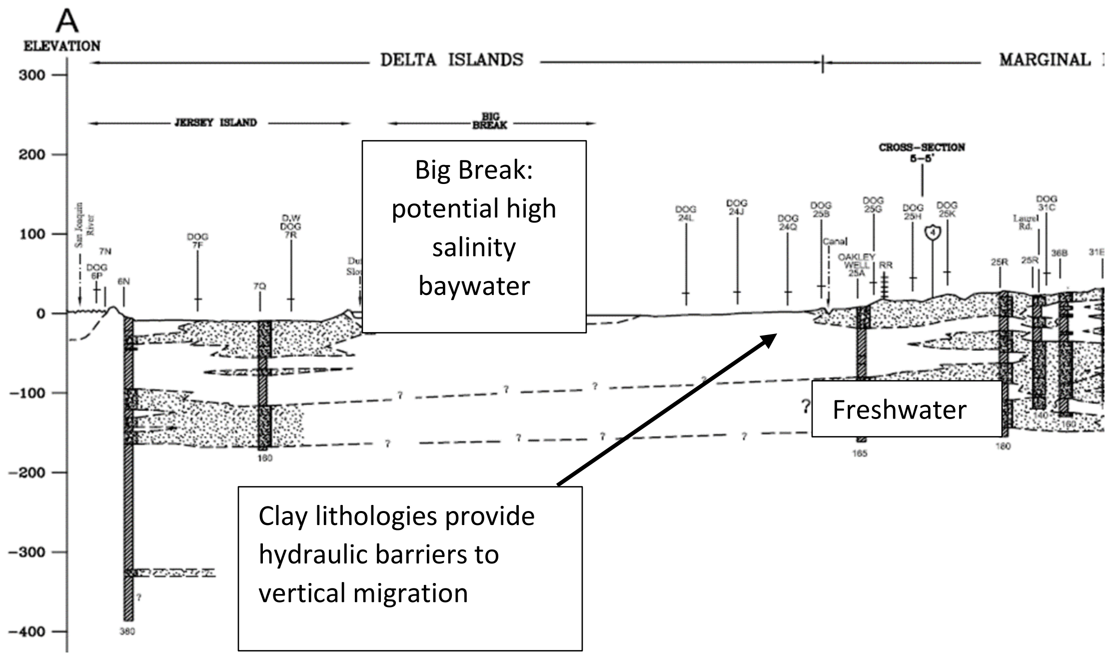
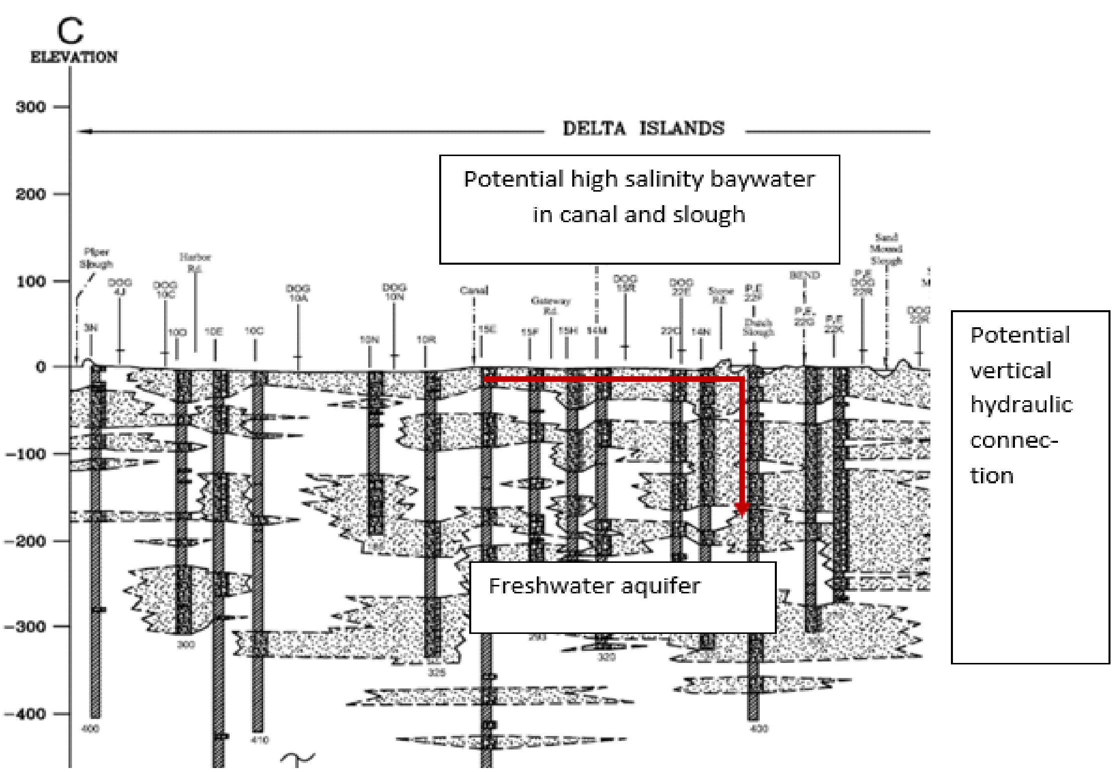
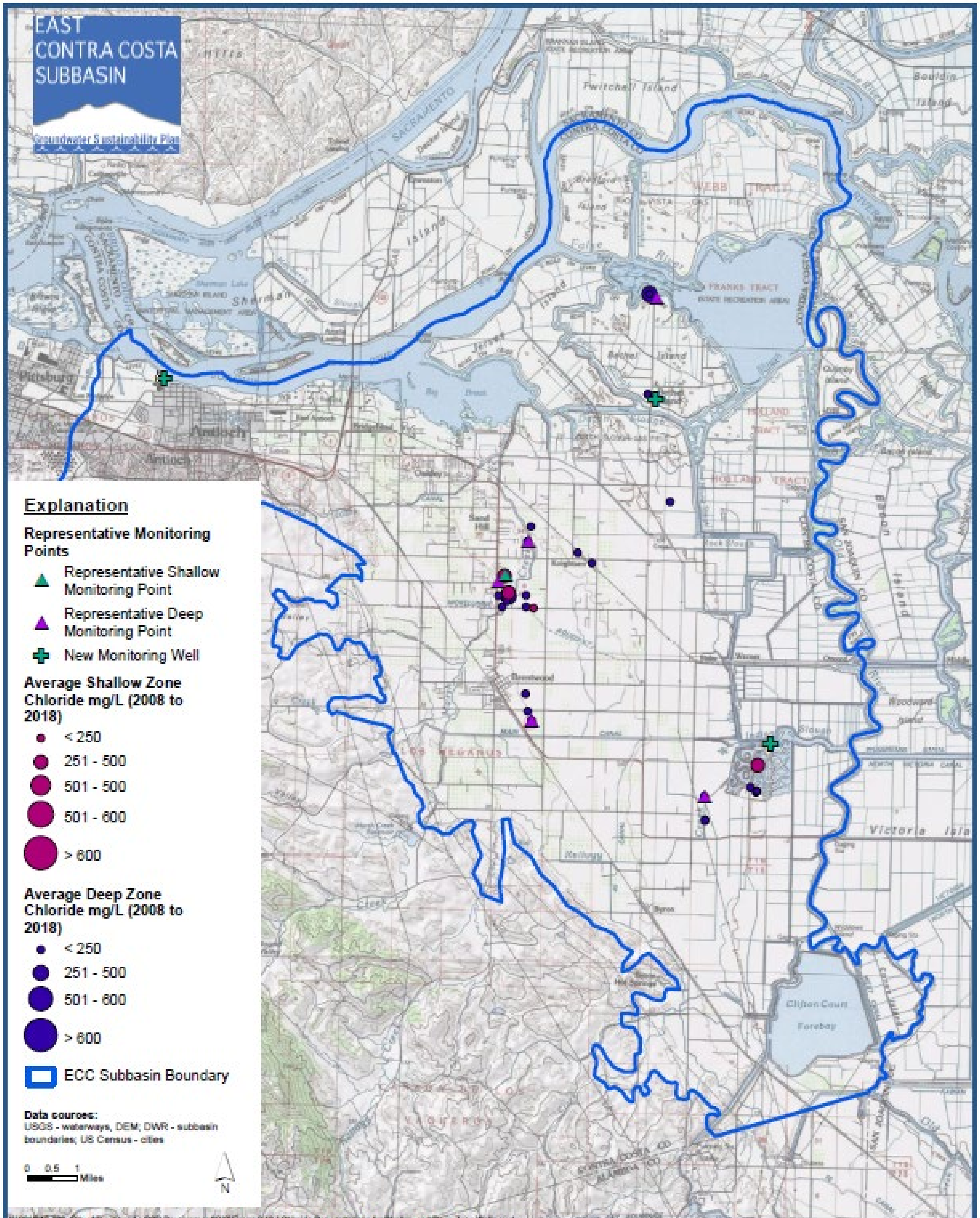


Figure 3-16c Partial Cross Section C-C': Potential for High Salinity Baywater Migration





Luhdorff & Scalmanini Consulting Engineers

Chloride Concentrations for Shallow and Deep Zone Wells

East Contra Costa Subbasin Groundwater Sustainability Plan
Contro Coasta County, California

Figure 3-16d

3.3.5 Groundwater Quality

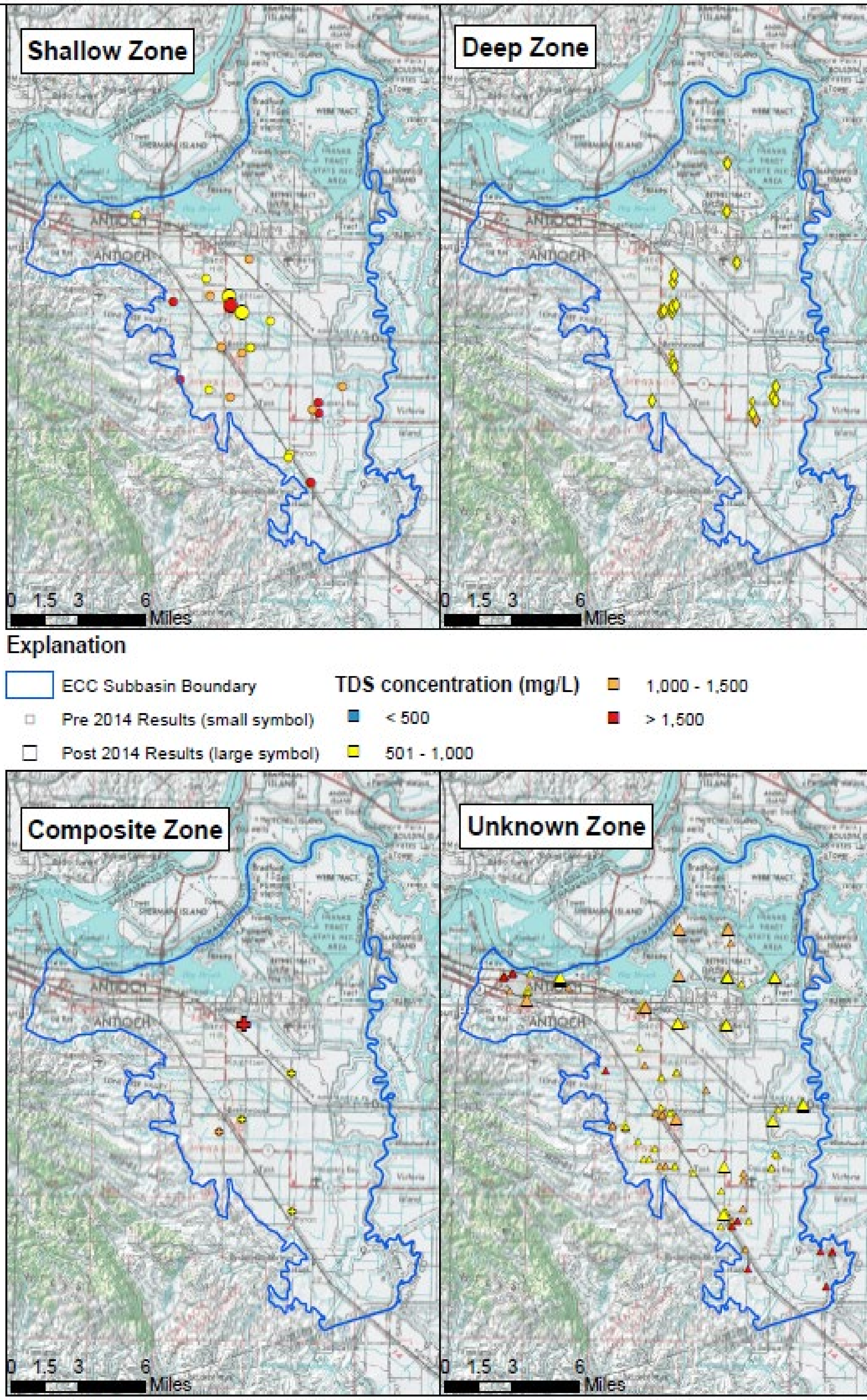
Groundwater quality in the Subbasin is characterized for this section through a variety of tables, maps and graphs. The entire water quality data set is provided in **Appendix 3f**. Key groundwater quality constituents discussed below include total dissolved solids (TDS), nitrate, chloride, arsenic, boron, and mercury. These constituents were selected because they have the potential to influence sustainability (as opposed to localized, or site-specific contamination). A concern for domestic water supply, including individual domestic wells and large public water systems serving municipalities, is groundwater hardness. This concern is included as a sustainability issue in **Section 7 Sustainable Management Criteria**. Monitoring and reporting on trends in hardness of well water are also discussed in **Section 6 Monitoring Network and Data Management System**.

Maps of average and maximum concentration for the selected constituents are displayed in **Figures 3-17a** and **b** through **3-20a** and **b.** Recent data (after 2014) are lacking for some constituents so concentrations for wells with results prior to 2014 are included on the map with a smaller symbol. Time series graphs for these same constituents are presented in **Appendix 3g** and can be used to evaluate trends over time (e.g., TDS or chloride increasing or decreasing over time). In general, groundwater quality meets most water quality objectives and serves a variety of domestic and agricultural uses throughout the Subbasin. However, minor restrictions (discussed in more detail below) are caused by naturally occurring salinity levels that are elevated basin wide and nitrate levels that are slightly elevated in the shallow zone (less than 150 ft bgs).

Water quality concentrations in wells are compared for some constituents (nitrate as nitrate, arsenic, and mercury) to the California State Water Quality Control Board (SWQCB) drinking water standards called maximum contaminant levels (MCLs). Not all constituents (e.g., TDS and chloride) have an MCL and are compared to the secondary MCLs (SMCLs) that address esthetics such as taste and odor.

Total Dissolved Solids

TDS is a general measure of salinity and overall water quality. Salinity of groundwater may increase as influenced by land use or may be naturally sourced where subsurface geologic materials are derived from marine sediments. **Figures 3-17a** and **b** illustrate the average and maximum TDS concentrations for Shallow, Deep, and Composite Zones and for wells where the zone is unknown. TDS varies widely across the Subbasin, although it is characteristically high, ranging between 500 and 1,500 mg/L, in all areas. The Secondary maximum contaminant level (SMCL) for TDS is 500 mg/L (Recommended), 1,000 mg/l (Upper Limit), and 1,500 (Short-Term Limit). The SMCL is established for aesthetic reasons such as taste and odor and is not based on public health concerns. In the Shallow Zone, only three wells in Brentwood have recent results (since 2014) with TDS concentrations ranging between 500 and over 1,500 mg/L and older data indicate similar values. The lack of data for Shallow Zone wells is noted as a data gap. A lower portion of the Shallow Zone (between 80 and 140 ft bgs) in the vicinity of Discovery Bay contains brackish to saline water with EC levels between 2,000 and 6,500 uS/cm (Wells 1B, 4A, and 7, spring 2013). To prevent cross contamination of aquifer units, production wells are constructed with a deep cement seal below 140 ft bgs. The Deep Zone has many wells with TDS concentrations between 500 and 1,000 mg/L. The Deep Zone Discovery Bay wells have TDS concentrations generally below 600 mg/L and three City of Brentwood wells (wells 6, 7, and 8) increased from 600 mg/L and have stabilized with TDS concentrations around 1,000 mg/L (the upper secondary MCL) (**Appendix 3g**). The areas around Antioch and Byron have elevated TDS concentrations compared to the rest of the Subbasin, with some average results over 2,000 mg/L.

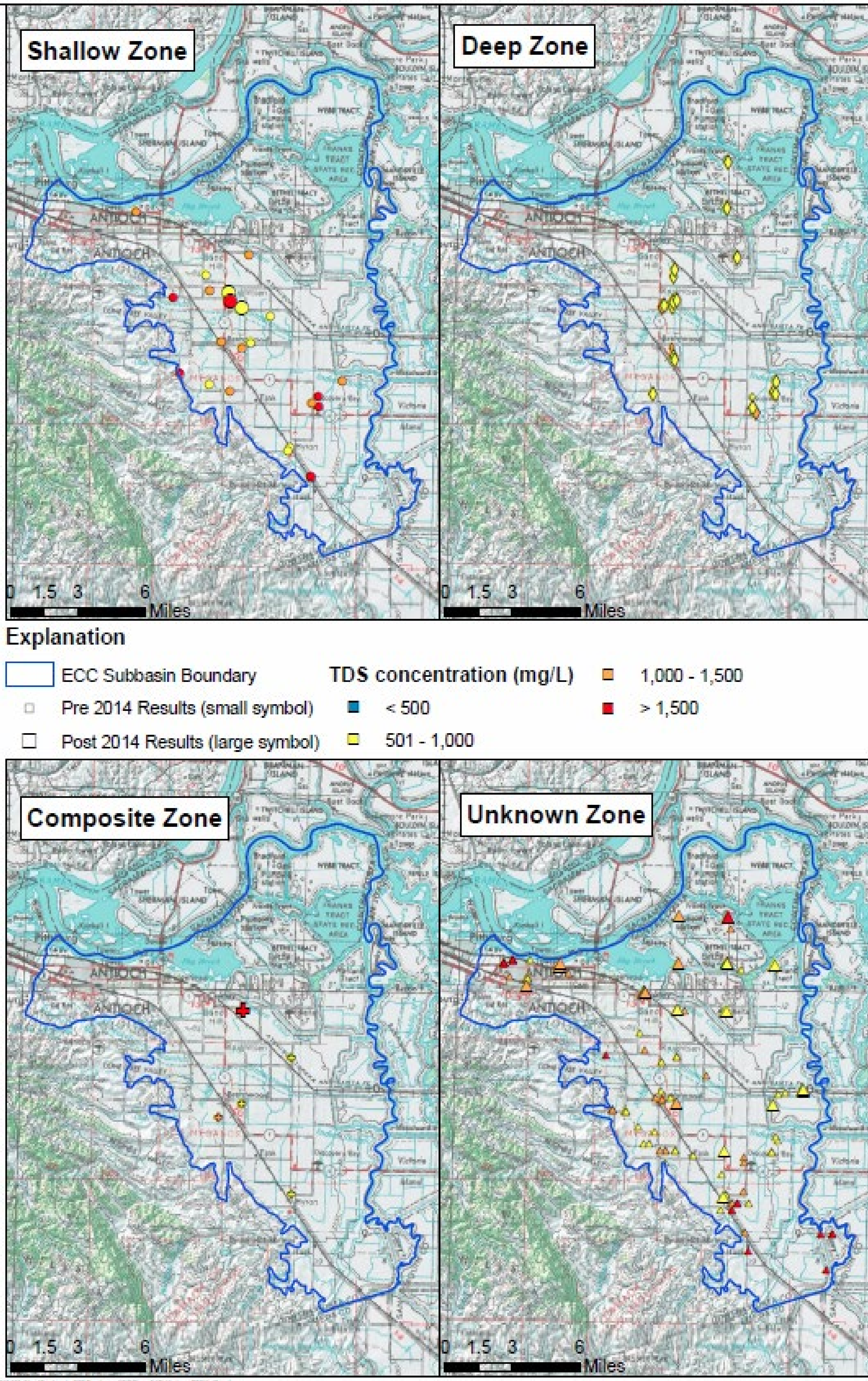


Luhdorff & Scalmanini Consulting Engineers

Average Total Dissolved Solids

East Contra Costa County Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-17a

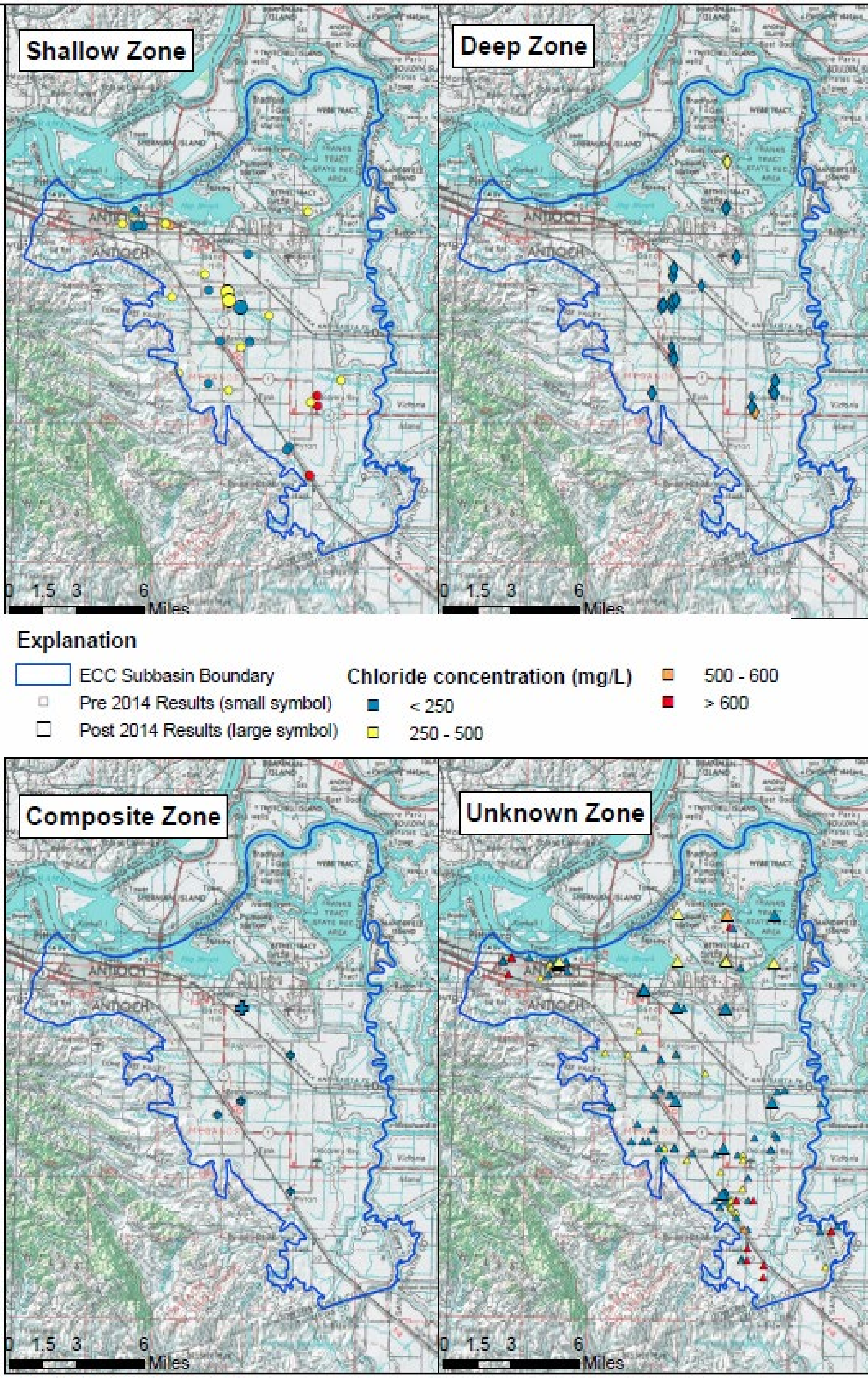


Maximum Total Dissolved Solids

East Contra Costa County Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-17b

Luhdorff & Scalmanini Consulting Engineers

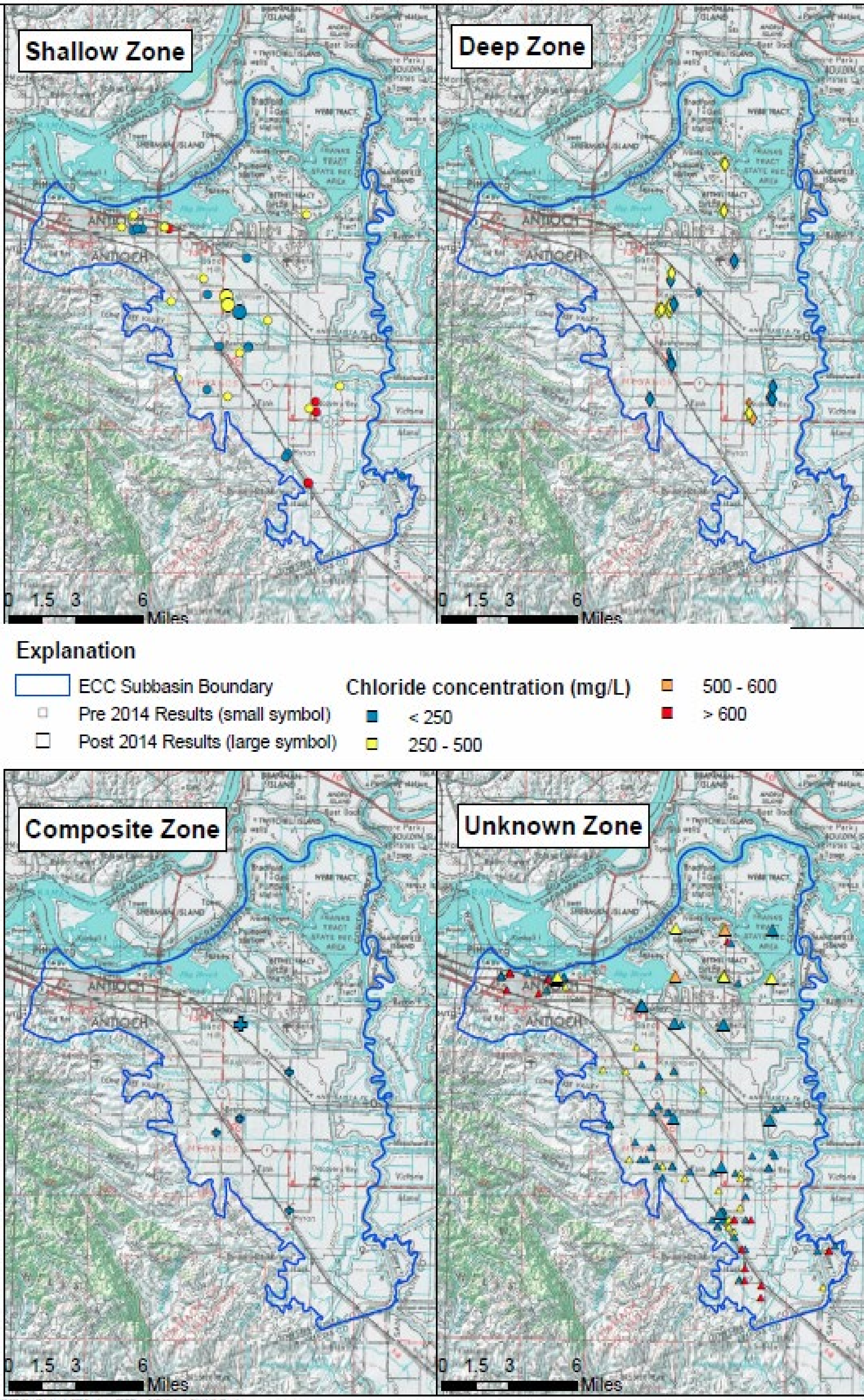


Luhdorff & Scalmanini Consulting Engineers

Average Chloride

East Contra Costa County Groundwater Sustainability Plan
Contra Costa County, California

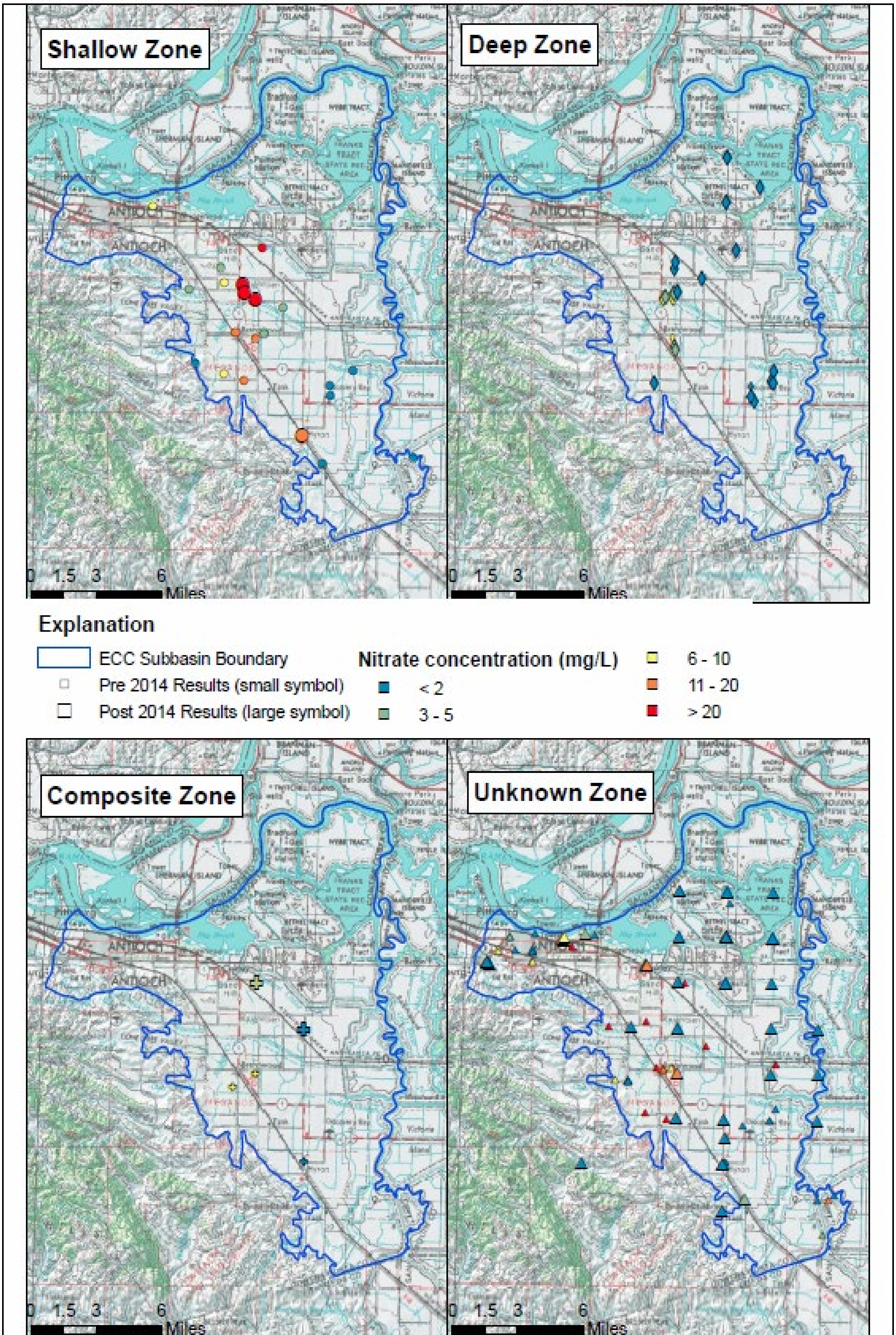
Figure 3-18a



Maximum Chloride

East Contra Costa County Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-18b

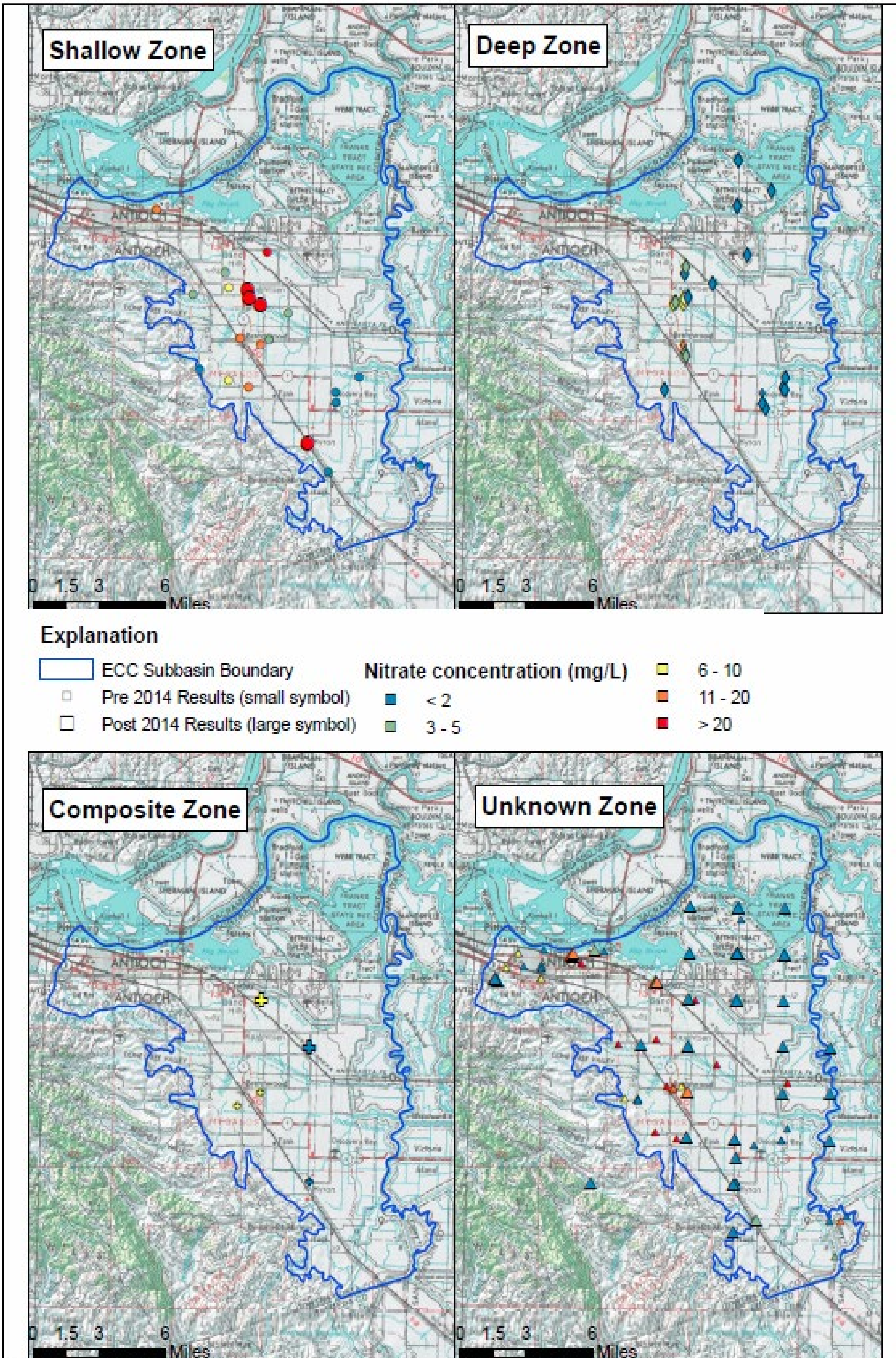


Luhdorff & Scalmanini Consulting Engineers

Average Nitrate

East Contra Costa County Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-19a

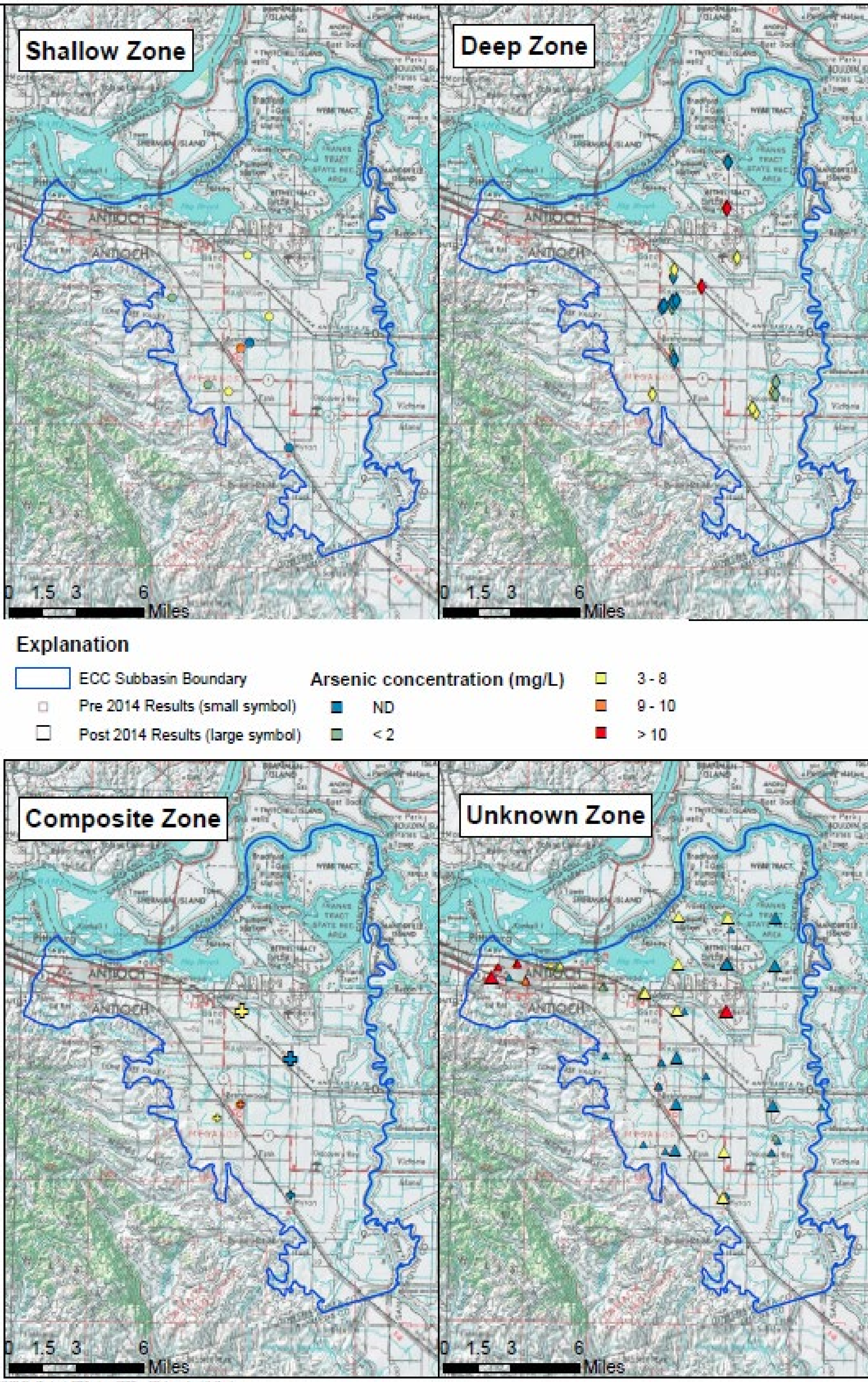


Luhdorff & Scalmanini Consulting Engineers

Maximum Nitrate

East Contra Costa County Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-19b

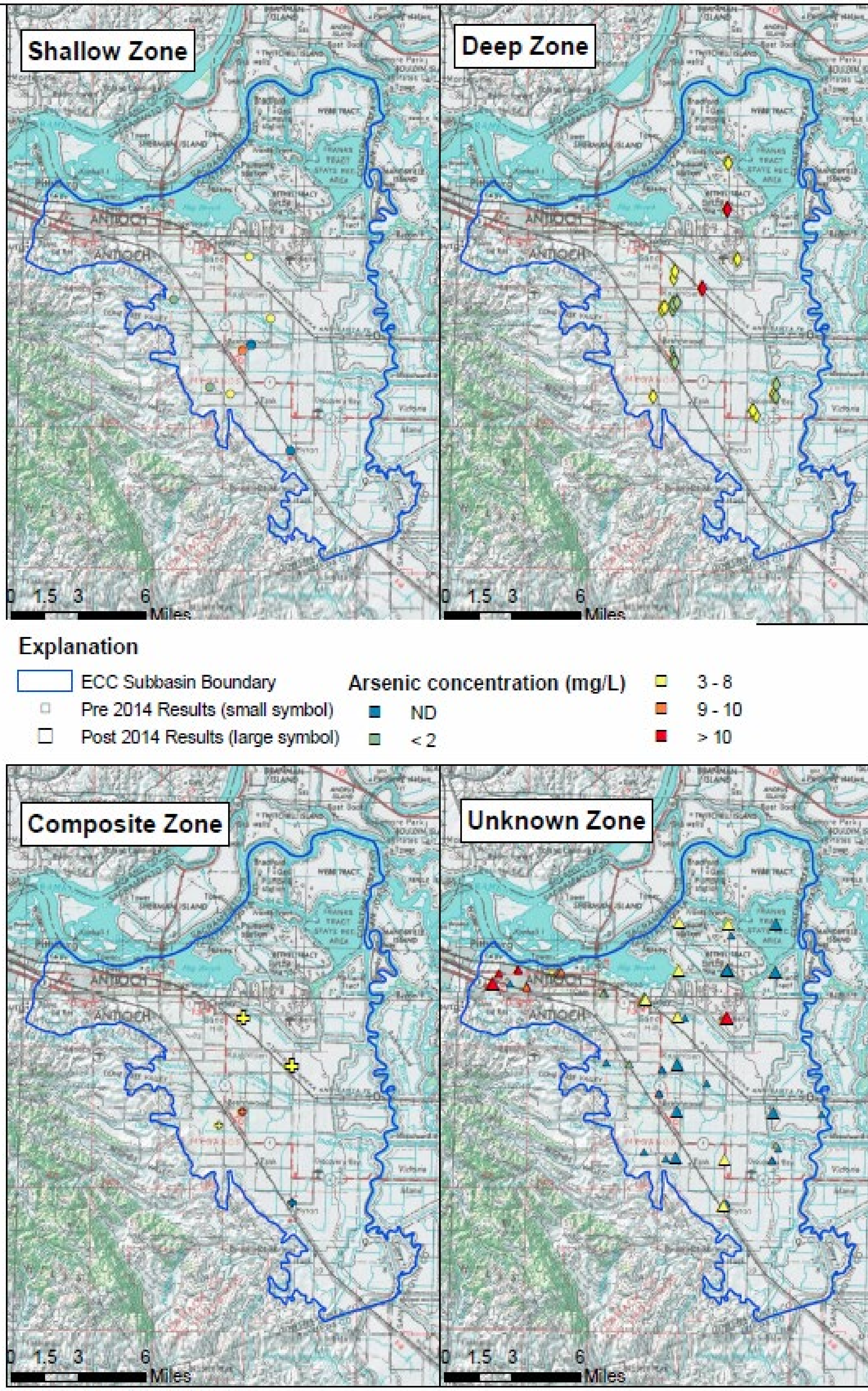


Luhdorff & Scalmanini Consulting Engineers

Average Arsenic

East Contra Costa County Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-20a



Luhdorff & Scalmanini Consulting Engineers

Maximum Arsenic

East Contra Costa County Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-20b

In summary, TDS concentrations in groundwater in the Subbasin exceed or are near the recommended SMCL (500 mg/L) in most wells (**Table 3-2**) suggesting that water concentrations are naturally higher for TDS (LSCE 1999).

Table 3-2. Water Quality Concentrations for Key Constituents

Constituent (Units)	Date Range	Number of Wells					No. of Measurements	Concentration			
		DDW	DWR	Geo-tracker	USGS	Total		Range	Median	Average	St Dev
TDS (mg/L)	1957-2019	87	46	73	22	228	802	86 - 20,400	885	1,098	1,431
Chloride (mg/L)	1957-2019	97	67	80	36	280	1562	11 - 4,900	168	231	310
NO3-N (mg/L)	1957-2019	135	23	125	30	313	2360	ND - 1,400	0.5	4.7	30.5
Arsenic (ug/L)	1957-2019	88	12	81	9	190	959	ND - 750	3	8	29

Chloride

Chloride is also a common way to indicate salinity. **Figures 3-18a** and **b** illustrate the average and maximum chloride results for the Shallow, Deep, and Composite Zones and the wells where the zone is unknown. Where zones are known, chloride concentrations generally decrease with depth to under 200 mg/L. Shallow Zone wells have higher chloride concentrations in the vicinity of Brentwood (230 to 280 mg/L) and Discovery Bay (360 to 2,000 mg/L) than the Deep Zone wells. Deep Zone wells (Wells 6, 7, and 8) in Brentwood have increased from less than 100 mg/L to over 200 mg/L) and Discovery Bay wells are stable and generally <100 mg/L. All results in the two zones (Shallow and Deep) are generally under 500 mg/. The areas around Antioch and Byron have elevated chloride concentrations compared to the rest of the Subbasin, with average results up to over 1,800 mg/L. The SMCL for chloride is 250 mg/L (Recommended), 500 mg/L (Upper Limit), and 600 mg/L (Short-Term).

In summary, chloride concentrations in groundwater in the Subbasin exceed or are near the recommended SMCL for chloride (250 mg/l) in most wells (**Table 3-2**) suggesting that water concentrations are naturally higher for chloride (LSCE 1999).

Nitrate

Nitrate is both naturally occurring and can be a result of human activity (e.g., fertilizers, septic systems, and animal waste). The MCL for nitrate as nitrogen (N) is 10 mg/L for drinking water. **Figures 3-19a** and **b** illustrate the average and maximum nitrate concentrations as N for the Shallow, Deep, and Composite Zones and for wells with an unknown aquifer zone. Wells with average nitrate as N concentrations that exceed the MCL are Shallow Zone wells in the Brentwood area (24 to 121 mg/L) and Unknown Zone wells scattered in the central western portion of the Subbasin. A few City of Brentwood composite production wells have been taken out of service due to high nitrate concentrations. In previous work, the higher Shallow Zone concentrations have been attributed to agricultural influences in the area and lack of confining clay units between soil horizons and shallow aquifer materials. Continued monitoring of

Brentwood Deep Zone wells (currently all below 10 mg/L) will monitor whether nitrate is migrating from the Shallow Zone. Deep Zone production wells in the Discovery Bay and Oakley area have nitrate concentrations less than 2 mg/L. Wells in the Delta Island area in the northern and eastern portion of the Subbasin generally have very low nitrate as N concentrations.

In summary, nitrate is observed in some Shallow Zone areas of the Subbasin (i.e., Brentwood), with concentrations exceeding the MCL (10 mg/L) that may be linked to historical agricultural influences in the area.

Arsenic

Arsenic is a naturally occurring constituent and is commonly found in groundwater throughout California. An MCL was established at 10 ug/L in California in 2008. **Figures 3-20a** and **b** illustrate the average and maximum arsenic concentrations for the Shallow, Deep, and Composite Zones and the wells where the zone is unknown. For wells in the Shallow and Deep Zones, all have average and maximum arsenic concentrations at or below 10 µg/L with four exceptions: Knightsen, two public water systems on Sandmound Blvd., and Bethel Island. Near Discovery Bay, there have been detections of 10 µg/L; but, on average, the Discovery Bay area has concentrations less than 8 µg/L. For Unknown Zones, most of the wells are less than 8 µg/L. An exception is in the Antioch area which has higher concentrations of arsenic with average results over 100 µg/L.

In summary, arsenic concentrations are less than the MCL (10 ug/L) basin wide.

Boron

Boron is a naturally occurring constituent in groundwater and particularly in Contra Costa County[5]. The most common sources of boron in drinking water are from leaching of rocks and soils, wastewater, and fertilizers/pesticides. Boron concentrations in the Subbasin range from 500 ug/L to over 4,000 ug/L with the majority over 1,000 (**Appendix 3f**). MCLs for boron have not been established but there is an agricultural goal (700 ug/L) where some crops may become sensitive, a state notification level (SNL)l[6] (1,000 ug/L), and a US EPA Health Advisory for non-cancer health effect (5,000 ug/L). Boron concentrations in groundwater in the Subbasin exceed the agricultural and SNL (1,000 ug/L) in most wells but are less than the EPA Health Advisory (5,000 ug/L) suggesting that water concentrations are naturally higher.

Mercury

Marsh Creek runs from Mt. Diablo through Brentwood and out to the San Joaquin River and drains water from the Mt. Diablo Mercury Mine operated from 1849 to 1971. There is potential for rainwater to leach mercury from mine tailings and to flow into the Marsh Creek watershed. However, there is no evidence that mercury has contaminated groundwater in the Subbasin and no wells in the ECC Subbasin tested for mercury have exceeded the MCL (2 ug/L).

---

[5] The SWQCB Division of Water Quality GAMA Program "Groundwater Information Sheet for Boron (B), revised November 2017. Contra Costa County was identified on one of the top three counties in the state for boron detection from a study of public water supply wells from 2007 to 2017.
[6] Notification levels are non-regulatory health-based advisory levels establish by the SWRCB for chemicals with not established MCL.

Appendix 3f is a table of all groundwater quality (general minerals and trace elements) in the Subbasin, by zone. Most of the wells in the Subbasin are missing construction information so water quality for the Shallow and Deep Zones is limited.

In summary, groundwater in the Subbasin generally exceeds or is near the recommended SMCL for TDS (500 mg/L) and chloride (250 mg/l) (**Table 3-2**). The observed concentrations may reflect a naturally higher baseline for these constituents (LSCE 1999). Nitrate is observed in some Shallow Zone areas (i.e., Brentwood) in the Subbasin, with concentrations generally exceeding the MCL (10 mg/L) that may be linked to past agricultural influences in the area. Arsenic concentrations are generally less than the MCL (10 ug/L) basin wide. Boron concentrations are high in most wells and are attributed to a naturally elevated baseline. Groundwater serves a variety of domestic and agricultural uses throughout the Subbasin with limited restrictions due to natural (salinity and boron) and anthropogenic (nitrate) causes. The availability of surface water gives the opportunity to mitigate these issues when necessary. Depending on local groundwater quality, the stringent municipal standards for drinking water are met by a mix of water sources: City of Antioch uses surface water only, DWD and Brentwood blend groundwater with surface water, and TODB uses groundwater only. The ECC Subbasin's groundwater quality is generally stable which indicates that groundwater extraction is not degrading water quality and the Subbasin is being operated within its sustainable yield.

3.3.6 Groundwater Contamination Risk

There are numerous potential anthropogenic sources of groundwater contamination in the ECC Subbasin. Almost any human related activity involving hazardous substances and waste has the potential to contaminate groundwater. Some activities may lead to groundwater contamination by first contacting soil and then seeping to groundwater. In the ECC Subbasin, the depth to groundwater may occur within a few feet of the ground surface thus increasing the risk that soil contamination may reach a shallow aquifer. Other sources may involve more direct contact between groundwater and hazardous substances such as associated with hydrocarbon transmission lines or leaky storage tanks at retail gasoline stations. Historical and current industrial activity in the east Contra Costa region is also a source of past and potential future groundwater contamination. In Oakley, shallow groundwater and soil contamination occurred at a former Dupont plant that manufactured a gasoline agent, refrigeration cooling compounds, and additives for household products and food. That site operated from 1956 to 1998 and, in 2015, remedial obligations were transferred to Chemours, a subsidiary of Dupont. Chemours worked with the Department of Toxic Substances Control (DTSC) to remediate the site and ultimately returning most of it to a new commercial use now underway[7].

Another potential source of groundwater contamination is the historical and current oil and gas activity in the area. Although areas of current and future activity may be more restrictive in areas of urban growth, it is expected that continued development and redevelopment of oil and gas fields may occur in rural and unincorporated areas of the subbasin. In the ECC Subbasin, oil and gas wells would penetrate the Shallow and Deep Zone freshwater aquifers that are a source of supply for domestic, agricultural, industrial, and environmental uses. Pathways for contamination via these wells would be present and may be of concern

[7] https://eastcountytoday.net/oakley-officially-breaks-ground-on-new-logistics-center-could-create-2800-jobs/

to GSAs seeking to protect water quality and maintain long-term sustainability of groundwater resources in the subbasin.

The following sections provide an overview of these anthropogenic sources of potential concern to groundwater quality. Although, SGMA does not transfer oversight of regulation of hazardous substances to GSAs, the agencies may seek to mitigate risks by informing the applicable regulatory agency of the intersection between contamination sources and mechanisms by which degradation may occur in the unique hydrogeologic setting of the ECC Subbasin. **Section 8** discusses a potential policy for GSA engagement with agencies responsible for mitigating and remediating hazardous waste that may reach groundwater.

3.3.6.1 Groundwater Contamination Sites

Figures 3-21a and 3-21b illustrate the open and closed groundwater contamination sites in the ECC Subbasin. Contaminated sites can pose a hazard to human health through the contamination of aquifers if the area is using groundwater. Contamination site data were taken from Geotracker[8] and are divided into cleanup program sites, leaky underground storage tank (LUST) sites, and land disposal sites. **Appendix 3h** lists the 35 open sites and 105 closed sites including the potential contaminants of concern for each site. The majority of sites are in Antioch and Brentwood and the most common contaminant is hydrocarbon.

3.3.6.2 Oil and Gas Wells

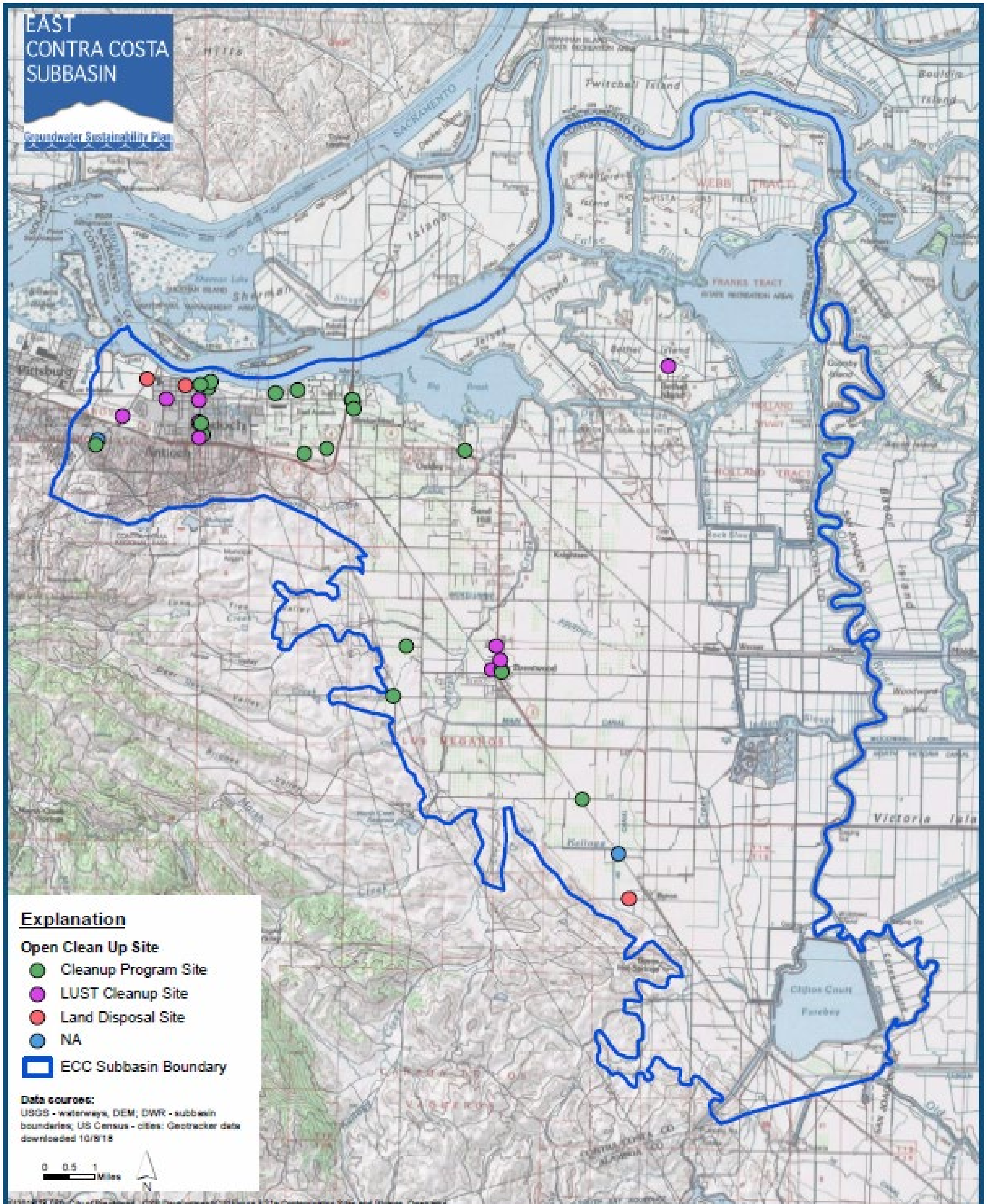
Oil and gas wells are regulated and permitted through the state Department of Conservation, Geologic Energy Management Division (CalGEM). In east Contra Costa County, there are as many as eleven oil and gas fields either wholly or partially within the ECC Subbasin which target oil and/or gas sands at several thousand feet below ground surface. Produced water in these sands is saline based on interpretation of electric geophysical logs performed in open boreholes prior to well installation.

As with all oil and gas wells in the subbasin, CalGEM regulations require a separate surface casing to be installed below the base of freshwater[9]. In Brentwood, for example, surface casings extend to 1,750 feet. This depth is consistent with the basin conceptualization presented in this GSP. Even though the interpreted base of freshwater is as deep as 1,750 feet, most groundwater production in the ECC Subbasin is shallower than 500 feet.

The legacy of oil and gas activity in the ECC Subbasin is the presence of up to several hundred abandoned and plugged wells. The abandonment programs are regulated through CalGEM requiring cement plugs at various depths to ensure that fluids in the oil zone (oil, gas and connate water) do not migrate upward into freshwater aquifers. **Appendix 3i** contains figures showing oil and gas fields and wells located in the ECC Subbasin as obtained from CalGEM's online well finder tool[10]. Production records are also available online through CalGEM[11].

---

[8] Geotracker is the state Water Board's online resource to track data from waste discharges to land and includes unauthorized releases of hazardous substances from underground tanks: https://geotracker.waterboards.ca.gov/.
[9] https://www.conservation.ca.gov/calgem/Pages/Oil,-Gas,-and-Geothermal-Rulemaking-and-Laws.aspx
[10] https://www.conservation.ca.gov/calgem/Pages/WellFinder.aspx
[11] https://filerequest.conservation.ca.gov/?q=production_injection_data

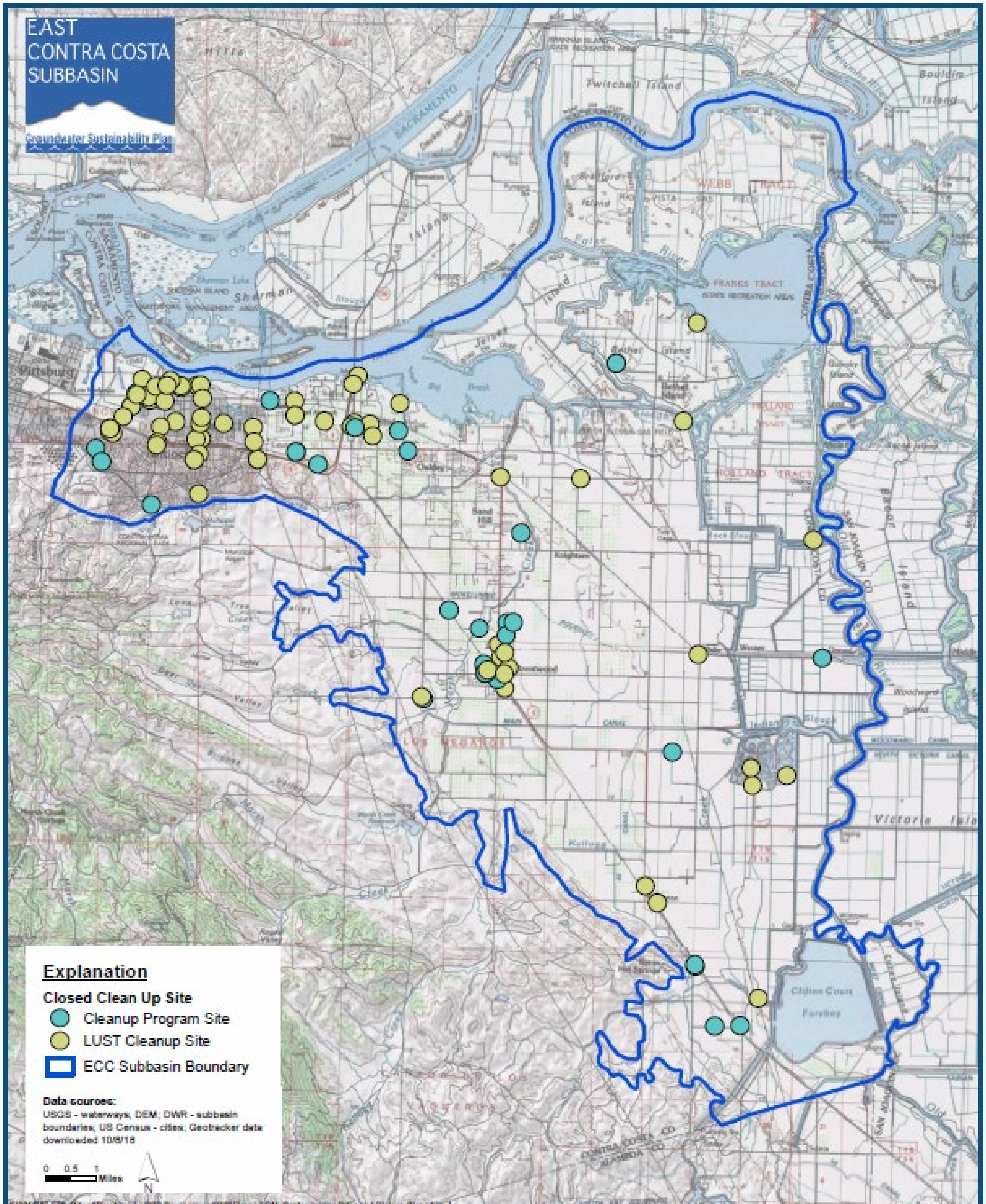


Luhdorff & Scalmanini
Consulting Engineers

Groundwater Contamination Sites and Plumes: Open Sites

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-21a



Luhdorff & Scalmanini Consulting Engineers

Groundwater Contamination Sites and Plumes- Closed Sites

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

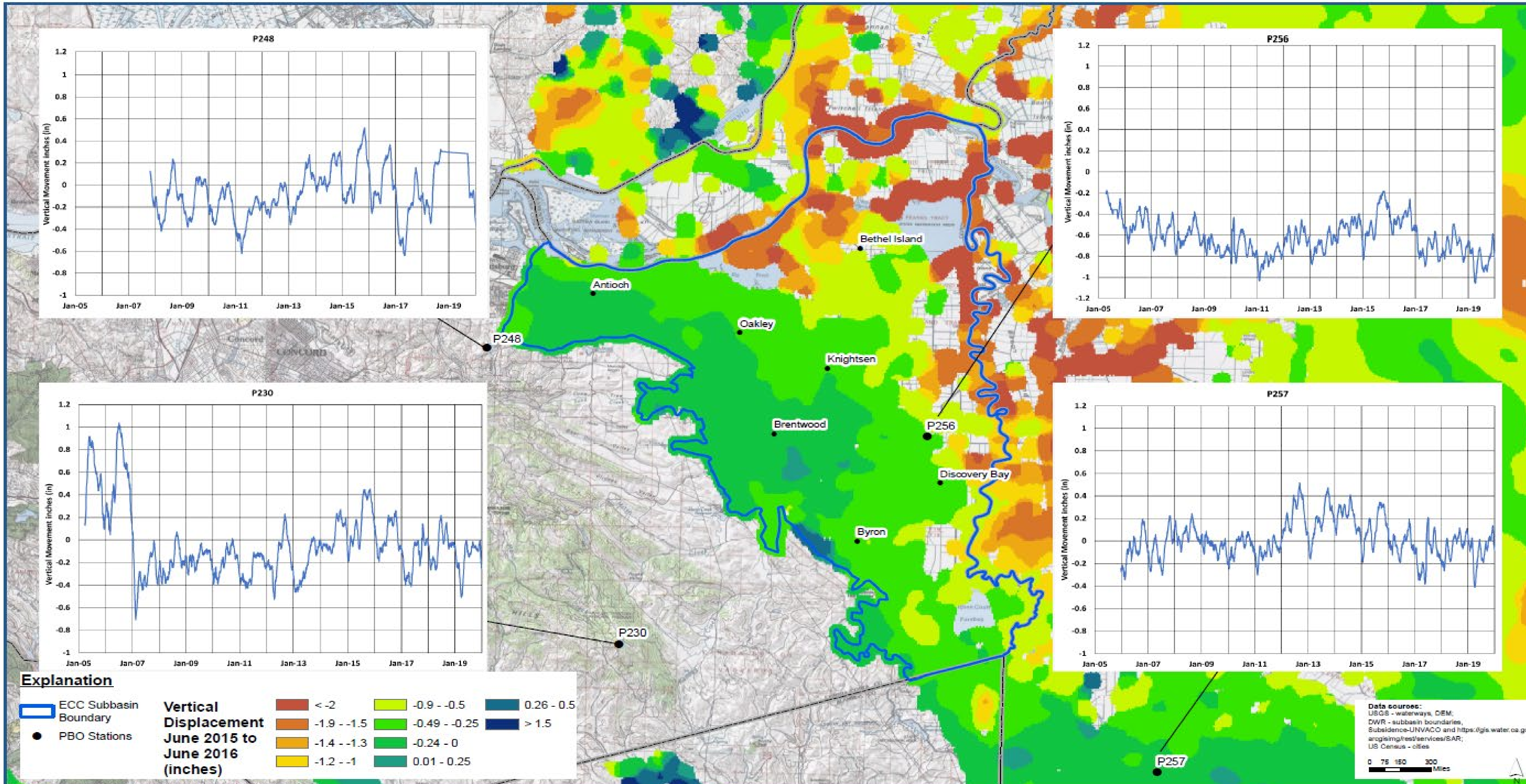
Figure 3-21b

3.3.7 Land Subsidence

There are no historical records of impacts from subsidence due to groundwater withdrawal in the ECC Subbasin. Land subsidence in the Subbasin is continuously monitored by the Plate Boundary Observatory (PBO) monitoring network managed by University NAVSTAR Consortium (UNVACO). The PBO's main task is to "quantify three-dimensional deformation and its temporal variability across the active boundary zone between the Pacific and North American plates." The PBO stations can be used to monitor for land subsidence using vertical land surface measurements. PBO stations are used to measure centimeter to millimeter-scale movement on the Earth's surface. Four stations located in or near the Subbasin (**Figure 3-22**) all show minor displacements. PBO stations take measurement once per day, to mitigate erroneous data a 30-day rolling average was applied to the data. PBO Station 256 (P256), located inside the Subbasin, has shown a vertical displacement from 2005 to 2019 of -0.01096 inches per year. PBO Station 230 (P230) west in the Diablo Mountains also has a slight downward displacement of -0.01461 inches per year. Two stations near Antioch and Tracy (P248 and P257) have a slight upward displacement of the land surface. **Table 3-3** below provides the estimated rate of land surface change. Trends do not indicate inelastic downward displacement in the land surface.

Table 3-3. Land Surface Displacement Rates at PBO Sites

Monitoring Location	Location Relative to Subbasin	Period of Record	Rate of Land Surface Displacement (inches per year)	Rate of Land Surface Displacement (feet per year)
Inside East Contra Costa Subbasin				
P256	East of Center of Subbasin	2005-2019	-0.0093	-0.00077
Outside East Contra Costa Subbasin				
P230	Southwest of Subbasin	2005-2019	-0.01487	-0.00124
P248	Northwest of Subbasin	2007-2019	.01092	0.00091
P257	Southeast of Subbasin	2006-2019	.001461	0.00122



Luhdorff & Scalmanini Consulting Engineers

Land Subsidence Monitoring Locations

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-22

DWR has also published Interferometric Synthetic Aperture Radar (InSAR) results in partnership with the European Space Agency's Sentinel-1A satellite with the data processed by TRE ALTAMIRA[12]. These data present measurements of vertical ground surface displacement between two different dates. InSAR mapping of land surface elevation is particularly useful for complementing high spatial and temporal resolution data at CGPS station locations with observations of land subsidence over a large area for highlighting locations where change is occurring. Throughout most of the Subbasin there has been minimal vertical changes between June 2015 and June 2019 (**Figure 3-22**), vertical measurement accuracy is reported to be about 18 millimeters (0.7in) (DWR 2021). Vertical displacement during this time period was mostly stable, no change to slightly downward with most values ranging from -0.5in to 0.25in in the western portion of the Subbasin. The Delta area (northern and eastern portion of the Subbasin) shows higher vertical displacement that is due to a mechanism that is described below (hydrocompaction). The InSAR data in the vicinity of P256 has a similar vertical displacement (about 0.4in) as observed at P256 during the June 2015 to June 2019 time period.

In the late 1800s to the early 1900s levees were built along stream channels in the delta and the rich land was converted to agriculture (discussed in more detail in **Section 2.1**). However, this caused ongoing land subsidence associated with drainage for agriculture, called hydrocompaction, on islands in the Delta including parts of the ECC Subbasin specifically.

Hydrocompaction is due to dewatering of peat soil that dries out and compresses[13] as a result of land reclamation. This caused many central Delta islands to drop 10 to nearly 25 feet below sea level (USGS, 1999, **Figure 3-23a).** The Delta soils are composed of 1) coarser sediments concentrated near the natural waterways of the Delta and 2) peat from decaying marsh vegetation concentrated near the centers of the islands (up to 60 feet thick in the western Delta). **Figure 3-23b** illustrates the late 1880's freshwater tidal marsh land surface profile (upper diagram) and the current configuration of many islands (lower diagram) that is saucer-shaped due to compacted peat soils in the interior and mineral sediments at their edge. Currently, groundwater levels are maintained on the islands by a network of drains at three to six feet bgs with drainage water pumped back into the stream channels (**Figure 3-23b**). Though this GSP is only required to discuss subsidence due to groundwater withdrawal, understanding of how these Delta islands are constructed improves understanding of interactions between surface water and groundwater in the Delta area.

[12] https://gis.water.ca.gov/arcgisimg/rest/services/SAR

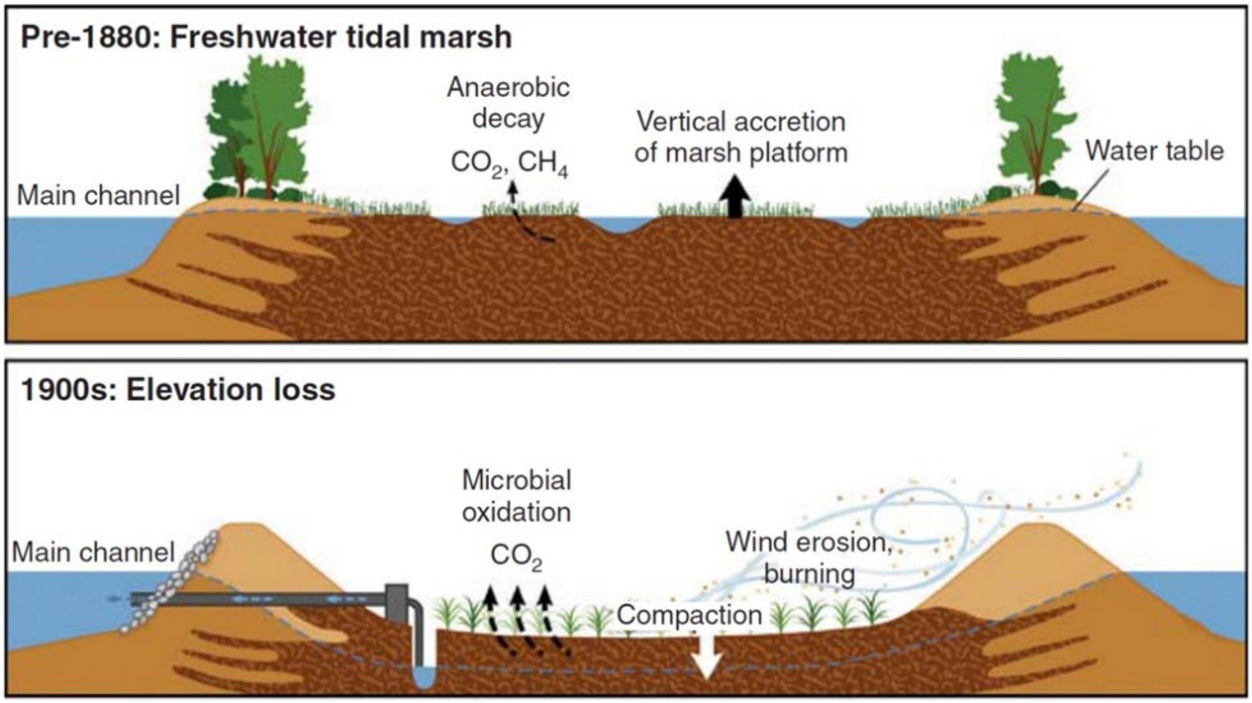
[13] Source: Water Education Foundation, 2020. Can Carbon Credits Save Sacramento-San Joaquin Delta Islands and Protect California's Vital Water Hub? Gary Pitzer, February 27, 2020.

Figure 3-23a. Subsidence on Delta Islands

(California Department of Water Resources)

(source: https://www.usgs.gov/centers/ca-water-ls/science/subsidence-sacramento-san-joaquin-delta?qt-science_center_objects=0#qt-science_center_objects)

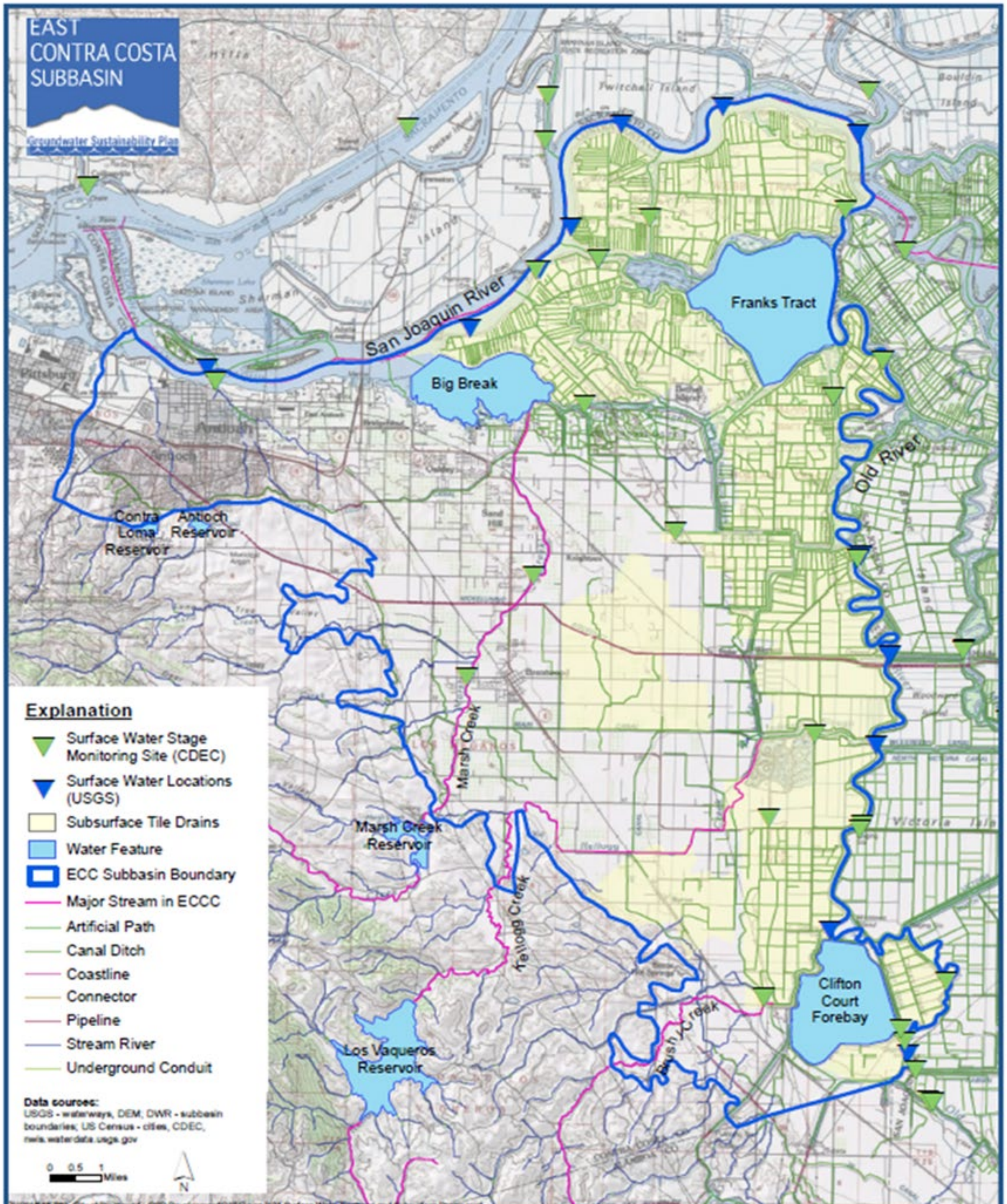
Figure 3-23b. Cross-section of Subsidence and Drains on Delta Island. Source: Mount and Twiss (2005)



3.3.8 Interconnected Surface Water Systems

Interconnected surface water systems are the locations where groundwater and surface water are hydrologically connected. It is important to know where these systems are located in order to minimize impacts of groundwater pumping on the surface water bodies and biological communities that rely on the interconnected water system. The ECC Subbasin is bounded by the San Joaquin River to the north and Old River to the east with an extensive network of canals installed (**Figure 3-10**). Delta islands located in the northern and eastern portion of the Subbasin, as described above, are protected by levees and require excess water that collects in subsurface drains to be discharged to the Delta. **Figure 3-24** identifies the surface water features in the Subbasin and vicinity and illustrates coverage of subsurface tile drains installed at between 5 and 8[14] feet bgs to provide drainage of water to the river. Given this unusual configuration, Old River and the San Joaquin River are considered interconnected rivers and currently or historically, surface water depletions have not occurred along these rivers. In the western portion of the Subbasin a few creeks are present that are considered a natural source of recharge to the Subbasin (**Figure 3-24**) and have the potential to be considered interconnected systems. Marsh Creek, the most prominent, is earthen lined and channelized, and is adjacent to both the City of Brentwood and DWD pumping wells. The Marsh Creek dam passively drains all flows that enter it until the level subsides to the primary spillway level. It may be vulnerable to impacts from the loss of interconnected surface water due to groundwater pumping and groundwater level declines. Currently there is an incomplete understanding of the ECC Subbasin surface water/groundwater connection, but this is expected to be remedied through installation of multiple completion monitoring wells and future monitoring efforts related to this GSP.

[14] As communicated by individual water districts.



Luhdorff & Scalmanini Consulting Engineers

Surface Water Features and Subsurface Drains

Figure 3-24

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

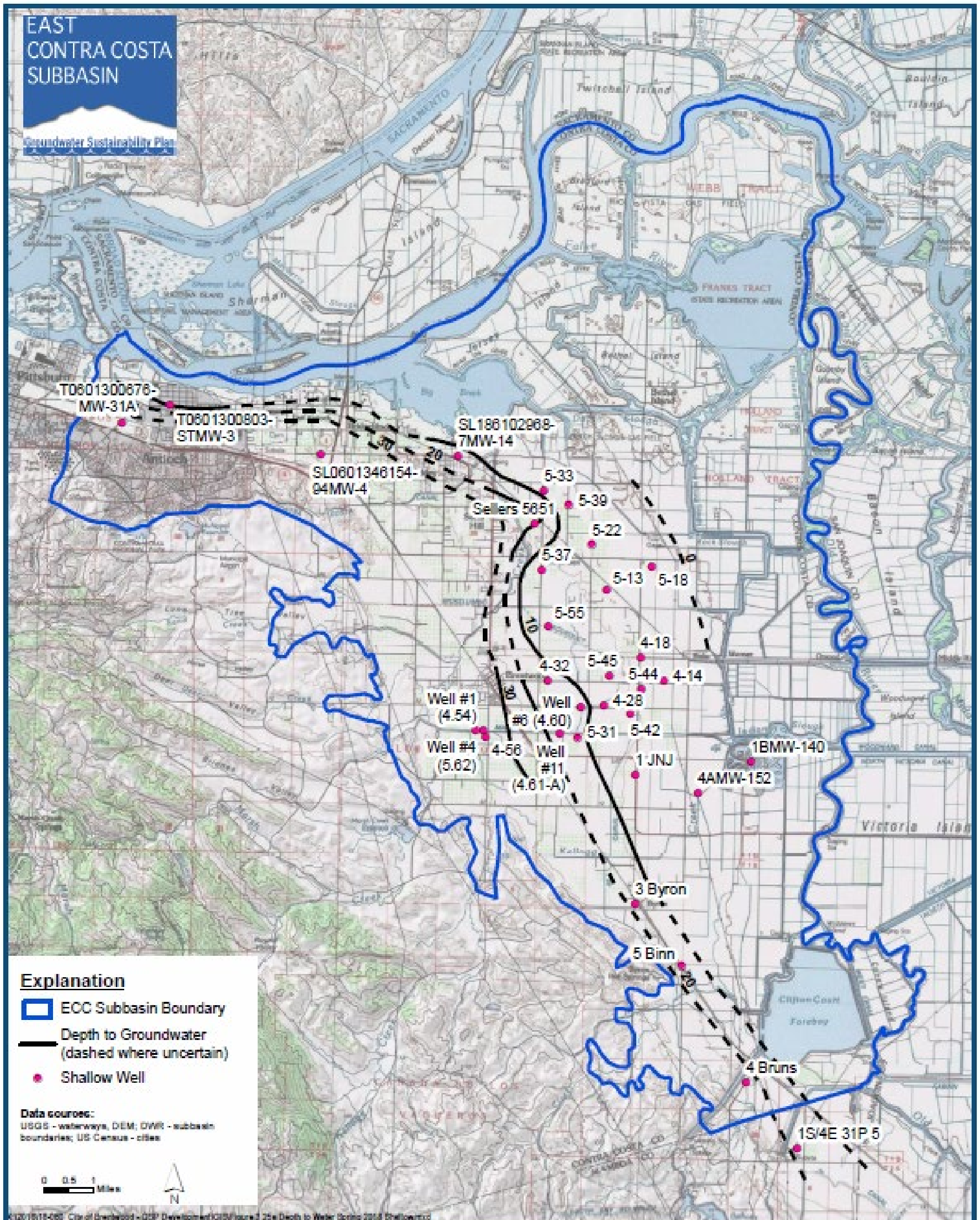
Figure 3-25a is a map illustrating the spring 2018 depth to shallow groundwater in the ECC Subbasin. There is not complete coverage of the Subbasin, but it does present the 30 ft depth to water contour that may represent the point when a stream is no longer considered interconnected to groundwater. Review of the depth to water figure indicates that the majority of the Subbasin may have interconnected surface water and groundwater. Specifically, the San Joaquin River, Old River, and portions of western creeks are likely connected to the groundwater system and there is then potential for regional groundwater pumping to impact groundwater dependent ecosystems (GDEs). **Figure 3-25b** shows the natural and artificial channels in the Subbasin with the most conservative estimates of potential for interconnectivity using 2018 shallow DTW created from subtracting the digital elevation model from groundwater elevation contours. Most of the natural channels in the Subbasin are located in the west of the Subbasin. Marsh Creek however starts to become likely connected with groundwater in Brentwood. Many artificial channels in the eastern part of the Subbasin may exhibit interconnectedness with groundwater as they are commonly located in areas where DTW is less than 10 feet.

3.3.9 Groundwater Dependent Ecosystems

Groundwater dependent ecosystems (GDEs) "refers to ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" outlined in the GSP Emergency Regulations. Each plan is required to identify groundwater dependent ecosystems within the basin, utilizing data available from DWR or the best available information. GSAs are only responsible for impacts to GDEs resulting from changing groundwater conditions resulting from pumping or groundwater management in the Subbasin (TNC, 2019). For example, if groundwater conditions stay the same but GDEs lose access to water due to surface water diversions/depletions, this is not the GSA's responsibility.

GDEs are similarly defined as "the plants, animals, and natural communities that rely on groundwater to sustain all or a portion of their water needs" by The Nature Conservancy (TNC) in the Guidance for preparing Groundwater Sustainability Plans (Rohde et al, 2018). GDEs are an important aspect of the diverse California landscape and are found in nearly all subbasins. The GDEs are diminishing rapidly and largely due to human interference and unsustainable groundwater extraction (Rohde et al, 2018). Water Code Section 10723.2 requires the GSP to identify GDEs and determine how groundwater does or does not affect them. The following section describes the process for identifying the GDEs within the ECC Subbasin and mapping their location.

The Natural Communities Commonly Associated with Groundwater (NCCAG) Dataset was used as a starting point to identify GDEs within the Subbasin. This dataset is compiled from 48 publicly available agencies datasets and was then reviewed by a working group comprised of DWR, TNC, and the California Fish and Wildlife **(Figures 3-26a** and **b)**. The Subbasin GDEs exhibited in **Figures 3-26a** and **b** were compared by the county with local information, and it was concluded that these are the best available data. Further analysis of GDEs in ECC was conducted by identifying areas where depth to groundwater is greater than 30 feet, the general vegetation maximum rooting depth. The assumption was that those areas could be eliminated however, groundwater level monitoring is lacking in some of the western areas of the Subbasin so no changes to Wetland or Vegetation NCCAG Datasets were made. Current land use was also analyzed to determine if the parcel was still a GDE. Using DWR's 2016 Land use data set it was found that 67 acres of vegetation and 18 acres of wetland were no longer classified as native materials and the corresponding GDEs were removed. A total of 13,970 potential GDE acres (11,985 wetlands and 4,304 vegetation with some areas of overlap in the ECC Subbasin) were identified by the NCCAG database and retained for this GSP. Most of these areas are located in the Delta with a few occurring along western creeks. **Table 3-4** includes all species in the ECC Subbasin as identified by TNC. TNC has identified 22 vegetation species and additional category of Not Applicable. The majority of species represent a small percentage of the total GDEs; the largest designation is Not Applicable. **Figure 3-27** identifies critical habitat for species in the ECC Subbasin: Steelhead (threatened), Delta smelt (threatened), and vernal pool fairy shrimp (threatened).

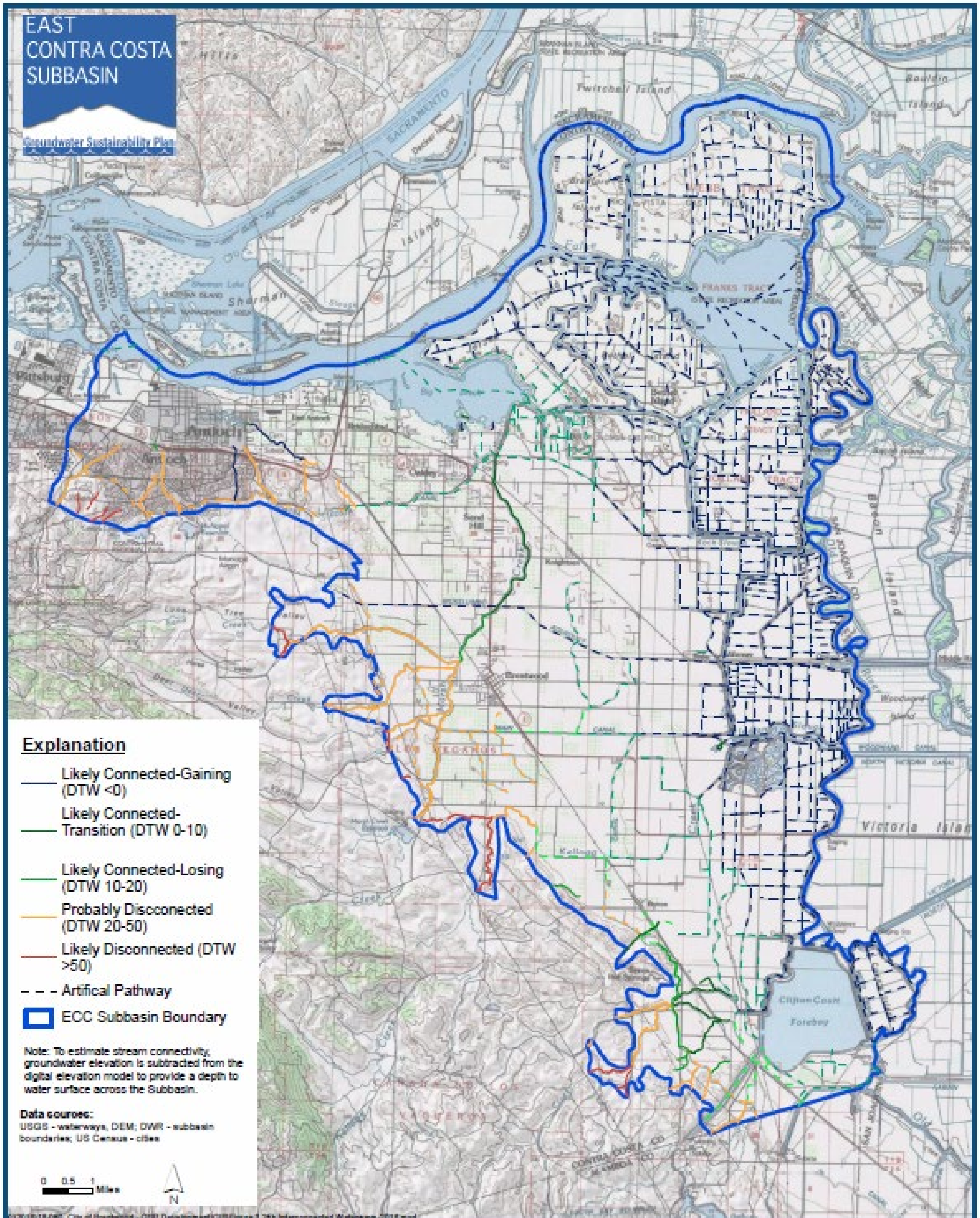


Luhdorff & Scalmanini Consulting Engineers

Depth to Shallow Groundwater- Spring 2018

Figure 3-25a

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

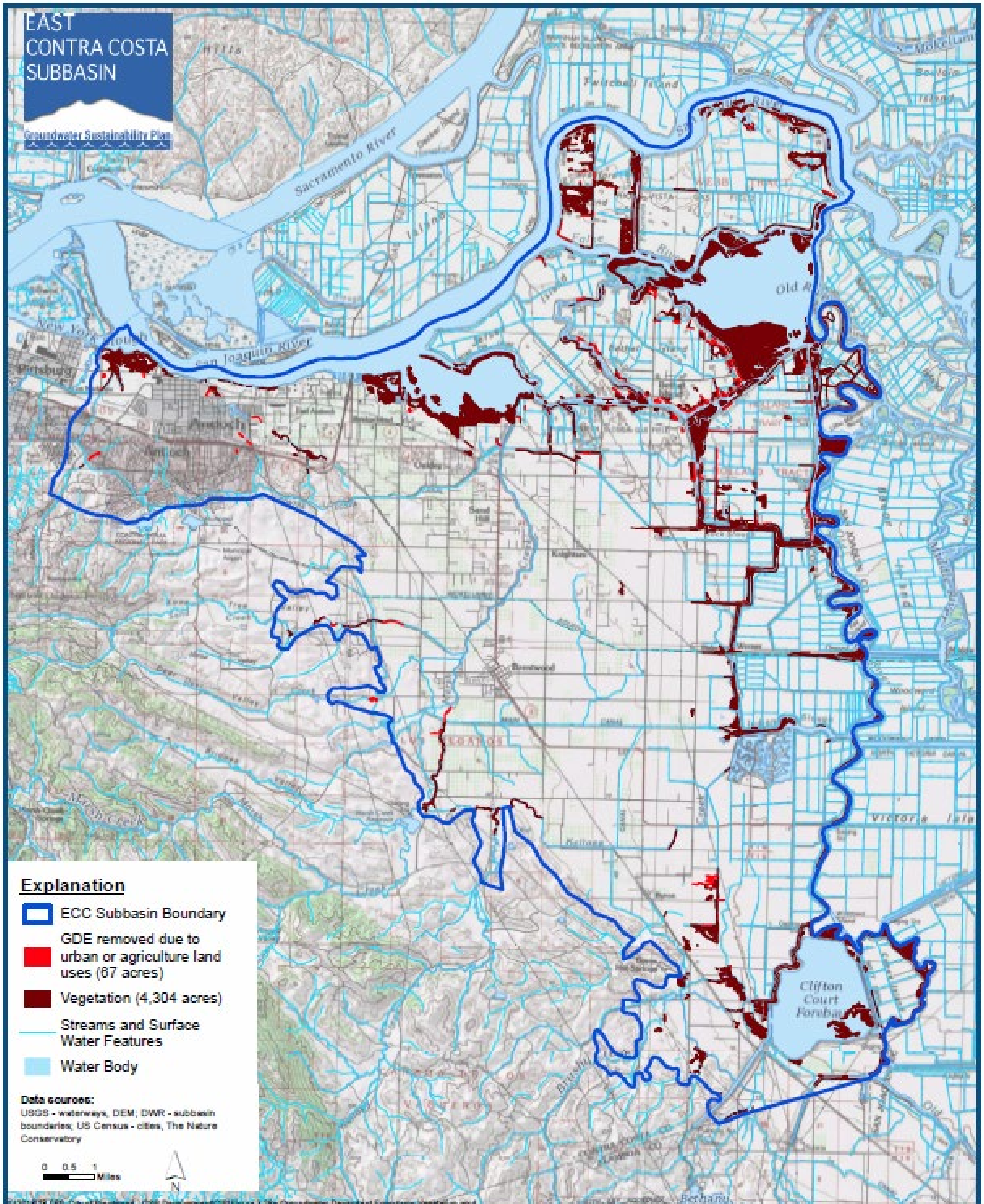


Luhdorff & Scalmanini Consulting Engineers

Interconected Surface Water-
Minumum Depth to Water Spring 2018

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-25b

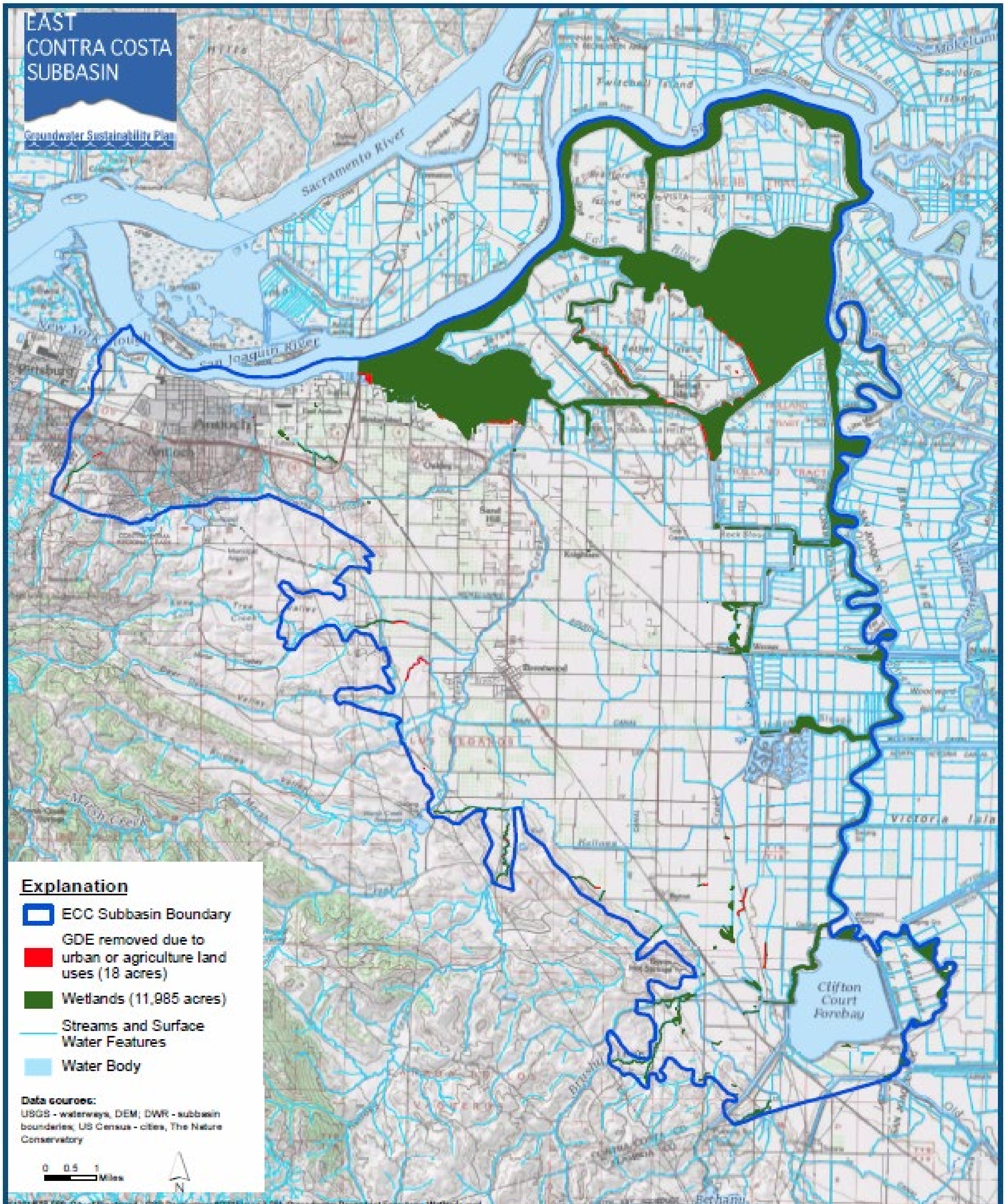


Luhdorff & Scalmanini
Consulting Engineers

Groundwater Dependent Ecosytems-Vegetation

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-26a

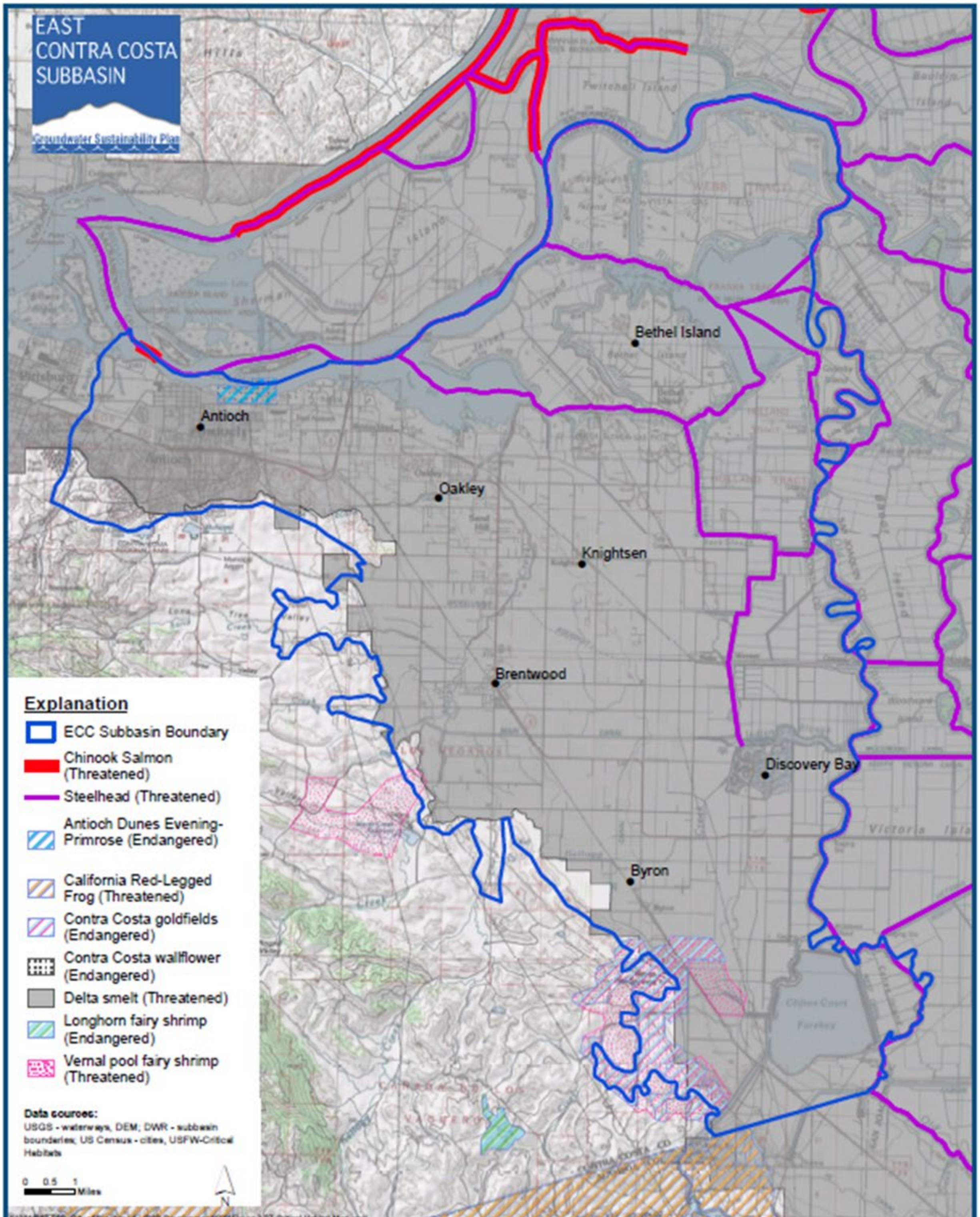


Luhdorff & Scalmanini Consulting Engineers

Groundwater Dependent Ecosytems- Wetlands

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-26b



Luhdorff & Scalmanini Consulting Engineers

Critical Habitat Map

East Contra Costa Subbasin Groundwater Sustainability Plan
Contro Coasta County, California

Figure 3-27

Table 3-4 Vegetation Species in Subbasin

Dominate Species	Percentage of Total Vegetation	Dominant Species	Percentage of Total Vegetation
Arctic Rush	< 1%	Iodine Bush	4%
Arroyo Willow	9%	Narrowleaf Cattail	< 1%
Broadleaf Cattail	1%	Narrowleaf Willow	2%
Broadleaf Pepper-grass	4%	Northern California Black Walnut	< 1%
California Bulrush	7%	Not applicable	37%
California Rose	< 1%	Red Willow	0%
Common Reed	1%	Shrubby Seepweed	1%
Fremont Cottonwood	1%	Three-square Bulrush	< 1%
Giant Reed	< 1%	Tree-of-Heaven	< 1%
Goodding's Willow	10%	Valley Oak	< 1%
Hardstem Bulrush	16%	White Alder	< 1%
Himalayan blackberry	5%	--	--

The Subbasin has multiple GDE areas, mostly in the Delta in the north along the San Joaquin River and the east along the Old River in addition to various canals located in the east. However, these areas have minimum groundwater pumping from mostly domestic wells (**Figure 2-3a**). TODB is wholly reliant on groundwater and has GDEs noted around the town; a shallow zone groundwater monitoring well has been identified as a Data Gap and will be installed as part of this GSP. Brentwood also uses groundwater but no GDEs are noted in the area; however, three shallow zone monitoring wells are part of the monitoring network. Bethel Island has a groundwater production well that is located near GDEs for both wetlands and vegetation, and this also has been identified as a Shallow Zone monitoring well Data Gap. The southern portion of the Subbasin has small areas of GDEs but with no municipal groundwater production; however, this area is also identified as a Shallow Zone monitoring well Data Gap for this GSP.

New projects that include construction of wetlands are in the planning and/or constructions phase and will be added to the GDE maps when completed. They include Dutch Slough Tidal Restoration Project[15] located at the intersection of Marsh Creek and the Delta (managed marsh and tidal), Three Creeks Parkway Project[16] located in Brentwood, and Franks Track State Park[17]. Municipal Water District of Southern California (MWD) owns all or parts of two islands[18] in the Delta area of the ECC Subbasin:

---

[15] Information can be access here: https://water.ca.gov/Programs/Integrated-Regional-Water-Management/Delta-Ecosystem-Enhancement-Program/Dutch-Slough-Tidal-Restoration-Project. Construction to restore 1,200 acres launched in 2018, planting occurred in 2020 and a levee breach is planned for 2021.
[16] Information can be accessed here: https://www.contracosta.ca.gov/5814/Three-Creeks-Parkway-Project
[17] Information can be accessed on Franks Tract Futures here: https://franks-tract-futures-ucdavis.hub.arcgis.com/
[18] Holland and Webb Tracts are owned by Municipal Water District (MWD) that are part of the proposed water storage project call Delta Wetlands Project. Information can be accessed here:

Webb Tract (100% MWD owned) and Holland Tract (75% MWD owned). Originally Webb Tract was slated to be a Reservoir Island to store available water in winter and discharged in summer or fall and 845 acres of Holland Tract was to be wetlands and a dedicated Habitat Island. However, as of September 2020 the islands are projected to continue as farms for at least the next 5 years with no major land use change and MWD is reportedly not pursuing the island storage project[19]. Future updates to the GSP will include refinement of GDE locations in the Subbasin as land use changes.

3.3.9.1 Evaluation of GDE Health

The GDE Pulse dataset, developed by TNC, was also reviewed and evaluated for the Subbasin (Klausmeyer et al., 2019) in relation to GDEs. The GDE Pulse dataset utilizes remote sensing data from Landsat satellites to monitor the health of GDEs by observing how moisture and greenness change over time (Klausmeyer et al., 2019). The most common way to assess the health of the GDEs using remote sensing data is through the Normalized Derived Vegetation Index (NDVI). NDVI is calculated as follows:

$$NDVI = \frac{Near\ Infrared - Visible\ Red\ Light}{Near\ Infared + Visible\ Red\ Light}$$

Calculated NDVI values less than zero indicate unhealthy or dead vegetation, values between zero and 0.1 are most likely barren, values of 0.2 to 0.3 are considered moderate vegetation, and values above 0.6 are very dense and green vegetation (Weier and Herring, 2000). TNC merged the NCCAG and remote sensing datasets together and removed background noises such as clouds and calculated the NDVI yearly average values. According to Klausmeyer et al. (2019), yearly average NDVI values between July 9 to September 7 represent readings during the typically dry months when GDEs would be dependent on groundwater. The yearly average was calculated by finding the medoid, which is “a multi-dimensional feature space median” (Klausmeyer et al., 2019). **Figure 3-28a through Figure 3-28e** illustrates the NDVI changes in the Subbasin for 1997, 2004, 2010, 2015, and 2018. The five years selected show the likely GDEs identified in the Subbasin under a variety of water year conditions ranging from wet (1997, during and after several wet years), dry (2004, during and after several dry years), more moderate (2010, above normal after a dry year; 2018, below normal after a very wet year), and critically dry (2015, during and after two critical years).

For evaluating the GDE health in the Subbasin over the last 20 years, NDVI values greater than 0.2 were interpreted to be healthy, based on guidance from Weier and Herring (2000), and values less than 0.2 were interpreted to be unhealthy. The NDVI changes throughout the Subbasin have occurred through many different water year types. NDVI data changed the most in Clifton Court Forebay and the Delta region of the Subbasin. Throughout time the GDE health has changed in several areas of the Subbasin particularly in Franks Tract, but in general GDE health poorer historically compared to recent years. In the earlier periods, larger areas had values of less than 0.2 while, in the more recent surveys (2015 and 2018), the overall health of the vegetation is greater than 0.2. NDVI data along Franks Tract and Clifton Court Forebay appear to be consistently below 0.2; however, in some instances, the values rise 0.2, but other factors could be contributing to this phenomenon. The values of less than 0.2 can be due to the NCCAG

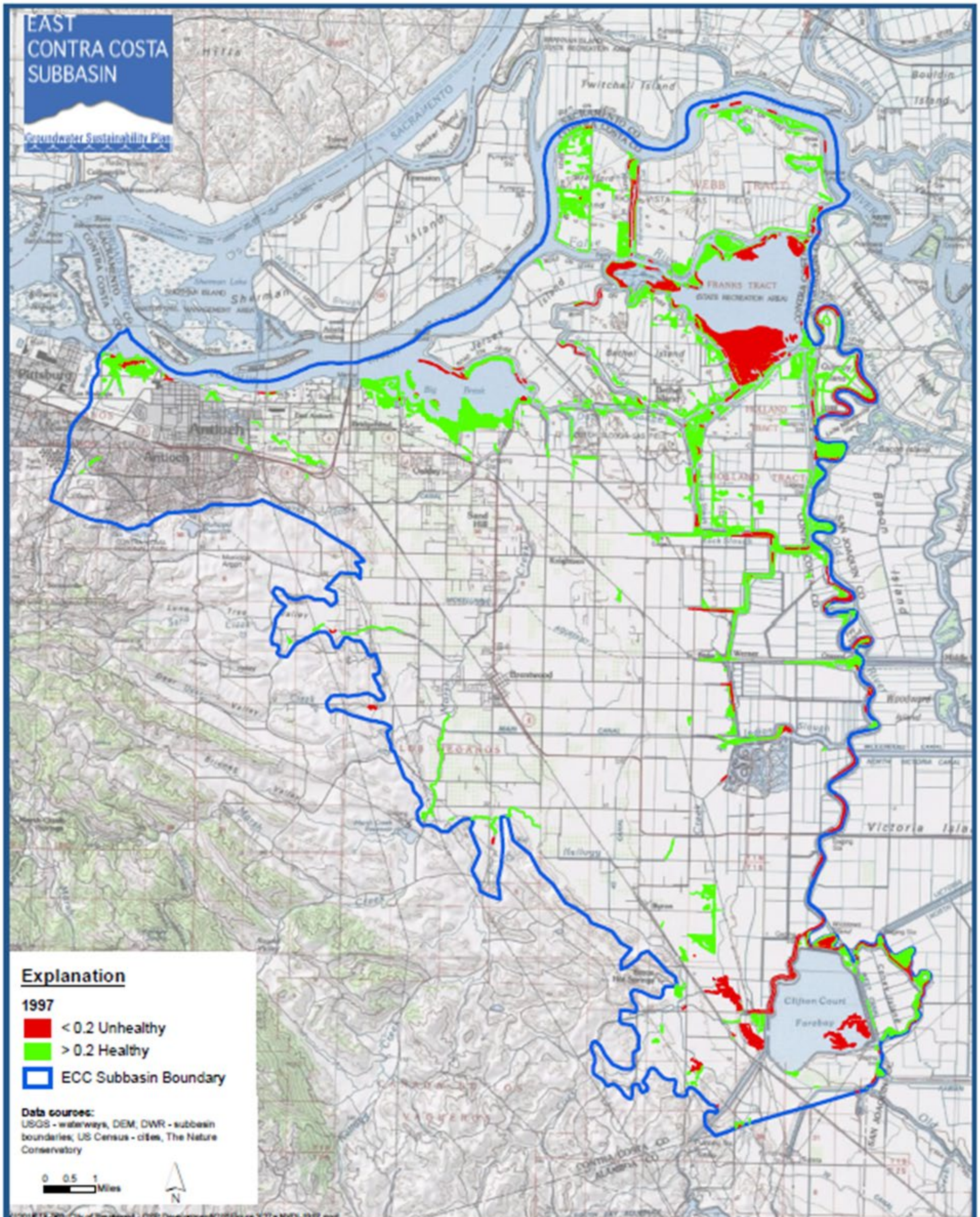
---

https://www.spk.usace.army.mil/Portals/12/documents/regulatory/eis/190109804-eis/190109804-SDEIS/AppendixJ.pdf

[19] Delta Protection Commission meeting, September 17, 2020, report by Stephen Arakawa, MWD, on Delta Islands.

vegetation dataset, which is based on more current conditions and historically vegetation may not have always been present in these areas.

The evaluation of NDVI data suggest that the overall GDE health within the Subbasin has experienced changes but generally remained stable between 1997 and 2018. The greatest periods of stress to GDE communities appears to have occurred during the earliest and later part of the 1997-2018 period, in 1997 and 2018. This could be explained by changes geography in the area, what was historically water channels could presently have vegetation or be considered a wetland. Very few areas of stressed GDE health are evident in 2015, when the groundwater conditions in the Subbasin were at historically low levels because of drought conditions, compared to the moderate 2018 conditions. **Figure 3-28f and Figure 3-28g** shows the NDVI changes throughout the available record (1985-2018) for likely GDE areas along Big Break and Marsh Creek. The NDVI data for communities along Big Break shows a gradual increase in GDE health with the average plotting above 0.2 for the entire record, only a small portion of GDEs plotted below 0.2 in the early part of the record. In Marsh Creek there are limited GDEs identified, and the health has been stable throughout time. These data suggest that overall health of the GDE communities along Big Break and Marsh Creek are healthy with majority of NDVI values above 0.2 and a long-term upward trend (Big Break) and stable healthy conditions (Marsh Creek), suggestive of general improving or stable health conditions between 1985 and 2018.

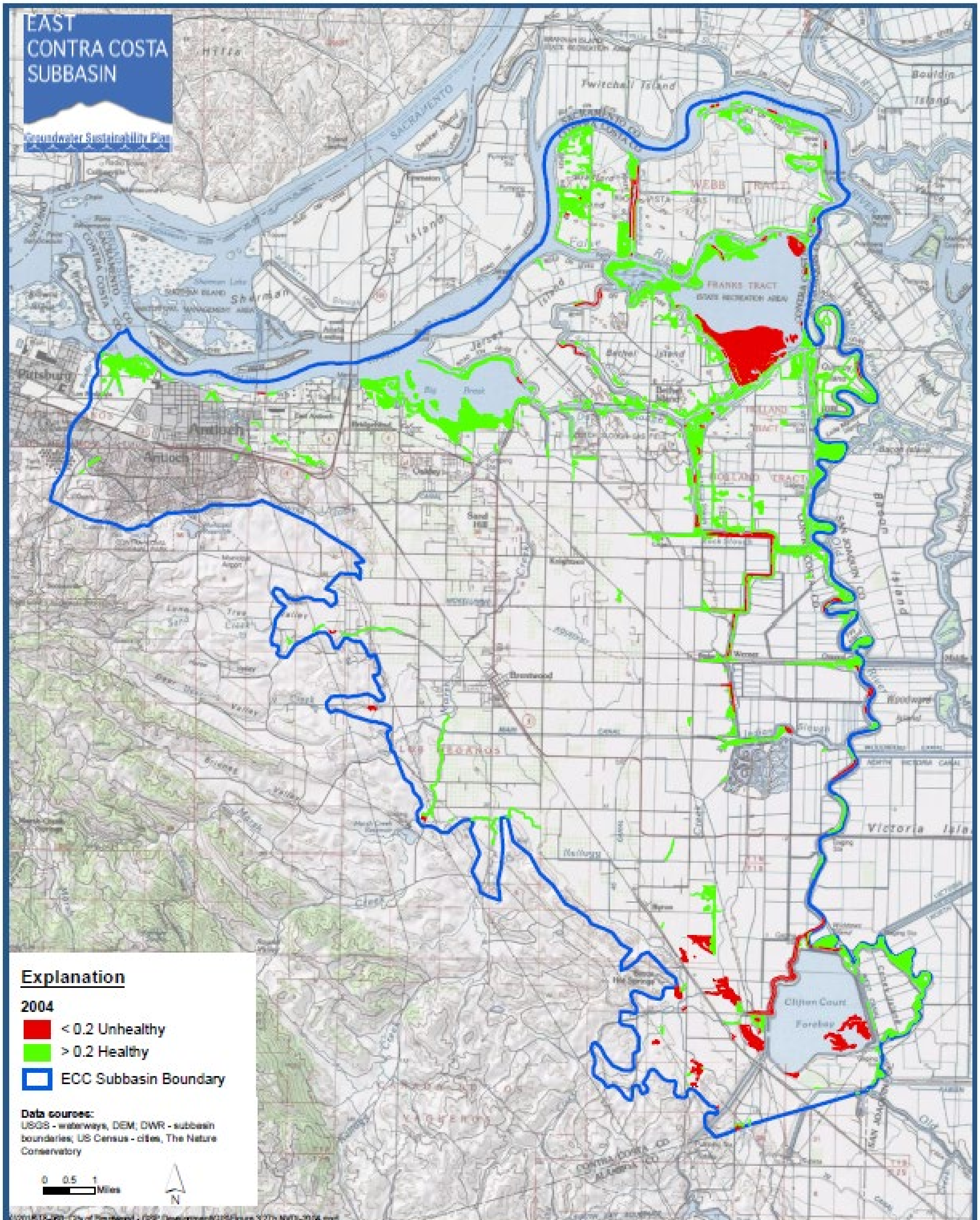


Luhdorff & Scalmanini Consulting Engineers

Normalized Difference Vegetation Index-1997

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-28a

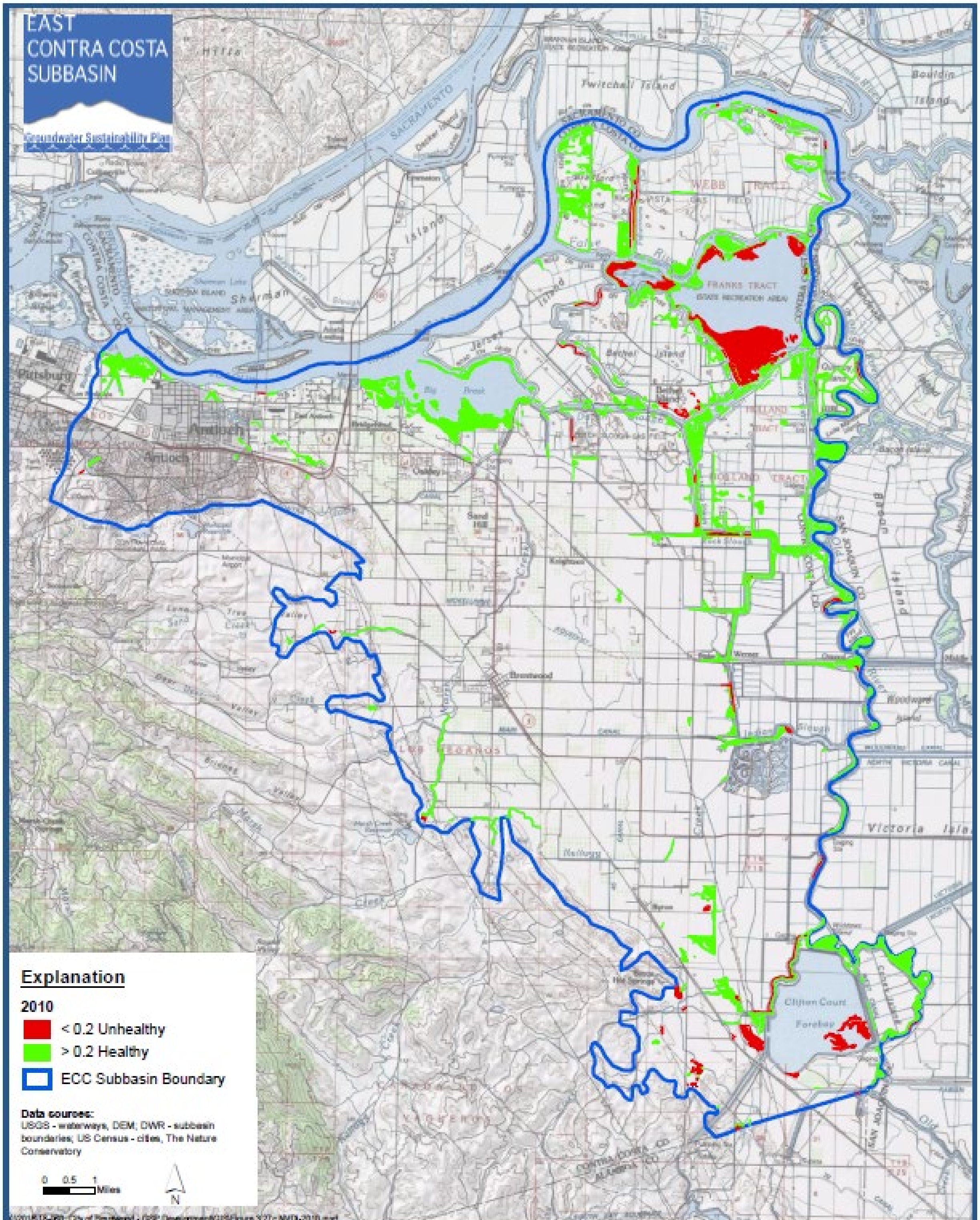


Luhdorff & Scalmanini Consulting Engineers

Normalized Difference Vegetation Index- 2004

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-28b

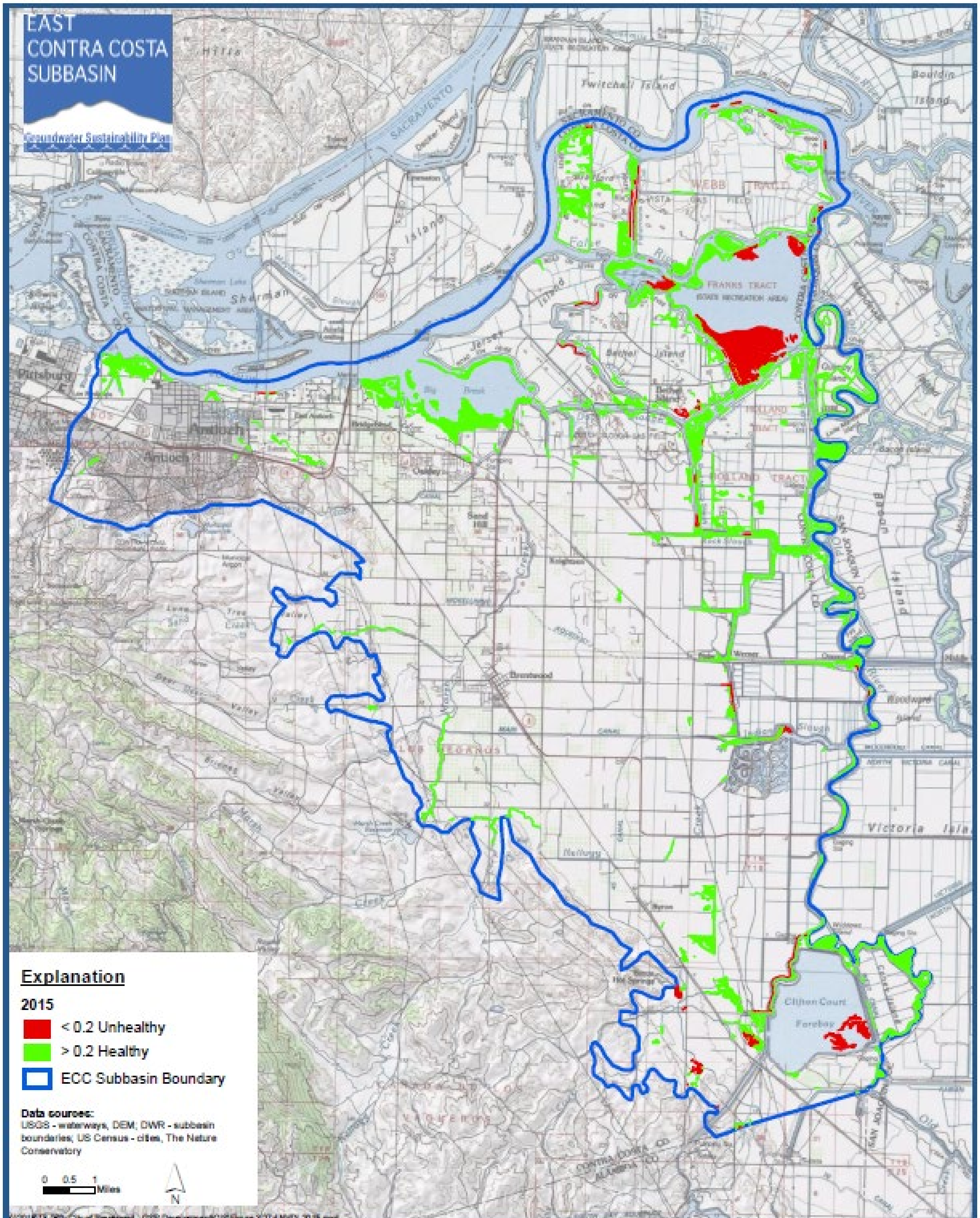


Luhdorff & Scalmanini Consulting Engineers

Normalized Difference Vegetation Index- 2010

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-28c

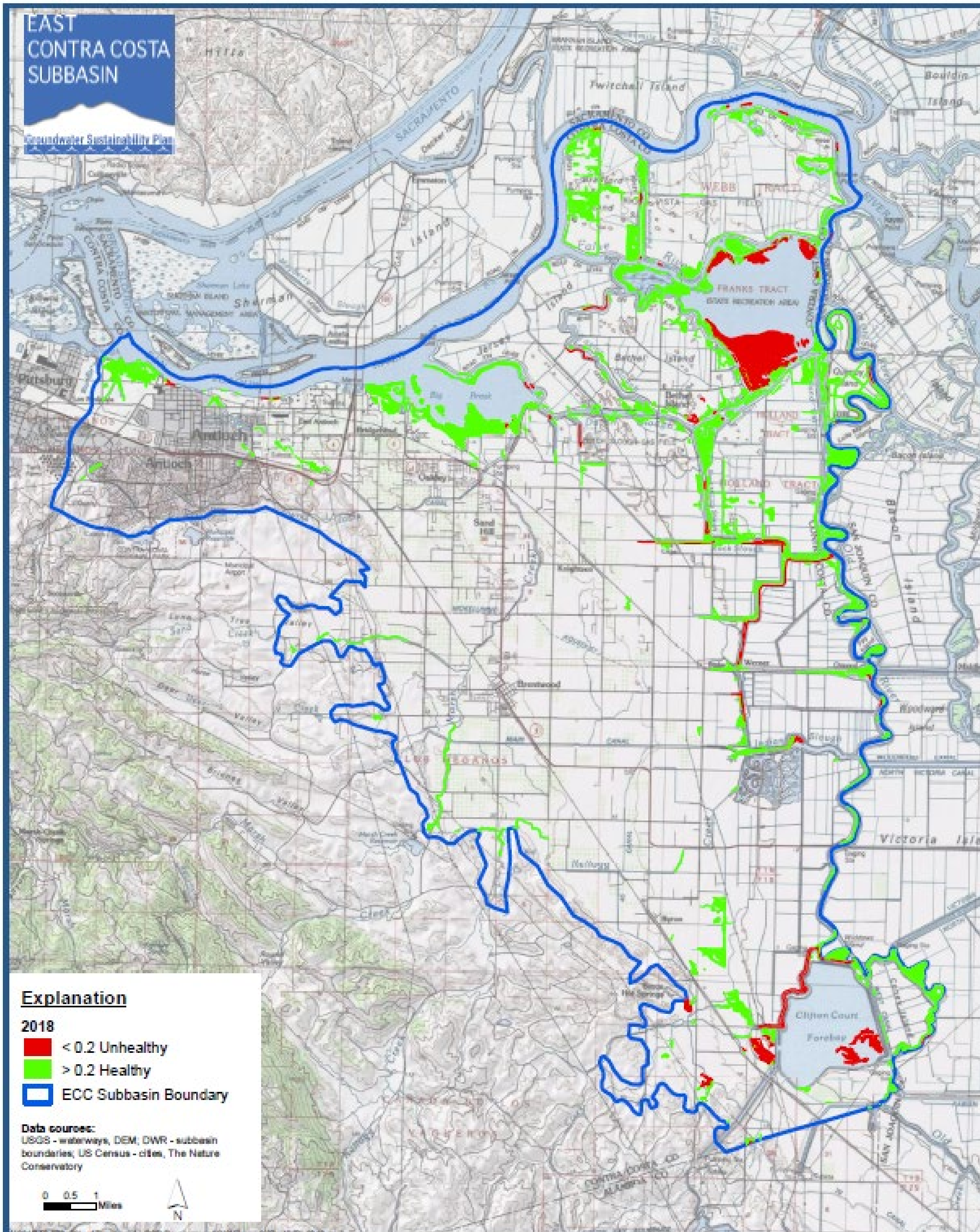


Luhdorff & Scalmanini Consulting Engineers

Normalized Difference Vegetation Index- 2015

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-28d

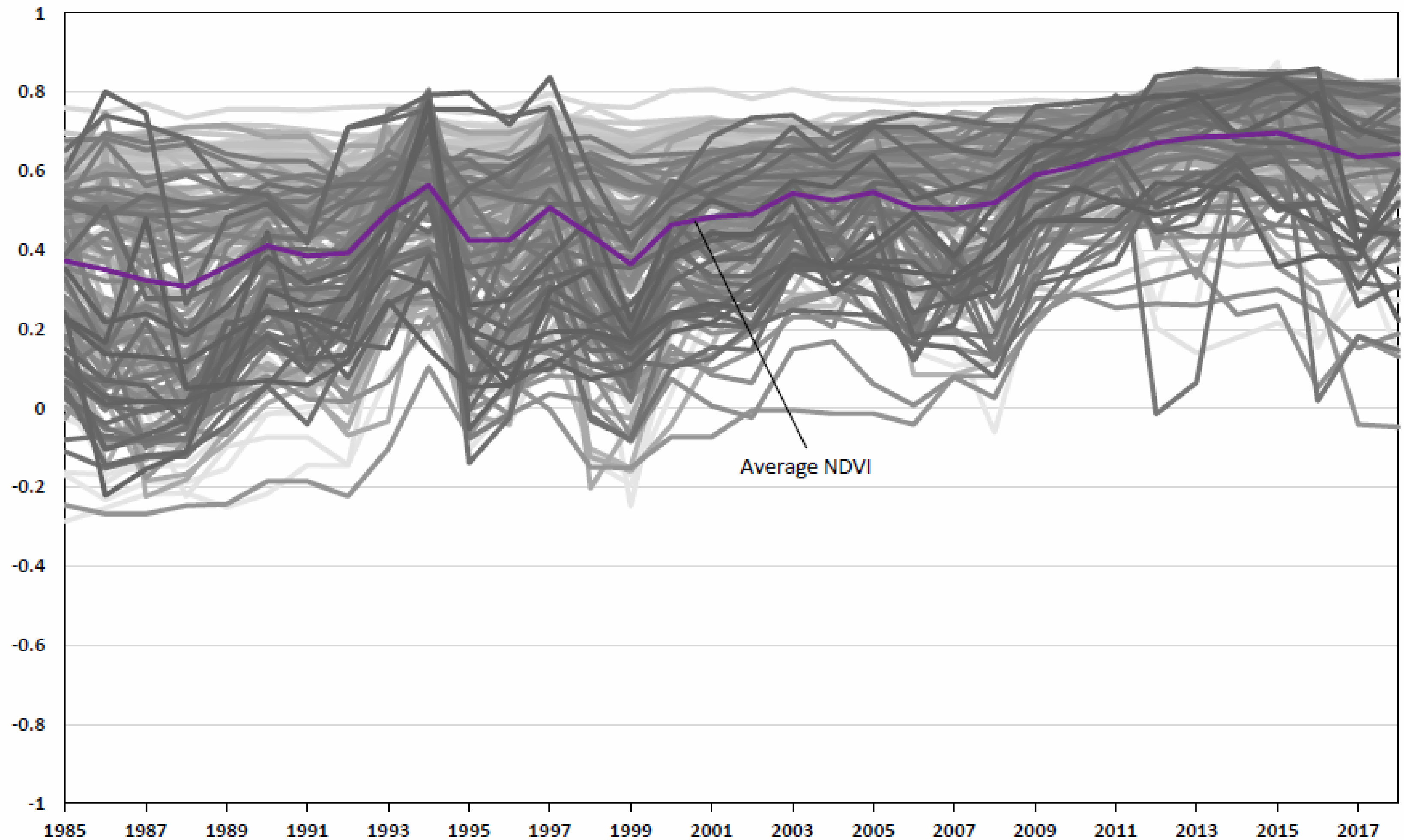


Luhdorff & Scalmanini Consulting Engineers

Normalized Difference Vegetation Index- 2018

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-28e



Data Source: *https://gde.codefornature.org*

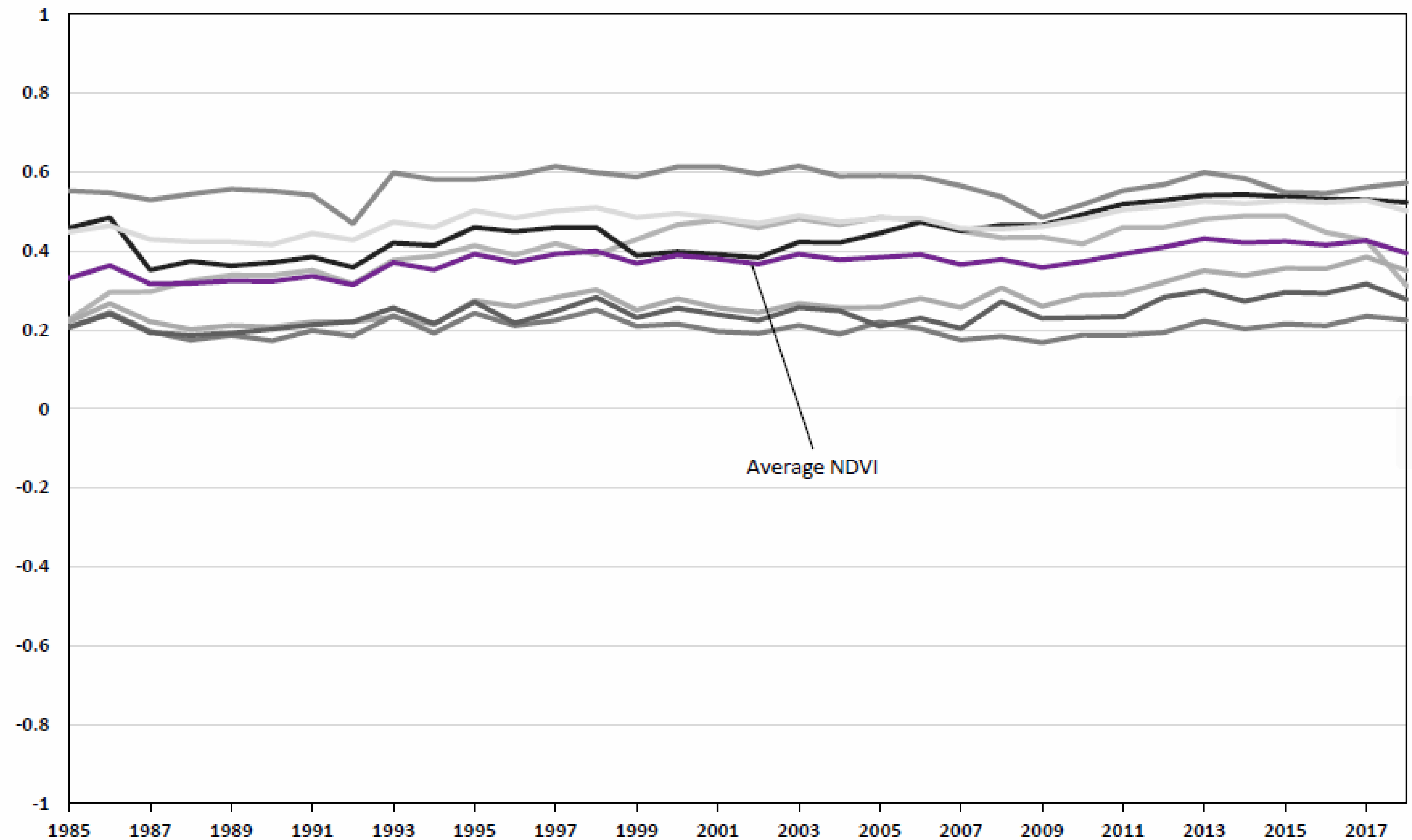
\\server-01\Clerical\2018\18-060 City of Brentwood - GSP Development\REPORT\Figures\Figure 3-27f Big Break NVDI.xlsx

Luhdorff & Scalmanini Consulting Engineers

Normalized Difference Vegetation Index- Big Break

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-28f



Data Source: *https://gde.codefornature.org*

\\server-01\Clerical\2018\18-060 City of Brentwood - GSP Development\REPORT\Figures\Figure 3-27f Marsh Creek NVDI.xlsx

Luhdorff & Scalmanini Consulting Engineers

Normalized Difference Vegetation Index- Marsh Creek

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 3-28g

3.4 Summary

Basin Setting

- ECC Subbasin is bounded on the north, east, and south by the Contra Costa County line, which is contiguous with the San Joaquin River (north) and Old River (east). In the west, the Subbasin is bounded by marine sediments of the Coast Range.
- Topography and geological formations gently slope to the northwest. The upper 400 feet of Subbasin sediments is comprised of alluvial deposits with discontinuous clay layers interspersed with more permeable coarse-grained units.
- The ECC Subbasin aquifer system is divided into the upper unconfined Shallow Zone (to about 150 ft bgs) and a lower semi-confined to confined Deep Zone (the Corcoran Clay is not present in the Subbasin). Most water wells are constructed within the upper 400 feet.

Groundwater Conditions

- Groundwater levels in the ECC Subbasin are stable which indicates that the Subbasin is being operated within its sustainable yield. This is due to surface water being the major supply source for agricultural and urban uses. Groundwater flow direction is generally from the southwest to the northeast toward the Delta.
- Groundwater quality is generally good with no restrictions for agricultural or urban uses in the Subbasin. Constituents of concern are TDS, chloride, nitrate as N, and boron which all have natural sources with the exception of nitrate. TDS concentrations in both the Shallow Zone and Deep Zone are generally stable and average 1,100 mg/L, around the SMCL of 1,000 mg/L. Chloride is another indicator of salinity and averages around 230 mg/L which is near the SMCL of 250 mg/L. Nitrate levels are primarily below the MCL of 10 mg/L, with slightly elevated concentrations in the Shallow Zone around Brentwood due to past land uses. Boron does not have a drinking water standard, but the agricultural goal is 700 ug/L where some crops may become sensitive to it. Boron concentrations in ECC wells are generally over 1,000 ug/L.
- Groundwater Storage: the total volume of groundwater in storage in the Subbasin was estimated to be between 4.5 MAF and 9 MAF when measuring to the base of fresh water (to over 1,000 ft bgs) and between 1.5 MAF to 3 MAF when measuring the current production zone (to average of 300 ft bgs). There has not been a change in groundwater storage overtime because groundwater levels between 1993 to 2019 have been stable.
- Land Subsidence: there are no historical records of inelastic subsidence due to groundwater withdrawal in the ECC Subbasin.
- Seawater Intrusion: the East Contra Costa Subbasin is located in the Bay-Delta with the potential for interactions between saline baywater and shallow groundwater. While the baywater is fresh, intrusion may be of concern if saline water infiltrates the Delta and intrudes into shallow groundwater. This potential mechanism may be triggered or exacerbated by sea level rise. There are no direct connections between ocean seawater and groundwater in the Subbasin.

- Interconnected Surface Water: are locations where groundwater and surface water are hydrologically connected. The San Joaquin River and Old River are considered interconnected rivers in this Subbasin. Impacts on these surface water bodies due to groundwater pumping will be managed under this GSP to minimize stream depletion.
- Groundwater Dependent Ecosystems: potential GDEs are identified and GDE health is stable or improving.

3.5 References

Anderson, R. 1985. Geological Society, London, Special Publications, 18, 31-47, 1 January 1985, https://doi.org/10.1144/GSL.SP.1985.018.01.03.

Bartow, J.A. 1985. Map showing Tertiary stratigraphy and structure of the Northern San Joaquin Valley, California, Field Studies Map MF-1761, Scale 1:250,000.

Bartow, J.A. 1991. The Cenozoic Evaluation of the San Joaquin Valley, California. U.S. Geological Survey, Professional Paper 1501.

Berkstresser, C.F., Jr. 1973, Map showing base of fresh ground-water, approximately 3,000 micromhos, in the Sacramento Valley and Sacramento-San Joaquin Delta, California: U.S. Geological Survey Water-Resources Investigations Report 40-73, 1 sheet.

Bertoldi, G., Johnston, R., and Evenson, K.D., 1991, Regional Aquifer-System Analysis-Central Valley, California: U.S. Geological Survey Professional Paper 1401-A.

Davis, T.A., Bennett, G.L., Metzger, L.F., Kjos, A.R., Peterson, M.F., Johnson, J., Johnson, T.D., Brilmyer, C.A., and Dillon, D.B., 2018, Data analyzed for the preliminary prioritization of California oil and gas fields for regional groundwater monitoring: U.S. Geological Survey data release, https://doi.org/10.5066/F7FJ2DV3.

Deverel, S.J., Ingrum, T. Leighton, D. (2016). Present-day oxidative subsidence of organic soils and mitigation in the Sacramento-San Joaquin Delta, California, USA. Hydrogeology Journal. Distributed under the Creative Commons Attribution 4.0 International License. http://creativecommons.org/licenses/by/4.0/.

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

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

DWR. 2017. Draft Best Management Practices for the Sustainable Management of Groundwater, Sustainable Management Criteria BMP. November 2017.

DWR. 2021. Vertical Displacement TRE ALTAMIRA Annual Rate June 2015 to June 2019. https://gis.water.ca.gov/arcgisimg/rest/services/SAR. Accessed May 2021.

GeoTracker. 2018. GeoTracker Cleanup Sites. https://geotracker.waterboards.ca.gov/datadownload

ECCC IRWM. 2019. https://www.eccc-irwm.org/east-county-irwm

Hydrofocus Inc. 2014. Dutch Slough Restoration Area Surface Water Quality Monitoring Report, September 2012 to August 2013. April 11, 2014. 228 pages.

Klausmeyer, Kirk R., Tanushree Biswas, Melissa M. Rohde, Falk Schuetzenmeister, Nathaniel Rindlaub, Ian Housman, and Jeanette K. Howard. 2019. GDE Pulse: Taking the Pulse of Groundwater Dependent Ecosystems with Satellite Data. San Francisco, California. Available at https://gde.codefornature.org.
Luhdorff and Scalmanini, Consulting Engineers. 1999. Investigation of Ground-Water Resources in the East Contra Costa Area. Prepared for East County water entities. March 1999.

Luhdorff and Scalmanini, Consulting Engineers. 2016. An Evaluation of Geologic Conditions East Contra Costa County. Prepared for East Contra Costa County Agencies. March 2016.

Page, R.W.,1973b, Base of fresh ground water (approximately 3,000 micro mhos) in the San Joaquin Valley, California: U.S. Geological Survey Hydrologic Investigations Atlas HA-489.

Rohde, M. M., S. Matsumoto, J. Howard, S. Liu, L. Riege, and E. J. Remson. 2018. Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans. The Nature Conservancy, San Francisco, California.

Town of Discovery Bay Community Services District and Luhdorff and Scalmanini, Consulting Engineers. 2017. 2015 Urban Water Management Plan. Adopted June 21, 2017.

UNAVCO. 2019. UNAVCO's Monitoring Network Map database.
https://www.unavco.org/instrumentation/networks/map/map.html#/Accessed on April 2019.

University of California, Davis (UCD) Department of Agriculture and Natural Resources. n.d. Soil Resource Lab. Soil Agricultural Groundwater Banking Index (SAGBI). https://casoilresource.lawr.ucdavis.edu/sagbi/. Accessed May 2019.

U.S. Geological Survey. 1999. Land subsidence in the United States: Sacramento-San Joaquin Delta. Circular 1182. Pages 83-94.

Weier, John and Herring, David. 2000.Measuring Vegetation (NDVI & EVI).
https://earthobservatory.nasa.gov/features/MeasuringVegetation. Accessed April 2021.

Williamson, A. K., Prudic, D.E., and Swain, L.A., 1989, Ground-water flow in the Central Valley, California, U.S. Geological Survey Professional Paper 1401-D, 127p.

SECTION 4 CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

4. HISTORICAL, CURRENT AND PROJECTED WATER SUPPLY

This section describes the East Contra Costa (ECC) Subbasin land uses, population, and metered historical, current and projected water supplies. Water supply amounts were provided by the Groundwater Sustainability Agencies (GSA) and Contra Costa Water District (CCWD). When historical or projected water supply were not provided, land uses and population data was used to estimate these data. This information is integrated into the Subbasin surface water/groundwater model (GSP **Section 5**).

4.1 Land Uses

Department of Water Resources Land Use Surveys

Since the 1950s, DWR has periodically conducted detailed and high-quality land use surveys. The project began as an effort to understand water and land use as well as to understand current and projected water demands. DWR land use surveys conducted in Contra Costa County provide historical land use details of the Subbasin for the years 1976 and 1995 (**Figures 2-11 and 2-10**, respectively). The most current land use conditions for the Subbasin are derived from a Delta crop map for 2015 (**Figure 2-9)** integrated with a 2014 statewide map to fill in areas not covered by the former. The resultant map does not cover the entire Subbasin leaving small areas along the western boundary as not designated, approximately 6,200 acres, which is about 6 percent of the area of the Subbasin. These lands were assigned a land use based on the 1995 land survey and cross-checked with Google earth. The total area of the Subbasin is 107, 596[1] acres.

A breakdown of land use categories reported in historical and current surveys is given in **Table 2-3**. In 1976, native vegetation and field crops were the major land use categories (about 25,000 and 23,000 acres, respectively), which collectively accounted for about 45 percent of the area within the Subbasin. Surface water and pasture (about 14,000 and 13,000 acres, respectively) covered about 25 percent of the land area. After field crops, deciduous trees and truck crops (e.g., melons and tomatoes) were the major cultivated crops (about 12,000 and 8,000 acres, respectively) accounting for about 18 percent of the area. Approximately 9 percent of the area in the Subbasin (about 9,700 acres) was designated as urban areas. The remaining land cover was comprised of semi-agricultural lands, idle lands, and vineyards.

Between 1976 and 1995, acreage of urban lands (**Figure 2-12**) increased to about 19,000 acres (about 18 percent of the Subbasin area). Area of the idle lands increased from about 900 acres in 1976 to 5,800 acres in 1995 (from about 1 percent to 5 percent of the Subbasin area). During this period, both deciduous trees and field crops acreages decreased by about 5,700 and 5,000 acres, respectively. Decrease of pasture, native vegetation and truck crops were about 1,900, 1,600 and 950 acres, respectively. Acreages of the other land use categories remained nearly unchanged during this period.

In 2015, the total area of urban lands was about 23,500 acres (22 percent of the Subbasin area), making it the largest single land use category within the Subbasin. Native vegetation coverage was about 15,500 acres (14 percent of the Subbasin area), which was a decrease of about 9,500 acres from 1995. A part of this decrease, approximately 4,000 acres may be attributed to the lands that were designated as native vegetation in previous surveys but categorized as "Not Designated" in the 2015 survey. Pasture and surface water bodies each covered about 14 percent of the Subbasin area (each about 15,000 acres). The

[1] The California Department of Water Resources ECC subbasin boundary shape file was used to calculate the area in GIS based on the map projection.

total area of all crop lands was about 23,000 acres (21 percent of the Subbasin area) in 2015. Field crops, which accounted for about 13,500 acres (13 percent of the Subbasin area) was the major crop category, and it showed a decrease of about 4,700 acres from 1995. Areas of truck crops, deciduous trees and vineyards totaled about 9,400 acres (about 9 percent of the Subbasin area). Semi-agricultural lands, which include farmsteads, feed lots (livestock and poultry), and dairies, increased from about 900 acres in 1995 to 6,300 acres in 2015 (6 percent of the Subbasin area). These figures indicate a transition from a predominantly agricultural area of field crops and other deciduous crops to a roughly even split between urban and agriculture. Within the Subbasin, a large area of native vegetation has been preserved over the time period evaluated (15,000 acres in 2015).

The current Contra Costa County General Plan (CCC, 2005) extends until 2020. The county is presently working to develop its 2040 General Plan that will outline the planned land use for the unincorporated areas of the subbasin. The 2040 General Plan is expected to be available in late 2020.

Farmland Mapping and Monitoring Program – Land Use Information

California Department of Conservation, Division of Land Resource Protection, Farmland Mapping and Monitoring Program (FMMP) has reported on the ECCC Subbasin land use. Land use data for the Subbasin has been recorded since 1984 on a biannual basis. The FMMP has designated the following eight types of land use:

1. Prime Farmland- Irrigated land with the best combination of physical and chemical features able to sustain long term production of agricultural crops. This land has the soil quality, growing season, and moisture supply needed to produce sustained high yields. Land must have been used for production of irrigated crops at some time during the four years prior to the mapping date.
2. Farmland of Statewide Importance- Irrigated land similar to Prime Farmland that has a good combination of physical and chemical characteristics for the production of agricultural crops. This land has minor shortcomings, such as greater slopes or less ability to store soil moisture than Prime Farmland. Land must have been used for production of irrigated crops at some time during the four years prior to the mapping date.
3. Unique Farmland- Lesser quality soils used for the production of the state's leading agricultural crops. This land is usually irrigated but may include non-irrigated orchards or vineyards as found in some climatic zones in California. Land must have been cropped at some time during the four years prior to the mapping date.
4. Farmland of Local Importance- These lands (the Antioch area and the Delta) are typically used for livestock grazing. They are capable of producing dryland grain on a two-year summer fallow or longer rotation with volunteer hay and pasture. The farmlands in this category are included in the U.S. Natural Resources Conservation Service's Land Capability Classes I, II, III, and IV, and lack some irrigation water.
5. Grazing Land- Land on which the existing vegetation is suited to the grazing of livestock. This category is used only in California and was developed in cooperation with the California Cattlemen's Association, University of California Cooperative Extension, and other groups interested in the extent of grazing activities.
6. Urban and Built-Up Land- Urban and Built-Up land is occupied by structures with a building density of at least 1 unit to 1.5 acres, or approximately 6 structures to a 10-acre parcel. Common examples

include residential, industrial, commercial, institutional facilities, cemeteries, airports, golf courses, sanitary landfills, sewage treatment, and water control structures.

7. Other land- Land which does not meet the criteria of any other category. Typical uses include low density rural development, heavily forested land, mined land, or government land with restrictions on use.
8. Water- Water areas with an extent of at least 40 acres.

All eight types of land use are present in the ECC Subbasin. The majority of land use has consistently been a type of farmland. Prime farmland has been the highest percentage of land use in the Subbasin since 1984 (**Figure 4-1**). Prime farmland had steady decline from 1984 to 2008 and from 2009 to 2016 the acreage was stable. Since 1984 there has been an increase in urban and farmland of local importance. The data produced by FMMP is not as detailed compared to DWR land use data. FMMP collects its data from aerial images, public review, computer mapping, and field inspections. The data provides the ECC Subbasin an approximation of changes in land use over time that supports DWR land use data findings of increasing urban land and decreasing farmland.

Irrigation Methods

DWR has irrigation data for the 1976 and 1995 land use surveys. The 1995 land use surveys also detail the irrigation method used. About 52 percent of lands in the ECC Subbasin were designated as irrigated in the 1976 survey. That percentage has decreased to about 45 percent in 1995, mainly due to increased urbanization. In the 1995 survey, DWR categorize irrigated lands into four groups based on irrigation methods employed in those lands:

Gravity - Surface Irrigations (most common method in the Subbasin area)

Micro - Low volume irrigation such as drip and micro spray

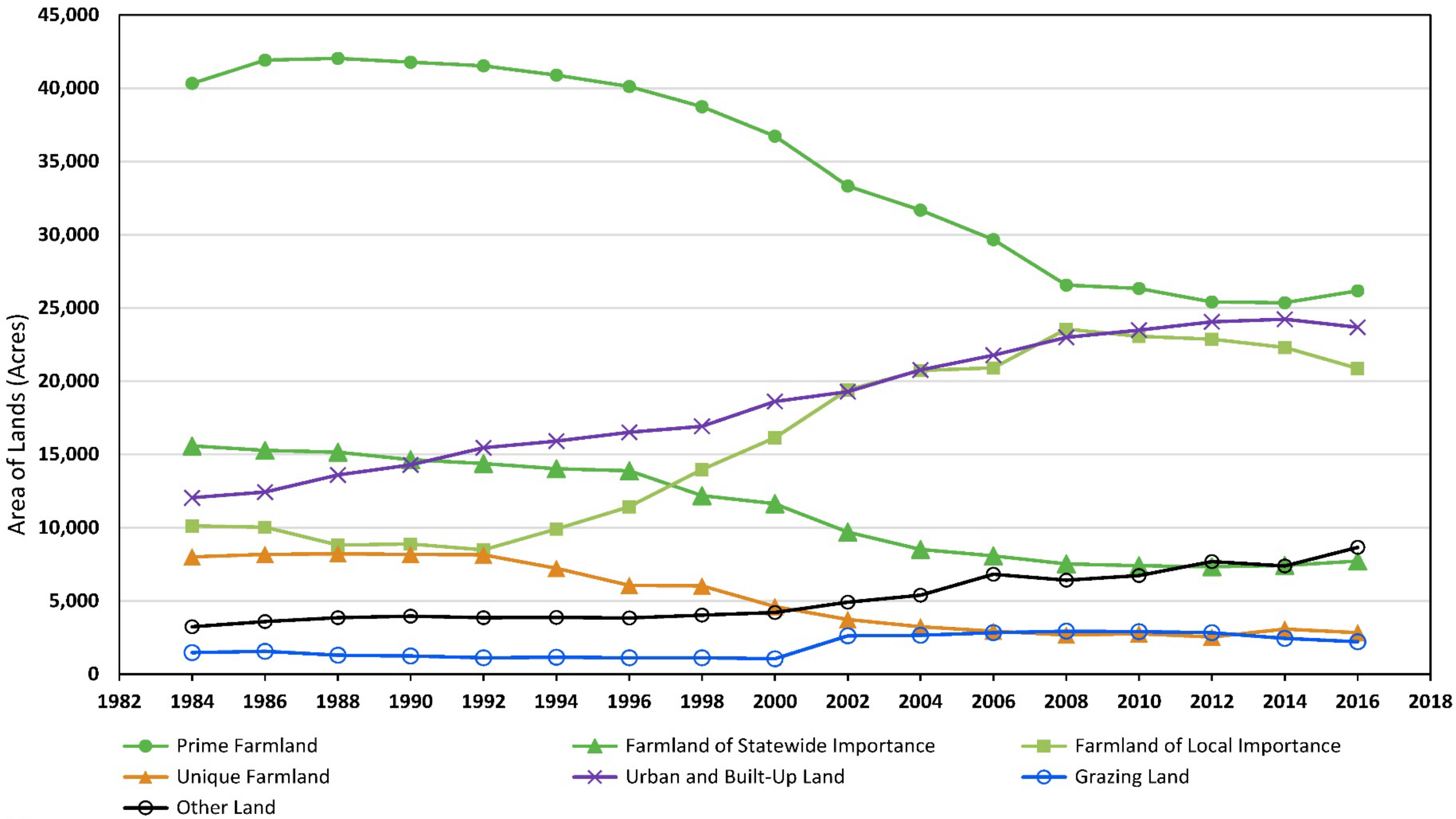
Sprinkler- Permanent, solid set, and movable sprinkler systems

- Irrigation method unknown

The crop map data sets of 2014 and 2015 provided by DWR do not include irrigation details. However, recent information on irrigation methods are available from local agencies that provide irrigation water. Byron Bethany Irrigation District (BBID) reports that in 2014[2] approximately 50 percent (3,100 acres) of irrigated lands in its service area uses drip and micro-spray methods (BBID, 2017 AWMP). Flood irrigation and sprinklers are used in about 39 percent and 11 percent of irrigated lands, respectively.

Drip and micro-spray methods are the primary irrigation methods in the ECCID service area (personal communication, Aaron Trott, August 2020).

[2] Since 2016, and in response to drought conditions, the percent of irrigated lands using drip and micro-spray methods has increased to nearly 90 percent, mostly a switch from prior flood irrigation methods.



Data Source:
California Department of Conservation, Division of Land Resource Protection, Farmland Mapping and Monitoring Program

\\server-01\Clerical\2018\18-060 City of Brentwood - GSP Development\REPORT\Figures\Figure 4-1 Land Use Summary.xlsx

Luhdorff & Scalmanini
Consulting Engineers

Change in Land Use 1984 - 2016

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 4-1

4.2 Population Trends

The East Contra Costa County region has exhibited increasing population growth over time (ECCC IRWMP, 2019). The Cities of Antioch, Brentwood, Oakley and the unincorporated communities of Town of Discovery Bay, Bethel Island, Byron, and Knightsen located within the ECC Subbasin have exhibited an increasing trend of population at variable rates. Parts of Antioch and Brentwood are located outside the ECC Subbasin. Therefore, in the following discussion, population of those two cities are proportioned based on the area located within the Subbasin (74 percent of the City of Antioch and 90 percent of the City of Brentwood). The comparatively smaller populations in rural areas in the Subbasin (i.e., outside the boundaries of cities, towns, and service areas of public water supply entities) are uncertain and are not included in the estimates presented in this discussion.

Historical, current, and projected populations of the cities and unincorporated communities are given in **Table 4-1** and shown in graphical form in **Figure 4-2**. Populations for 1950 through 2010 are based on the US decennial census data. Estimated population of 2015 through 2040 are based on the projections presented in 2015 Urban Water Management Plans (UWMP) of City of Antioch, City of Brentwood, and the Diablo Water District, as well as the Town of Discovery Bay 2020 Draft UWMP (population of 2020-2045) and the City of Antioch 2020 Water System Master Plan Update Technical Memorandum (Brown and Caldwell, 2020), and the DWD 2020 Facilities Plan (CDM Smith, 2020). Projections for 2045 and 2050 were obtained by applying the countywide population growth rate provided in CA Department of Finance Population Projections as detailed below.

According to the US census data, the total population within the ECC Subbasin in 2010 was about 176,000. Population in the Cities of Antioch, Brentwood and Oakley were about 75,500, 46,300 and 35,400, respectively. In unincorporated communities, the Town of Discovery Bay (TODB) had the highest population (about 13,400) and the other three communities had a combined population of about 5,000. Historical data show that the population of the Cities of Antioch, Brentwood and Oakley increased at a rapid rate (112 percent, 426 percent, and 800 percent, respectively, or 198 percent in their combined areas, from 1980 to 2000 (**Figure 4-2**). The growth rate has decreased since then but remained higher than the overall growth rate of Contra Costa County (49 percent in the three cities in the ECC Subbasin versus 22 percent in the County). The eastern region of the County in which the Subbasin is situated "is expected to be the fastest growing area of the County in the foreseeable future" (ECCC IRWMP, 2019). As the Cities reach the build-out population limits in 2040, growth is expected to continue but at a slower rate. This post-2040 slower growth rate was the basis to apply the countywide growth rate to estimate the 2045 and 2050 population given in **Table 4-1**. The total population in the Subbasin is expected to increase to about 264,000 in 2040 and 279,000 in 2050, which correspond to increases of 50 percent and 59 percent compared to 2010 population **(Table 4-1**). For these same time periods, the countywide population has an expected growth rate of 27 percent (2040) and 32 percent (2050) relative to 2010 population (Department of Finance Population Projections, 2019).

Table 4-1 Historical, Current and Projected Population

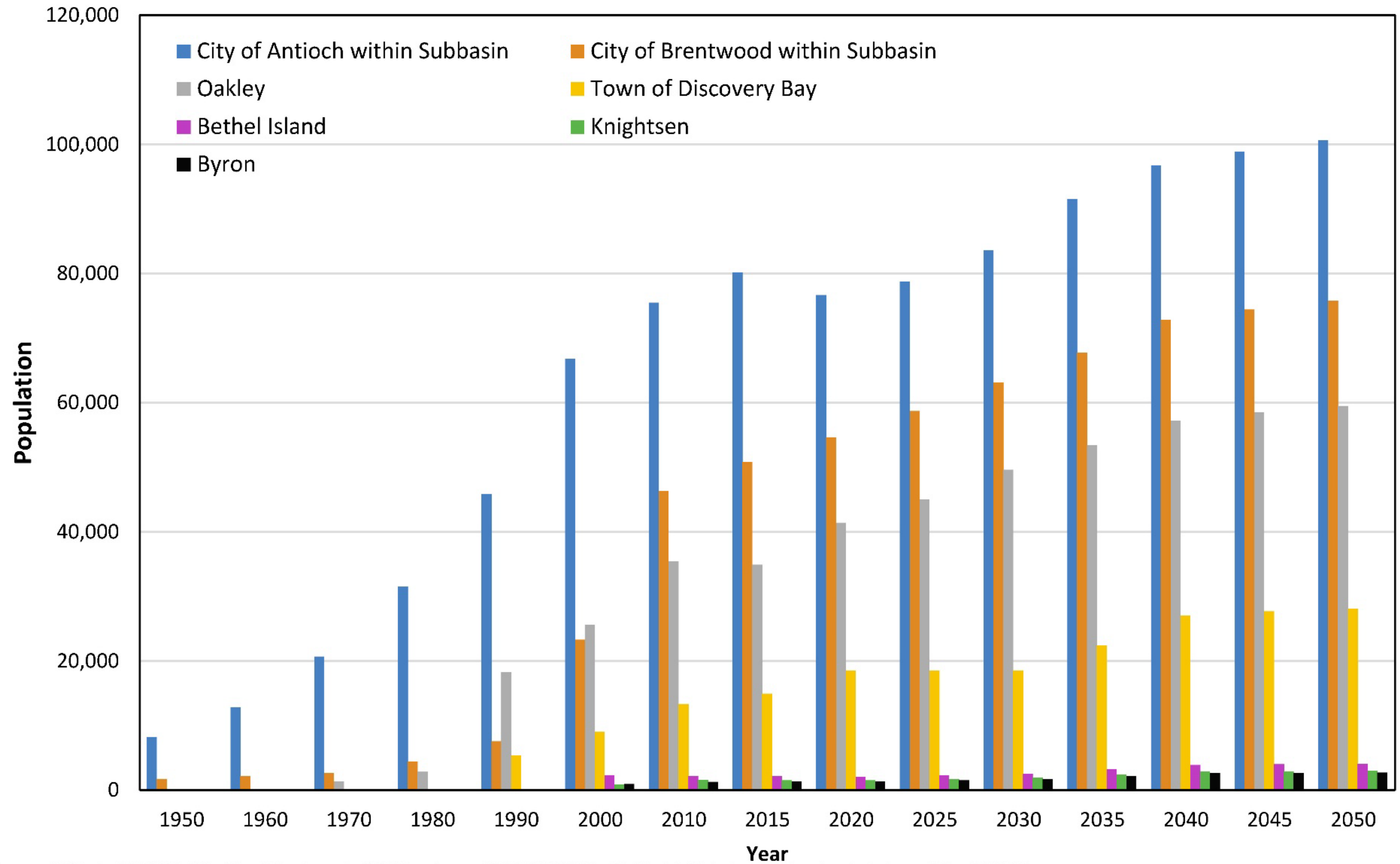
Year	Population within ECC Subbasin[1]									Entire City Population	
	City of Antioch within Subbasin[2]	City of Brentwood within Subbasin[3]	Oakley	Town of Discovery Bay	Bethel Island	Knight-sen	Byron	Subbasin Total	% increase since 2010	City of Antioch	City of Brent-wood
1950	8,200	1,729						9,929	–	11,051	1,729
1960	12,800	2,186						14,986	–	17,305	2,186
1970	20,700	2,649	1,306					24,655	–	28,060	2,649
1980	31,500	4,434	2,844					38,778	–	42,683	4,434
1990	45,900	7,563	18,225	5,351				77,039	–	62,195	7,563
2000	66,800	23,302	25,619	8,981	2,312	861	916	128,791	–	90,532	23,302
2010	75,500	46,300	35,432	13,352	2,137	1,568	1,277	175,566	0%	102,372	51,481
2015	79,900	50,800	34,900	14,895	2,200	1,500	1,300	185,500	6%	108,298	56,493
2020	76,400	54,600	41,400	15,575	2,000	1,500	1,400	192,900	10%	103,595	60,702
2025	78,600	58,700	45,000	18,600	2,300	1,700	1,500	206,400	18%	106,480	65,225
2030	83,300	63,100	49,600	21,600	2,500	1,900	1,700	223,700	27%	112,960	70,084
2035	91,300	67,800	53,400	24,500	3,200	2,400	2,200	244,800	39%	123,755	75,306
2040	96,500	72,800	57,200	28,300	3,900	2,900	2,600	264,200	50%	130,725	80,917
2045	98,600	74,400	58,500	32,600	4,000	2,900	2,600	273,600	56%	133,600	82,700
2050	100,300	75,800	59,500	33,200	4,100	3,000	2,700	278,600	59%	136,000	84,200

1. Populations of rural areas in the Subbasin are uncertain and not included in this table.
2. Area-weighted adjustments were applied for all years to estimate City of Antioch population within the Subbasin (about 74% of the City's area in the Subbasin).
3. Area-weighted adjustments were applied for 2010 and later years to estimate the City of Brentwood population within the Subbasin (expansion of the City outside the Subbasin was about 10% in and after 2010.

Data Sources

-US Census Bureau (1950 through 2010 population data)

-2015 through 2040 population estimates: 2015 Urban Water Management Plans (City of Antioch, City of Brentwood, Diablo Water District); City of Antioch 2020 Water System Master Plan Update Technical Memorandum; Diablo Water District 2020 Facilities Plan; Town of Discovery Bay Community Services District 2020 Draft UWMP (population of 2020-2045).
-Bethel Island, Knightsen and Byron 2010 and 2015 populations--https://worldpopulationreview.com
-Populations of 2045 and 2050 were estimated applying the countywide growth rates (provided by CA Department of Finance) to 2040 polulations.



\\server-01\Clerical\2018\18-060 City of Brentwood - GSP Development\REPORT\Tables\Table 4-1 Historic current and projected population 2020-08-20_Updated.xlsx

Luhdorff & Scalmanini Consulting Engineers

Historical, Current and Projected Population

East Contra Costa Subbasin Groundwater Sustainability Plan

Figure 4-2

4.3 Water Demands, Supplies and Utilization

The purpose of defining water demand (outflows) and supplies (inflows) is that they contribute to the understanding of the ECC Subbasin water budget. This section describes the groundwater and surface water components of the water budget that are measured (e.g., groundwater pumping and surface water deliveries). Other water budget components will be developed in the groundwater/surface water model described in **Section 5**. A water budget accounts for the total groundwater and surface water entering and leaving a subbasin and are necessary to develop a sustainable water budget for the ECC Subbasin.

4.3.1 Historic and Current Water Supplies

Annual water usage and sources of water supply from 1985 to 2019 by seven entities in the Subbasin are provided in **Tables 4-2 and Table 4-3. Table 4-2** lists annual metered groundwater extracted by water use sector (urban, industrial, and agricultural). Groundwater production by domestic well users (de minimis user) and small community systems are not metered but are estimated and described below. Groundwater use by private agricultural wells and native vegetation are estimated in **Section 4**. **Table 4-3** lists annual metered surface water use for the seven entities by sector and individual surface water diverters with water rights permits. **Table 4-4** lists the total water use by source and water use sector from 1985 to 2019. Projected available supplies and water demand (2020 through 2050) for the seven entities are provided in **Table 4-5**. Below is a description of the seven retail and wholesale water suppliers that operate within the Subbasin, their water rights, and sources of water. Surface water diverted out of Old River for uses outside the ECC Subbasin (e.g., California Aqueduct and the Delta Mendota Canal) does not play a role in supplying water to fulfill the demand of the Subbasin and is therefore not included in the water budget.

Byron Bethany Irrigation District

The BBID service area extends beyond the ECC Subbasin boundaries, into the adjacent Tracy and Delta Mendota Subbasins. Byron and a portion of the Bethany Divisions of BBID are located within the ECC Subbasin. For purposes of this GSP, only the reported Byron Division supply will be used and the small portion of the Bethany Division that falls in the ECC Subbasin will not be estimated. The Byron and Bethany Divisions are served by the District's pre-1914 water rights of 50,000 AFY[3]. Water is obtained from the intake channel at the Harvey O. Banks Pumping Plant located between the Byron and Bethany Divisions and delivered to customers through distribution canals. During normal conditions, water is delivered for agricultural uses from March to November. During drought periods (e.g., 2013-2015) the water delivery period was extended depending on supply and demand conditions.

From 1997 to 2019, the pre-1914 surface water supply to the Byron Division ranged from about 7,000 AF (2017) to 28,000 AF (2009) and averaged about 14,500 AFY (**Table 4-3**). In 2015, during the drought, available surface water was not sufficient to meet water demands of the service area. Byron Division received two additional sources of water: about 2,000 AF purchased (transfer) water and, for the first time in its operational history, BBID obtained about 510 AF of groundwater (3 percent of total supplies) from private well owners in the Byron District. BBID does not maintain records on groundwater use for irrigation by private well owners in the District.

[3] Ch2M, 2017: "The District asserts claims under this pre-1914 water right for reasonable and beneficial use of 60,000 AF. In exchange for operational certainty, the District has agreed to limit their annual diversion from the Delta to 50,000 AF through their Agreement with DWR"

Table 4-2 Groundwater Extractions by Water Use Sector, Historical and Current ECC Subbasin (acre-feet), 23CCR $354.18(b)(3)

Year	Urban and Industrial (metered)			Agricultural (metered)		Total Metered	Unmetered Groundwater			Total Un-metered
	City of Brent-wood[a]	DWD	TODB	ECCID	BBID[b]		Dom-estic Wells[c]	Small PWS[d]	Native Vege-tation	
1994	2,100	270	1,811		0	**4,181**				
1995	2,312	270	1,912		0	**4,494**				
1996	2,524	269	2,019		0	**4,813**				
1997	2,735	287	2,256		0	**5,277**				
1998	3,109	252	2,157		0	**5,518**				
1999	4,011	178	2,403		0	**6,592**				
2000	3,619	70	2,480		0	**6,169**				
2001	3,840		2,510		0	**6,350**				
2002	4,852		2,612		0	**7,464**				
2003	5,196		2,826		0	**8,023**				
2004	5,302		3,176		0	**8,478**				
2005	5,350		3,695		0	**9,045**				
2006	5,788	198	3,637		0	**9,622**				
2007	4,085	942	4,057	977	0	**10,061**				
2008	4,016	927	4,075	3,127	0	**12,145**				
2009	3,791	791	3,934	4,176	0	**12,692**				
2010	3,536	1,032	4,009	793	0	**9,370**				
2011	2,709	1,326	3,600	751	0	**8,385**				
2012	3,076	650	3,738	327	0	**7,790**				
2013	5,053	787	3,947	415	0	**10,202**				
2014	4,503	965	3,446	1,028	0	**9,942**				
2015	2,541	736	2,613	2,132	515	**8,537**	600	500		**1,100**
2016	1,328	524	2,765	514	23	**5,154**	600	500		**1,100**
2017	2,081	819	2,842	456	0	**6,197**	600	500		**1,100**
2018	1,685	900	2,724	600	11	**5,920**	600	500		**1,100**
2019	1,992	905	2,970	694	0	**6,561**	600	500		**1,100**

Notes: Red text indicate estimated values. Blank space indicates no information.

a. Groundwater volumes were not adjusted because all groundwater is pumped from areas within the ECC Subbasin.

b. Bethany and Mountain House Divisions of BBID are located outside the ECC Subbasin and are not included in this estimate

c. It was estimated that 620 domestic wells are active in the subbasin and that the average domestic well pumps about 1 AFY. The Total Domestic well uses is about 600 AFY. This is identified as a data gap and will be refined over the next five years.

d. Small public water systems groundwater pumping was estimated from reported pumpage from 11 water systems and the estimated population served. This is identified as a data gap and will be refined in future reports.

Table 4-3 Historical and Current Metered Surface Water Supplies by Water Use Sector ECC Subbasin (AF)

Entity	Urban and Industrial						Agricultural					Total Metered Surface Water
	City of Antioch[a]		Brentwood[b]			DWD[d]	BBID[e]		ECCID	CCWD	Individual Diverters with Water Rights Permits[f]	
Water Supply Type	Purchased from CCWD (CVP)	River Water Rights	Purchased from ECCID (via CCWD RBWTP[c])	Purchased from ECCID (COBWTP[c])	Purchased from ECCID for Irrigation	Purchased from CCWD RBWTP (CVP)	Pre-1914 Surface Water Rights	Purchased (transfer)	Surface Water Rights (pre-1914)	Agricultural water (Antioch area)		
1994	9,548	4,233				4,430	15,000	0	33,513	87		66,811
1995	6,619	4,396				4,639	15,000	0	32,315	64		63,033
1996	8,122	4,559				4,790	15,000	0	32,420	35		64,926
1997	9,049	9,516	241			4,790	16,225	0	36,031	103		75,954
1998	3,020	9,307	359			3,565	12,656	0	27,294	62		56,264
1999	7,523	6,091	850			3,925	15,981	0	31,785	62		66,218
2000	9,098	4,668	1,794			4,132	15,664	0	30,382	80		65,818
2001	11,462	3,361	2,574			4,593	16,173	0	26,605	61		64,828
2002	10,278	5,205	2,636			4,915	14,858	0	24,197	10		62,099
2003	8,915	6,451	2,714			5,055	13,615	0	24,119	5		60,874
2004	11,868	4,077	3,742			5,374	15,094	0	25,861	11		66,026
2005	9,428	5,895	4,535			5,470	13,615	0	21,968	3		60,914
2006	8,896	5,975	4,720			5,257	13,074	0	21,132	4		59,059
2007	12,462	3,548	7,320		1,525	5,492	16,137	0	27,900	4		74,387
2008	10,898	3,638	4,827	2,475	1,554	5,453	26,373	0	23,994	14	89,861	169,087
2009	9,507	3,794	1,551	5,727	1,377	4,895	27,734	0	21,813	3	142,655	219,057
2010	6,971	5,619	1,556	4,706	1,098	4,676	12,489	0	20,883	3	177,649	235,650
2011	5,015	8,110	2,288	4,631	1,154	4,365	12,038	0	20,576	4	179,091	237,271
2012	9,099	3,786	704	6,768	1,197	5,359	13,537	0	22,252	6	176,444	239,152
2013	8,371	3,482	1,629	4,898	1,102	5,327	14,681	0	21,743	6	195,874	257,112
2014	11,100	1,263	2,567	3,252	829	4,526	15,859	0	21,201	20	140,380	200,997
2015	8,908	926	1,948	3,052	739	3,730	11,259	2,224	18,922	4	122,719	174,430
2016	7,077	3,262	1,572	4,794	594	4,005	8,776	0	18,057	2	155,526	203,664
2017	6,046	4,909	2,112	4,901	488	4,334	7,200	0	16,090	4	145,912	191,995
2018	8,509	2,833	960	6,734	696	4,657	9,531	0	16,933	5	114,184	165,043
2019	6,112	4,860	1,620	5,862	781	4,566	8,318	0	18,529	2	137,186	187,835

Notes: Red text indicates estimated values. Blue text indicates uncertain values. Blank space indicates no information.

a. City of Antioch: Area-weighted adjustments (about 74%) were applied to all supplies from 1994 when google earth images show development in areas outside the subbasin. Amounts purchased from CCWD are based on data provided by CCWD.

b. City of Brentwood: Area-weighted adjustments (95% from 2005 to 2009 and 90% from 2010) were applied to surface water and recycled water supplies. Google Earth images were used to identify development in areas outside the subbasin. Groundwater volumes were not adjusted because all groundwater is pumped from areas within the ECC Subbasin.

c. The annual surface water supply reported in this table from RBWTP and COBWTP are reported by the City of Brentwood. These amounts are generally 20% to 0% less than the amount reported for the same period by CCWD, possibly due to water losses.

d. The annual supply listed was reported by DWD with the exception of 2001-2003 and 2005 when CCWD annual supply was used because DWD data were incomplete. The annual supply of 1995, 1996 and 1999 reported by DWD are 7% to 12% higher than annual supply reported by CCWD. In other years, CCWD reports annual supply amounts that vary from DWD amounts by up to 5%.

e. BBID: includes Byron Division only, the Bethany and Mountain House Divisions of BBID are located outside the ECC Subbasin and are not included in this estimate.

f. Individual Diverters: The uncertainty of diversion data has been acknowledged by the Water Boards and will be improved in the future.

Table 4-4 Total Water Use by Source and Water Use Sector ECC Subbasin (AF)

	Urban and Industrial[a]			PWS and Rural Domestic	Agricultural[b]		Managed Wetlands, Managed Recharge, Native Vegetation		Total
Water Supply Type	Ground-water	Surface Water	Recycled Water	Ground-water	Ground-water	Surface Water	Ground-water	Surface Water	
1994	4,181	18,211	0			48,600			70,991
1995	4,494	15,654	0			47,379			67,528
1996	4,813	17,471	0			47,455			69,738
1997	5,277	23,596	0			52,359			81,232
1998	5,518	16,251	0			40,012			61,782
1999	6,592	18,389	0			47,828			72,809
2000	6,169	19,692	0			46,126			71,987
2001	6,350	21,990	0			42,839			71,179
2002	7,464	23,034	0			39,065			69,563
2003	8,023	23,134	0			37,739			68,896
2004	8,478	25,061	0			40,965			74,504
2005	9,045	25,328	115			35,586			70,074
2006	9,622	24,848	78			34,210			68,759
2007	9,084	30,347	23		977	44,041			84,472
2008	9,018	28,845	73		3,127	140,242			181,305
2009	8,516	26,851	67		4,176	192,206			231,815
2010	8,577	24,626	50		793	211,024			245,070
2011	7,634	25,563	66		751	211,709			245,722
2012	7,463	26,913	99		327	212,239			247,041
2013	9,787	24,809	195		415	232,303			267,510
2014	8,915	23,537	374		1,028	177,460			211,313
2015	5,891	19,303	371	1,100	2,647	155,128			184,439
2016	4,617	21,304	466	1,100	537	182,361			210,384
2017	5,741	22,790	501	1,100	456	169,205			199,793
2018	5,309	24,389	495	1,100	611	140,654			172,558
2019	5,867	23,801	401	1,100	694	164,035			195,897

Note: Blank space indicates no information. Red indicates Estimated or uncertain. Black text indicates metered values. Blue text indicates some uncertain metered values adjusted (see table 4-3).

a. Area-weighted adjustments were applied to the Cities of Antioch (from 1994) and Brentwood (from 2005) supplies to account for parts of the cities in the Subbasin. Google Earth images were used to identify development in areas outside the subbasin. City of Brentwood adjustments applied to surface water and recycled water supplies only, all groundwater supplies are assumed to be used inside the ECC Subbasin.

b. Includes BBID Byron Division only , the Bethany and Mountain House Divisions of BBID are located outside the ECC Subbasin and are not included in this estimate.

Table 4-5 Projected Water Demand and Supply (including Antioch and Brentwood areas outside the Subasin)

Entity	Water Demand/Supply Type	Projected Water Demand (AFY)							Projected Available Supply (AFY)						
		2020	2025	2030	2035	2040	2045	2050	2020	2025	2030	2035	2040	2045	2050
Bethany-Byron Irrigation District Total Water[1]		9,242	10,000	10,000	10,000	10,000	10,000	10,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
	Demand within ECC Subbasin (Byron Division)	9,242	10,000	10,000	10,000	10,000	10,000	10,000							
	Surface Water (Pre-1914 Rights)								25,000	25,000	25,000	25,000	25,000	25,000	25,000
City of Antioch Total Water		12,100	12,400	12,600	12,800	13,100	13,400	13,600	59,000	59,000	59,000	59,000	59,000	59,000	59,000
(including areas outside the subbasin)	Surface Water (purchased from CCWD, CVP)[2]	11,100	10,900	11,100	11,300	11,600	11,900	12,100	40,000	40,000	40,000	40,000	40,000	40,000	40,000
	Surface Water (City of Antioch River Rights)[3]								18,000	18,000	18,000	18,000	18,000	18,000	18,000
	Recycled Water	1,000	1,500	1,500	1,500	1,500	1,500	1,500	1,000	1,500	1,500	1,500	1,500	1,500	1,500
City of Brentwood Total Water		13,800	15,100	16,300	17,700	19,200	19,600	20,000	28,200	30,800	30,800	30,800	30,800	30,800	30,800
(including areas outside the subbasin)	Groundwater	*3,300*	*3,550*	*3,800*	*4,100*	*4,400*	*4,500*	*4,600*	5,600	5,600	5,600	5,600	5,600	5,600	5,600
	Surface Water (ECCID entitlement[4], RBWTP purchased from CCWD)								6,700	6,700	6,700	6,700	6,700	6,700	6,700
	Surface Water (ECCID entitlement[4], COBWTP)	*9,900*	*10,650*	*11,400*	*12,300*	*13,200*	*13,500*	*13,800*	7,300	7,300	7,300	7,300	7,300	7,300	7,300
	Surface Water (ECCID entitlement[4], non-potable raw water for irrigation)								800	800	800	800	800	800	800
	Total demand potable and raw water	13,200	14,200	15,200	16,400	17,600	18,000	18,400							
	Recycled Water	600	900	1,100	1,300	1,600	1,600	1,600	7,800	10,400	10,400	10,400	10,400	10,400	10,400
Contra Costa Water District	Surface Water- irrigation to Antioch Area[5]	<60	<60	<60	<60	<60	<60	<60							
Diablo Water District Total Water		5,900	7,900	10,000	12,000	14,000	14,400	14,600	16,800	16,800	20,400	20,400	20,400	20,400	20,400
	Surface Water (purchased from CCWD, CVP)	4,700	6,300	8,000	9,600	11,200	11,500	11,700	14,000	14,000	16,800	16,800	16,800	16,800	16,800
	Groundwater[6]	1,200	1,600	2,000	2,400	2,800	2,900	2,900	2,800	2,800	3,600	3,600	3,600	3,600	3,600
East Contra Costa Irrigation District Total Water		20,038	20,038	20,038	20,038	20,038	20,038	20,038	35,200	35,200	35,200	35,200	35,200	35,200	35,200
	Surface Water (Pre-2014 Rights)[7]								35,200	35,200	35,200	35,200	35,200	35,200	35,200
Town of Discovery Bay (Discovery Bay Community Services District)	Groundwater	3,200	4,400	5,000	5,600	6,600	7,600	7,900	7,700	7,700	7,700	7,700	7,700	7,700	7,700
	Total	68,280	73,838	77,938	82,138	86,938	89,038	90,138	171,900	175,000	178,600	178,600	178,600	178,600	178,600
	SW Total (AF)	54,980	57,888	60,538	63,238	66,038	66,938	67,638	147,000	147,000	149,800	149,800	149,800	149,800	149,800
	GW Total (AF)	7,700	9,550	10,800	12,100	13,800	15,000	15,400	16,100	16,100	16,900	16,900	16,900	16,900	16,900
	Recycled (AF)	1,600	2,400	2,600	2,800	3,100	3,100	3,100	8,800	11,900	11,900	11,900	11,900	11,900	11,900
	SW Total %	81%	78%	78%	77%	76%	75%	75%	86%	84%	84%	84%	84%	84%	84%
	GW Total%	11%	13%	14%	15%	16%	17%	17%	9%	9%	9%	9%	9%	9%	9%
	Recycled%	2%	3%	3%	3%	4%	3%	3%	5%	7%	7%	7%	7%	7%	7%

Footnotes

1. BBID pre-1914 water right is 50,000 AFY for both Byron and Bethany Districts. 25,000 AFY is used here as available supply for Byron District.
2. City of Antioch: Calculated based on the peak supply of 36.0 MGD (40,000 AFY)
3. City of Antioch available supply from river water rights is limited at 7,500 AFY by the water conveyance infrastructure capacity
4. ECCID and Brentwood have an agreement that ECCID will provide up to 14,800 AFY of raw water. Total demand "potable and raw water" amounts provided in COB UWMP (2016). Separation of Groundwater and surface water based on 25% estimated groundwater use from historical record. It is not know if this is viable.
5. Demand will be between 0 and 60 based on recent supply data and expected land developments
6. When groundwater supply fully implemented it could comprise up to 20% of DWD's total supply (page 4-1 CDM Smith, 2020).
7. ECCID total pre-2014 surface water rights are 50,000 AFY however, 14,800 AFY are shown under the City of Brentwood and not shown here.

Notes on projected demand/supply:

a. Projected demands and supplies of 2020 through 2040 were taken from 2015 or 2020 UWMPs of entities
b. 2045 and 2050 water demands were estimated using the projected population and per capita water demand (PCWD) of each entity
c. 2045 and 2050 water demands of DWD are based on the estimated total population of Oakley, Bethel Island and Knightsen

Data Sources

1 - City of Antioch 2020 UWMP
2 - Town of Discovery Bay 2015 UWMP
3 - City of Brentwood 2020 UWMP
4 - Diablo Water District 2015 UWMP and 2020 Water Master Plan

City of Antioch

The City of Antioch (Antioch) relies entirely on surface water for water supply. Antioch purchases raw water from CCWD and pumps water from the Sacramento-San Joaquin Delta when the chloride concentration is not over 250 milligrams per liter (mg/L). The current agreement between Antioch and CCWD is for a peak supply of 40,000 AFY (WYA, 2015). Antioch's water right to obtain water from the Delta for beneficial use does not specify a limitation, but the withdrawal rate is currently constrained to about 18,000 AFY by pumping and conveyance systems. Raw water from both sources can be directly pumped to Antioch's Water Treatment Plant (WTP) or into a municipal reservoir (Antioch Reservoir, **Figure 2-4**[1]) for storage. The municipal reservoir has a capacity of 736 AF and is used to maintain a reliable supply to the WTP when the ability to pump from the Delta is limited due to water quality. The maximum capacity of the WTP is over 40,000 AFY.

From 1997 to 2019, surface water supplies for the entire City of Antioch ranged from a low of around 14,000 AFY (2015 to 2017) to a high of 19,000 AFY to 21,000 AFY (2001 to 2008). However, 26 percent of the City's jurisdiction falls outside the ECC Subbasin. To account for this, the total Antioch supply is adjusted in **Table 4-3** to remove the estimated 26 percent delivered to the portion of the city that falls outside the Subbasin. The adjusted surface water supply for the Subbasin ranges from around 10,000 AFY to 11,500 AFY (2015 to 2019) and 14,000 AFY to 16,000 AFY (2001 to 2008). The reduction in demand in recent years (2015 to 2019) is due to changes in customer water use patterns since the recent drought. As a result, projected demands are expected to decrease due to conservation and continuation of the drought-influenced water use patterns through 2040. Antioch's projected total water demand (**Table 4-4**) is expected to increase to about 13,500 AFY in 2050 with 12,000 AFY derived from surface water and 1,500 AFY from recycled water. Since 2011, the City has purchased recycled water from Delta Diablo for landscape irrigation, which currently accounts for about 0.25 percent of the City's total water usage.

The City of Brentwood

The City of Brentwood (COB or Brentwood) uses three sources of water to meet demand: surface water, groundwater, and recycled water. In 1999, Brentwood entered into an agreement with ECCID to obtain up to 14,800 AFY of raw surface water that is pumped from the Delta. The majority of water is transported from the Rock Slough intake through the Contra Costa Canal to the City of Brentwood Water Treatment Plant (COBWTP). The COBWTP was constructed in 2008 jointly by the City and CCWD. The current capacity of the COBWTP is 18,500 AFY[4] (16.5 million gallons per day [MGD]), but it can be increased to 36,000 AFY to meet future water demand. In addition, raw surface water used for landscape irrigation is purchased from ECCID and transported through their Main Canal. A portion of the ECCID entitlement is treated at the Randall-Bold Water Treatment Plant (RBWTP) under an agreement with CCWD[5]. In a 1999 agreement with a 2000 amendment, COB has a permanent capacity of around 3,200 AFY (6 MGD) at the RBWTP[6]. Historically, surface water purchased by COB from both ECCID and CCWD has increased from a low in 1994 to 1999 (less than 1,000 AFY) to the higher range in 2007 to 2019 (6,300 AFY to 9,600 AFY). Future surface water supply (to 2050) is expected to not exceed the current allocation of 14,800 AFY.

[4] Personal communication, Eric Brennan, City of Brentwood November 13, 2020.
[5] Even though this water is provided under an agreement with CCWD it is included as part of the total 14,800 AFY agreement with ECCID; it is not CVP water.
[6] Personal communication, Jill Mosley, CCWD, November 13, 2020.

As of 2015, the City has seven active groundwater production wells within its service area. Capacity of the active wells in 2015 was over 7,000 AFY (COB 2015 UWMP). From 1998 to 2019, COB pumped between 1,300 AFY (2016) to 5,800 AFY (2006). On an annual basis, contribution of groundwater has decreased in relation to the total city demand over the last 25 years. COB groundwater supply percentage was the highest from 1994 to 1999 with 80 percent to 90 percent (2,000 AFY to 4,000 AFY). From 2000 to 2006, 50 percent to 70 percent (3,600 AFY to 5,800) of COB water supply was from groundwater. In the last 13 years groundwater supply decreased to 15 percent and 25 percent (1,300 AFY to 3,000 AFY) in normal years and from 30 percent to about 40 percent (4,000 AFY to 5,000 AFY) in drought years (2007 to 2009 and 2013 and 2014) as a result of the greater use of surface water sources. Future City pumpage is expected to not exceed 5,600 AFY through 2050 (**Table 4-4**).

Recycled water provided by the City's wastewater treatment plant has been used for landscape irrigation and industrial purposes. Recycled water has accounted for less than 1 percent to 5 percent of the total water supply of the City since 2005 when recycled water became available. Projected buildout recycled water demand for 2040 was estimated at 1,500 AFY (COB 2015).

Contra Costa Water District

CCWD is a regional water supplier to entities within and outside the Subbasin. It has a contract with the United States Bureau of Reclamation (USBR) for 195,000 AF per year through February 2045 (CDM Smith, 2016). The Sacramento-San Joaquin Delta (Delta) is the primary source of water and CCWD receives this water from the Central Valley Project (CVP). CCWD also obtains water through Delta surplus water right, Mallard Slough water rights and transfers from ECCID, as well as uses recycled water and a minor amount of local groundwater (CCWD, 2016).

CCWD serves both as a retail and wholesale water supplier to the northern, eastern, and central parts of Contra Costa County but only CCWD surface water supplies for the ECC Subbasin will be discussed here. In the ECC Subbasin area, CCWD is a wholesale supplier of treated and raw water to the City of Antioch and Diablo Water District (DWD). CCWD also diverts and conveys ECCID surface water for the City of Brentwood. CCWD water supplied to these three entities is listed in **Table 4-3** under the entity name. Water supplied to these entities is pumped from Rock Slough, Old River, and Victoria Canal (Middle River) intakes located in the Sacramento-San Joaquin Delta (Delta) and, is treated at the RBWTP and COBWTP. The RBWTP is jointly owned by CCWD and DWD and operated by CCWD and primarily serves the Subbasin. Water pumped from Old River and Victoria Canal intakes can be stored in the Los Vaqueros Reservoir, which has a 160,000 AF capacity, and released when supplies from the Delta are limited due to poor water quality. In addition, CCWD supplies agricultural water (**Table 4-3**) to the Antioch area inside the ECC Subbasin. These agricultural water supplies within the Subbasin (Antioch area) have ranged from 60-100 AFY (1994-2001) to 2-5 AFY (2015-2019). Future agricultural demands may decrease further depending on the conversion of agricultural lands to urban.

Diablo Water District

DWD supplies water to the City of Oakley, the Town of Knightsen, and some areas of Bethel Island. DWD uses two sources of water to meet demand (CDM Smith, 2020), the primary source is surface water with additional supply from groundwater (10-20 percent, 2007 to 2019). Surface water is purchased from CCWD, supplied from the Contra Costa Canal and the Los Vaqueros Project, and treated at the RBWTP. DWD's current capacity of the RBWTP is 8,400 AFY but this can be increased to 16,800 AFY per agreement with

CCWD. DWD purchases CVP water from CCWD which has a contract with the US Bureau of Reclamation (USBR) for 195,000 AFY through February 2045. From 1994 to 2019 total water supply ranged from around 3,000 AFY (2001) to about 6,400 AFY (2007 and 2008). DWD's surface water supply has ranged from 3,100 AFY (2001) to 5,500 AFY (2007) (**Table 4-3**) and groundwater supply has ranged from a low of 0 AFY (2001-2005) to a high of 1,300 AFY (2011) (**Table 4-2**). From 2012 to 2019, groundwater supply has averaged about 800 AFY. Future demand is dependent on rate of DWD's growth and consumer conservation but is expected to be about 14,000 AFY in 2040 with 80 percent met by surface water and 20 percent met by groundwater (**Table 4-4**). DWD is proposing the installation of two new groundwater production wells in the vicinity of the Glen Park well (south-central portion of the District) in the next 10 to 20 years.

Groundwater is currently pumped from two wells in Oakley, then conveyed to the Blending Facility, where it is treated and blended with treated surface water prior to distribution to customers. The Blending Facility is operated so that the distributed water does not exceed 280 mg/L total dissolved solids (TDS). During water shortages this may be relaxed by DWD to 500 mg/L (TDS). Groundwater is supplied year-round because it can be provided at a lower cost than surface water.

DWD does not use recycled water for any beneficial use. Ironhouse Sanitary District (ISD) owns and operates the wastewater treatment system in DWD's service area and also includes Bethel Island, Jersey Island, and part of Holland Tract. In 2011, ISD completed construction of the Waste Recycling Facility producing tertiary-treated recycled water. The operating capacity is currently 4,800 AFY with an expansion capacity up to 7,600 AFY. The recycled water is currently applied on agricultural land owned by ISD (on Jersey Island), provided at fill stations, or discharged to the San Joaquin River.

Other groundwater pumping in the DWD service area is described in the Oakley General Plan (City of Oakley, 2016 amended) that states that over 30 small water companies or service districts serving less than 5,000 people are located in the eastern portion of the District's sphere of influence (SOI). Also, within the District's SOI are residences with individual domestic wells, generally shallower than 200 feet, that are considered di minimis users for SGMA purposes. However, these wells will be considered as beneficial users and potentially impacted by other groundwater pumping as discussed further below. The Oakley General Plan has a policy (4.8.8) that encourages rural residences currently served by well water to connect to municipal water service when it becomes available. DWD assumes that the small water systems would be replaced by a system meeting DWD standards when DWD treated water service becomes available in these areas (CDM Smith, 2020).

East Contra Costa Irrigation District

The East Contra Costa Irrigation District (ECCID) is an independent special district established in 1926. The primary purpose of ECCID is to provide agricultural irrigation water to properties within the District boundaries. In addition, it provides raw water for treatment facilities in urban areas. ECCID's approximately 40 square mile service area includes the City of Brentwood, parts of the Cities of Antioch and Oakley, the unincorporated community of Knightsen, and unincorporated areas located south and east of Brentwood. Water is supplied primarily from surface water diverted from Indian Slough off Old River but is also supplemented with groundwater. ECCID holds pre-1914 water rights for up to 50,000 AFY, that is not subject to delivery reduction during water shortages including regulatory-restricted and drought years.

Surface water provided for agricultural irrigation ranged from about 30,000 AFY to 34,000 AFY) between 1994 to 2000 to about 17,000 AFY in 2017 and 2018 (**Table 4-3**). The decrease reflects the conversion of agricultural lands to urban lands within ECCID's service area.

ECCID also operates nine groundwater wells (ECWMA, 2019) that generally pump between 300 to 800 AFY in normal years and increases to between 1000 to 4,000 AFY in drought years (2008, 2009, 2014, and 2015). As mentioned above, CCWD has an agreement with ECCID to provide groundwater to CCWD when there is a shortage of CVP water as represented in ECCID's drought year pumping.

ECCID provides surface water to Brentwood and CCWD through agreements described below. These annual surface water diversions for Brentwood and CCWD are tabulated under the Brentwood heading in **Table 4-3**.

- In 1999, Brentwood and ECCID entered into an agreement under which ECCID would provide up to 14,800 AFY of raw water each year. The water is available on Indian Slough, Rock Slough, or the intake on Old River to the Vaqueros Project. The City treats and distributes water to customers located within the City or ECCID boundaries.
- In 2000, CCWD and ECCID entered into an agreement in which ECCID provides up to 8,200 AFY surplus irrigation water to CCWD to serve municipal and industrial needs within the overlapping areas of the two agencies. Furthermore, ECCID may provide up to 4,000 AFY of groundwater to CCWD by exchange for the use within the CCWD service area when there is a shortage of CVP water.

In the future, ECCID anticipates some reduction in agricultural lands, however, these lands have been fallowed for many years so water demand by the agricultural core area is not expected to change and would remain at about 20,000 AFY. In the next 15 years, ECCID expects a 15 percent increase in urban non-potable landscape water deliveries for Brentwood that is fed through the ECCID main canal.

The Town of Discovery Bay

TODB Community Services District operates the public water supply system of the Town. The TODB relies exclusively on groundwater. Raw water pumped from six groundwater wells are treated at two water treatment plants (Willow Lake WTP and Newport WTP) located in the area. The combined capacity of wells is approximately 16,000 AFY, while the combined capacity of the two water treatment plants is approximately 12,000 AFY. Groundwater pumped between 1994 varied from about 1,800 AFY in 1994 to over 4,000 AFY in the drought years of 2007 to 2009 (**Table 4-2**). The District operates two wastewater treatment facilities, but recycled water is not used for any beneficial purpose because it is not cost effective and all water demands can be sustainably met with groundwater. Projected demand is expected to reach about 6,200 AFY by 2040 that will be met entirely by groundwater (**Table 4-4**).

Small Water Systems and De Minimis Users

Additional groundwater is pumped in the Subbasin by small public water systems (PWS) and rural domestic (de minimis) wells that are not metered. In order to estimate groundwater pumped by the PWS, a variety of information was collected. In 2018, Contra Costa County Environmental Health reported 62 small public water systems (those with <200 connections) in the ECC Subbasin. This list was refined with duplicates removed leaving 51 PWS currently in the ECC Subbasin. These consisted of a variety of facilities including marinas, schools, churches, a golf course, restaurants, and mutual water companies.

However, the County does not estimate total groundwater demand by these users. The California State Water Resources Control Board (Water Board) collects self-reported annual inventory information of public water systems. As per the most recent data available from the Water Board[7] (reporting year 2016, data set updated in October 2019), 26 small water systems owned by local governments or private parties exist within the ECC Subbasin. These water systems are designed to serve a population of more than 4,500. Reported data from 11 water systems show that about 83 AFY of water, entirely obtained from groundwater wells, has been distributed to a population of about 2,300 in 2016. Supply details of the other 15 water systems are not available. To account for these groundwater users, an estimate was assigned of about 500 AFY total water for the PWS. PWS locations and groundwater demand have been identified as a data gap and will be refined over the next five years.

DWR's well completion report database[8] lists about 975 domestic wells (de minimis user) in the ECC Subbasin (**Figure 2-6a**). This list was refined to remove any well installed over 30 years ago (assuming that a domestic well life span is 30 years) leaving about 620 domestic wells. It was assumed that the average domestic well pumps about 1[9] AFY; domestic wells in the ECC subbasin produce about 600 AFY. The number of domestic wells, their locations, and average water use has been identified as a data gap and will be refined over the next five years.

Individual Surface Water Diversions

Individual surface water diversions are made by those with water rights permits and are reported by the State Water Resources Control Board (SWRCB). **Table 4-3** lists the annual amount reported[10] as diverted by individual water rights holders in the ECC Subbasin and ranges in the last 10 year from between 114,000 AFY (2018) to 196,000 AFY (2013). California Water Code § 5101 requires individual surface water diversions made by those with water rights permits to report water diversion to the state on an annual basis. At present, there are 272 currently active "Application Numbers", each of which uniquely identifies a surface water diversion point and its owner, in the ECC Subbasin. However, the Electronic Water Rights Information Management System (eWRIMS) of the SWRCB does not contain diversion records of any of those Application Numbers until 2008. Diversion data of about 15% of Application Numbers are available for 2009, but that percentage is 68% for 2010, 79% for 2015 and 95% for 2019. **Appendix 4a** lists the diversions by tract and subarea. The State Water Board acknowledges that the data is uncertain, possibly due to a mix of units (gallons vs acre-feet) and/or double reporting[11] and they are working to improve the reporting. For purposes of calculating total water use in the ECC Subbasin, these amounts are used and will be refined in the future.

[7] https://data.ca.gov/dataset/drinking-water-public-water-system-annually-reported-water-production-and-delivery-information. Downloaded July 14, 2020.

[8] Downloaded May 2019.

[9] Estimate for domestic well pumpage: 100 gallons/day/person x 4 persons/household*365 days/year=about .5 AFY plus extra for irrigation= total for one domestic well annual pumpage 1 AFY.

[10] Monthly self-reported surface water diversions for the years 2008-2019 downloaded from:
https://ciwqs.waterboards.ca.gov/ciwqs/ewrims/reportingDiversionDownloadPublicSetup.do.
GIS files of Points of Diversion downloaded from:
https://waterrightsmaps.waterboards.ca.gov/viewer/index.html?viewer=eWRIMS.eWRIMS_gvh#

[11] Michael George, Delta Watermaster, Delta Protection Commission meeting, September 17, 2020.

Summary

In the previous 10 years (2010 to 2019), the ECC Subbasin total metered and estimated water use (**Table 4-4**) has ranged from, 173,000 AFY (2018) to, 214,000 AFY (2013). Sources of water supplies during this same time frame included: surface water ranging from 165,000 AFY to 259,000 AFY (95 percent to 97 percent of total supply); groundwater supplies range from about 6,000 AFY to 11,000 AFY (3 percent to 5 percent of total supply); and recycled water supplies ranged from 50 AFY to 500 AFY (less than 1 percent of total supply).

4.3.2 Projected Water Demands and Supplies

Table 4-5 provides the projected water demand from 2020 to 2050 in five-year intervals within the service area of each supplier. Note that projections are for major water users and do not include unmetered di minimis users, PWS, or individual surface water diverters. Estimated demands and supplies for the 2020-2040 period were obtained from the following sources: 2015 or draft 2020 Urban Water Management Plans of the water suppliers, Technical Memorandum of City of Antioch 2020 Existing and Projected Water Use, Diablo Water District 2020 Facilities Plan, and personal communication (ECCID and BBID). Water demands for 2045 and 2050 were estimated using the projected population for those years and 2040 per capita water demands given in UWMPs and other reports. Available supplies for the 2045 and 2050 were assumed to be equal to the supplies estimated for 2040 in UWMPs.

As mentioned above, population in the ECC Subbasin will be increasing and water demand in service areas of water suppliers are expected to stay the same or increase with the new development in the area. In comparison to reported water supplies in 2019, water demand in 2050 is projected to decrease by 7 percent in Antioch because of water conservation practices. Irrigation water demand of ECCID and BBID service area is expected to remain nearly unchanged during the projected period. Projected water demands for all other entities are expected to increase with population growth and other developments in the area. Within the same period, the increase of water demand will be about 70 percent in Brentwood, 170 percent in both the DWD and TODB service areas. The demand for water is expected to increase: for surface water from the 2019 amount[12] (50,000 AF) to the 2050 amount[13] (68,000 AF), for groundwater[14] from the 2019 pumped amount (10,000 AF) to the projected amount in 2050 (15,000 AF), and recycled water from the current 2019 amount (400 AF) to the projected 2050 amount (3,000 AF). In 2050, groundwater is expected to supply 17 percent (15,000 AFY) of the ECC Subbasin demand which is an increase of 5,000 AFY from 2019.

---

[12] All 2019 amounts are from Table 4-3 for the ECC Subbasin only,

[13] 2050 amounts are from Table 4-4 and are for the entire ECC Subbasin.

[14] Note that groundwater totals from 2019 and projected 2050 include an estimated groundwater use for domestic wells and public water systems totally 4,000 AFY.

4.3.3 Water Availability and Reliability

Historically, 80 to 87 percent of annual water demand in the Subbasin was met with surface water (2000 – 2019 period). Availability of water from the Delta, the primary source of surface water, largely depends on water quality and water rights.

It has been reported that the water quality of the Delta has been degrading regardless of the measures taken to improve it (CCWD, 2015 UWMP). CCWD, one of the main water suppliers in the Subbasin, identified several contributing factors to deteriorating water quality in its 2015 UWMP.

Changes in local and regional precipitation patterns can affect the timing and quantity of freshwater flow into the Delta. Lack of local precipitation and reduced flow from the upstream contribute to increased salinity levels in the Delta.

Excessive pumping of Delta water and sea level rise can increase the salinity of the Delta water.

- Increased flows of wastewater, storm water and agricultural drainage to the Delta also degrade the water quality of Delta.

Water quality of the Delta is generally evaluated using its chloride concentration. The secondary maximum contaminant level of chloride in drinking water is 250 mg/L. Historically, chloride concentration at Delta water intakes has fluctuated between 20 and 250 mg/L (DWD, 2015 UWMP), but periods where daily mean chloride concentration increased over 1,000 mg/L have been reported (CCWD, 2010). The Los Vaqueros reservoir (160,000 AF capacity) is used to store higher quality Delta water to blend with high salinity water pumped from the Delta during late summer and fall months as well as dry periods. Furthermore, the reservoir can provide emergency supply; a minimum of 70,000 AF in wet years and 44,000 AF in dry years (CCWD, 2015 UWMP).

Another critical factor that affects availability of CCWD CVP water from the Delta is regulatory actions imposed due to biological opinions associated with environmental protection. As per some biological opinions, quantity and timing of CVP and State Water Project water supplies used for urban or irrigation purposes may be limited when environmental supplies are prioritized. As a policy, CCWD plans to meet the entire demand in normal years and meet 85 percent of demand during drought periods. The unmet supply of 15 percent is to be managed with short-term demand management measures.

The City of Antioch, which entirely relies on surface water to meet its water demands, is expected to meet 100 percent of the projected water demands in normal years (COA, 2015 UWMP). During drought conditions, at least 85 percent of the 2040 projected demand will be met during the third year of a drought period. The deficiency of supplies will be managed with short-term water purchases and short-term water conservation programs during droughts.

Raw and treated water supplies that Brentwood receives may be affected by the limitations of availability of surface water. At present, groundwater quality of the City's active supply wells meets potable water quality requirements. Groundwater is pumped from the Tulare Formation from wells perforated from 200 to 500 ft deep. Relatively high total dissolved solids (TDS), nitrate and chloride concentrations have been reported in shallow groundwater, but water quality improves with the increasing depth. If necessary, in the future, groundwater will be mixed with surface water to preserve quality. Available supplies exceed the 2040 projected water demand even in the third year of a drought period (COB, 2015 UWMP).

DWD is capable of meeting 100 percent of 2040 projected water demand in normal years and until the first year of a drought period only with water received from CCWD RBWTP (CDM Smith, 2016). Surface water supplies from CCWD are expected to fulfil up to 94 percent and 85 percent of the 2040 projected demand in the second and third years of a drought period, respectively. The remaining demand will be met with groundwater supplies from the District's wells. DWD plans to increase the groundwater supply up to about 20 percent of the total supplies by 2030 (CDM Smith, 2020) and it is expected to remain at 20 percent through 2040. However, if sufficient amounts of groundwater are not available during drought periods, DWD will request additional water from CCWD, explore other local sources, and/or implement water conservation programs as needed.

TODB, which uses groundwater to meet its entire water demand, has been conducting a groundwater monitoring program since 1980s. The perforated interval of supply wells ranges from 250 to 350 ft bgs. Groundwater water level data indicate that groundwater pumping has been sustainable, even during the 2013 to 2015 drought period (TODB, 2015 UWMP). Groundwater quality from its supply wells meet all state of California primary drinking water standards. Manganese concentration exceeds the maximum limit specified in the secondary standards (0.005 mg/L); therefore, water is treated to remove excess manganese before distribution. Groundwater supplies can meet 100 percent of 2040 projected water demand during the third year of a drought period.

Both irrigation districts (BBID and ECCID) have pre-1914 rights which is projected to meet the Districts' water demands in 2050. To prepare for reliable water during droughts, BBID has executed an agreement with CCWD for an intertie between the Byron Division Canal 45 and the Old River Pipeline to allow storage of BBID water in the Los Vaqueros Reservoir for later use in the Byron Division and to facilitate water transfers with CCWD (Ch2M, 2017).

Available supplies for the BBID, Antioch, Brentwood, CCWD, DWD, ECCID, and TODB meet or exceed the projected water demand of 2050 in normal years.

4.4 References

City of Antioch. 2020. Technical Memorandum - 2020 Water System Master Plan Update. Prepared by Brown and Caldwell. February 2020.

CDM Smith. 2016. Final 2015 Urban Water Management Plan. Prepared for Diablo Water District.

CDM Smith. 2020. 2020 Facilities Plan. Prepared for Diablo Water District. June 2020.

Ch2M. 2017. Byron Bethany Irrigation District Agricultural Water Management Plan. Prepared for Byron Bethany Irrigation District. October 2017.

City of Oakley. 2016. City of Oakley 2020 General Plan. Adopted December 2002, amended February 2016.

City of Brentwood (COB). 2016. 2015 Urban Water Management Plan, Prepared for the City of Brentwood by Brown and Caldwell. June 2016

Contra Costa County Department of Conservation and Development. 2005. Contra Costa County General Plan. January 18, 2005 (Reprint July 2010).

Contra Costa Water District (CCWD). 2016. 2015 Urban Water Management Plan for the Contra Costa Water District. June 2016.

Contra Costa Water District (CCWD). 2010. Historical Fresh Water and Salinity Conditions in the Western Sacramento-San Joaquin Delta and Suisun Bay - A summary of historical reviews, reports, analyses, and measurements. February 2010.

Contra Costa Water District (CCWD). 2015. Urban Water Management Plan. June 2016

East Contra Costa County. 2007. Waste and Wastewater Services Municipal Services Review for East Contra Costa County, Prepared for Contra Costa Local Agency Formation Commission by Dudek. December 2017

East Contra Costa County. 2015. East Contra Costa County Integrated Regional Water Management Plan. September 2015

East Contra Costa County. 2019. East Contra Costa County Integrated Regional Water Management Plan Update 2019. March 2019

Town of Discovery Bay Community Services District. 2017. 2015 Urban Water Management Plan. May 2017

West Yost Associates (WYA). 2016. City of Antioch 2015 Urban Water Management Plan. Prepared for City of Antioch. May 2016.

SECTION 5 CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

5. WATER BUDGET (§ 354.18)

The water budget developed for the East Contra Costa Subbasin provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the Subbasin, including historical, current and projected water budget conditions, and the change in the volume of water stored. The water budgets for various future scenarios were quantified in accordance with DWR Best Management Practices guidelines for water budgets and modeling (DWR, 2016).

5.1 East Contra Costa Subbasin Hydrologic Base Period[1]

In accordance with GSP regulations and BMP guidelines, a base period was selected in order to reduce bias that might result from the selection of an overly wet or dry period, while accounting for changes in other conditions including land use and water demands. The historical base period must include a minimum of 10 years of surface water supply information, with 30 years recommended. The current base period must also include a representative recent one-year period; and the projected base period must include a minimum of 50 years of historical precipitation, evapotranspiration, and streamflow data.

The historical, current, and projected water budget base periods were selected on a water year(WY) basis considering the following criteria:

1. Cumulative departure from average annual precipitation curves[2];
2. San Joaquin Valley water year type[3];
3. Inclusion of both wet and dry periods;
4. Antecedent dry conditions[4];
5. Adequate data availability; and
6. Inclusion of current hydrologic, cultural, and water management conditions in the Subbasin.

For the ECC Subbasin, a 22-year historical water budget base period of water years 1997-2018 was selected. The cumulative departure from mean annual precipitation curve provided an efficient way to analyze historic and current water conditions in the Subbasin. The cumulative departure curve is presented in **Figure 5-1 Cumulative Departure from Mean Annual Precipitation** and illustrates that the

[1] A base period is representative of long-term conditions in the basin that reflects natural variations in precipitation and is not biased by being overly wet.

[2] Cumulative departure curves are used to show patterns of precipitation or streamflow to characterize long-term hydrology including drier and wetter periods relative to the mean annual precipitation. Negative, or downward, slopes indicate dry patterns while positive or upward slopes indicate wetter periods relative to the mean. Flatter portions of the cumulative departure curve indicate stable, or average, conditions during that period.

[3] Water year types are used for the development of historical and current water budgets as available from the Department of Water Resources. The dataset applicable to the ECC Subbasin is based on the San Joaquin Valley Index from which precipitation is derived for various conditions (i.e., wet, above normal, below normal, dry, critical); DWR (2021).

[4] Selecting a base period with antecedent (or prior) dry conditions minimizes the effects of the unsaturated zone on basin-wide groundwater budgets. The volume of water in the unsaturated zone is difficult to determine on the scale of a groundwater basin, so it is best to select a base period that has relatively dry conditions antecedent to the beginning of the study or base period.

selected base period (1997 to 2018) includes both wet and dry periods, along with dry conditions prior to the beginning of the start of the base period and represents current land use and water practices.

The selected base period also has the best collection of groundwater and surface water data. Groundwater pumping records from entities within the Subbasin are typically not available prior to the 1990s, and the quality and quantity of specific groundwater data improves closer to the present. Surface water data is also available during the selected base period through public databases, and greatly improves in quality and quantity to the present, particularly for surface water deliveries.

5.2 Summary of Water Year 2015 Hydrologic Conditions

For the current water budget, the water year 2015 is used. This year is appropriate because it represents current land use in years with available data at the initiation of SGMA data collection and analysis work. Hydrologic conditions in water year 2015 including precipitation[5], evapotranspiration[6], groundwater levels[7], and surface water flows[8] can also be used to represent current conditions.

5.3 Projected 50-Year Hydrology (§354.18(c)(3))

The projected 50-year hydrology was developed using average historical precipitation, evapotranspiration, and streamflow information from the selected model base period as the baseline condition for estimating future hydrology. A numerical groundwater flow model was used to simulate projected future scenarios including under expected changes in urban growth[9] (land use), and anticipated climate change[10] and sea level rise[11] (hydrology). Model selection is described in **Section 5.1.5** and is referred to as the East Contra Costa Groundwater-Surface Water Simulation Model, or ECCSim. Model simulation scenarios are run from WY 2019 through 2068 (50 years) beginning on October 1, 2018, and ending September 30, 2068, at a monthly time step.

The projected water demand uses the most recent land use at the beginning of the scenario and follows urban growth patterns from IRWMP, UWMP, or Contra Costa LAFCO documents. For future scenarios, evapotranspiration, precipitation, and streamflow are varied using DWR's SGMA Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development document (DWR, 2018). DWR provides adjustments for different climate change scenarios. DWR summarizes the various model outputs and respective timelines, which indicates that the most recent fifty-year period of common simulation periods is 1954-2003. Therefore, the historic simulation period selected to apply climatic adjustments over a 50-year period for ECC is 1954-2003. The adjustment factors for precipitation and reference evapotranspiration were gridded over the entire state and provided by DWR. Sea level rise is also considered and incorporated into the future scenarios using DWR's guidance documentation that provides median predicted values for the years 2030 and 2070 that translate to about 0.5 to 1.4 feet of

---

[5] Precipitation is water released from clouds in the form of rain, freezing rain, sleet, snow, or hail.
[6] Evapotranspiration is the sum of evaporation from the land surface plus transpiration from plants.
[7] Groundwater level is the depth or elevation above or below sea level at which the surface of groundwater stands.
[8] Surface water flow is the continuous movement of water in runoff or open channels
[9] Urban growth is the rate at which the population of an urban area increases.
[10] Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional, and global climates.
[11] Sea level rise is an increase in the level of the world's oceans due to the effects of global warming.

sea-level rise, respectively[12]. The combination of land use, climate change, and sea level rise is also simulated for the projected 50-year hydrology simulations.

The water demand uncertainty associated with projected changes in local land use planning, population growth, and climate is addressed by evaluating the groundwater budget components using all of the various future model scenarios.

Projected surface water supply uses the most recent water supply information as the baseline condition for estimating future surface water supply. The surface water supply availability and reliability are a function of the historical surface water supply, which has been generally stable over the model Base Period where records of diversions are available. While some users in the Subbasin rely wholly on groundwater as a source of supply (e.g., individual domestic well owners and small domestic water systems[13]), large-scale users (e.g., municipal water systems and agriculture) are projected to use groundwater to supplement surface water when insufficient amounts are available.

5.4 Water Budget Framework

The water budget framework for the ECC Subbasin accounts for the total annual volumes of groundwater and surface water entering and leaving the subbasin. These volumes are described as inflows and outflows as described below.

5.4.1 Surface Water Inflows and Outflows

There are many surface water bodies that comprise the surface water system in the ECC basin, including Marsh Creek, Clifton Court Forebay, Franks Tract, Old River, San Joaquin River, Big Break, and other Delta features. Surface water inflows and outflows are summarized below:

- Surface water inflows into the Subbasin as streamflow occur via Marsh Creek, San Joaquin River, and Old River;
- Surface water inflows to the Subbasin from outside through conveyance facilities via a series of sloughs and canals off of Old River and San Joaquin River;
- Surface water outflows from the Subbasin as runoff and groundwater discharge to surface water bodies including the Delta.

5.4.2 Groundwater Inflows and Outflows

Groundwater flows are summarized below for the Subbasin:

- Groundwater inflows to the Subbasin from groundwater recharge and subsurface inflows along Subbasin boundaries;
- Groundwater outflows from the Subbasin via subsurface lateral flow; and

[12] Department of Water Resources, Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development, July 2018.
[13] In Contra Costa County, a small water system is defined as a Public Water System (CA Health and Safety Code §11625) serving domestic purposes for two to one-hundred ninety-nine connections (County Ordinance Code §414-4.221).

- Groundwater outflows due to evapotranspiration, subsurface drains, and groundwater pumping.

5.4.3 Summary of Water Budget Components

All water budget components and sources of data used with the ECCSim model are summarized in **Table 5-1**, including a) general components included in every water use sector water budget and b) specific components unique to individual water use sectors.

Table 5-1. Water Budget Components

Component	Category	Data Type	Calculation Or Estimation Method
Precipitation	Inflow	Meteorological Data	C2VSim and Antioch/Brentwood precipitation stations
Subsurface Lateral Flow	Inflow/Outflow	Groundwater Data	ECCSim
Surface Water Deliveries	Inflow	Surface Water Data	Reported by historical water rights and statements of diversion (eWRIMS); estimated based on records when unavailable.
Evapotranspiration (ET) of Applied Water	Outflow	Meteorological Data, Crop Water Use	Estimated by the Integrated Water Flow Model Demand Calculator (IDC) component of the ECCSim model
Evapotranspiration (ET) of Precipitation	Outflow	Meteorological Data, Crop Water Use	Estimated by the Integrated Water Flow Model Demand Calculator (IDC) component of the ECCSim model
Runoff	Outflow	Surface Data	Estimated by the Integrated Water Flow Model Demand Calculator (IDC) component of the ECCSim model
Groundwater Pumping	Outflow	Groundwater Data	Pumping records for municipalities and closure term for domestic/irrigation pumping (pumping records provided by Brentwood, ECCID, Town of Discovery Bay, and Diablo Water District (Oakley).
Drains	Outflow	Groundwater Data	Drain elevations and extent based on historic maps and data requests to GSAs
Change in Storage	Inflow/Outflow	Groundwater Data	Estimated using analytical methods and numerical modeling (ECCSim) techniques.

5.5 Groundwater/Surface Water Flow Model

5.5.1 Evaluation of Existing Integrated Hydrologic Models

The development of the East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) involved starting with and evaluating the U.S. Geological Survey's Central Valley Hydrologic Model (CVHM) and the beta version (released 5/1/2018) of DWR's fine-grid version of the California Central Valley Groundwater-Surface Water Flow Model (C2VSim-FG Beta2). Both publicly available models were evaluated for suitability in the preparation of the ECC Subbasin GSP. The CVHM model was published in 2009, but the simulation period ends in September 2003. C2VSim-FG Beta2 simulated to September 2015. Neither of these models were current at the time of ECCSim development, and they lacked important simulated surface water features specific to the ECC area due to their application for more regional analyses. Additionally, neither existing model had sufficient calibration points in the ECC Subbasin.

Since the C2VSim model's simulation period more closely matched the end of the model Base Period (i.e., water years 1997-2018), and that the aquifer parameters in the ECC domain were more similar, the C2VSim-fine grid beta version was selected for use as a basis for the ECC Subbasin model. This led to extracting a local model domain and conducting local refinements to the model structure (e.g., nodes, elements) and modifying or replacing inputs as needed to accurately simulate local conditions in the Subbasin within the model domain.

C2VSim-FG Beta2 utilizes the most current version of the Integrated Water Flow Model (IWFM) code available at the time of the ECCSim development. IWFM and C2VSim-FG Beta2 were selected as the modeling platform, in part, due to:

1. the versatility in simulating crop-water demands in the predominantly agricultural setting of the subbasins,
2. groundwater surface-water interaction,
3. the existing hydrologic inputs existing in the model for the time period through the end of water year 2015, and
4. the ability to customize the existing C2VSim-FG Beta2 model to be more representative of local conditions in the area of the ECC Subbasin.
5. ECCSim was refined from C2VSim-FG Beta2 and calibrated to a diverse set of available historical data using industry standard techniques.

5.5.2 Selection and Refinements to Model Platform

The modeling code and platform utilized for ECCSim are described below. As required by GSP regulations, the selected model code is in the public domain (see link below or request data from groundwaterinfo@dcd.cccounty.us). The decision to select the model codes for the ECCSim was based on providing the Subbasin with a modeling tool that can be used for GSP development and future planning with sufficient representation of local conditions, while utilizing to the extent possible, other available modeling tools, including regional models.

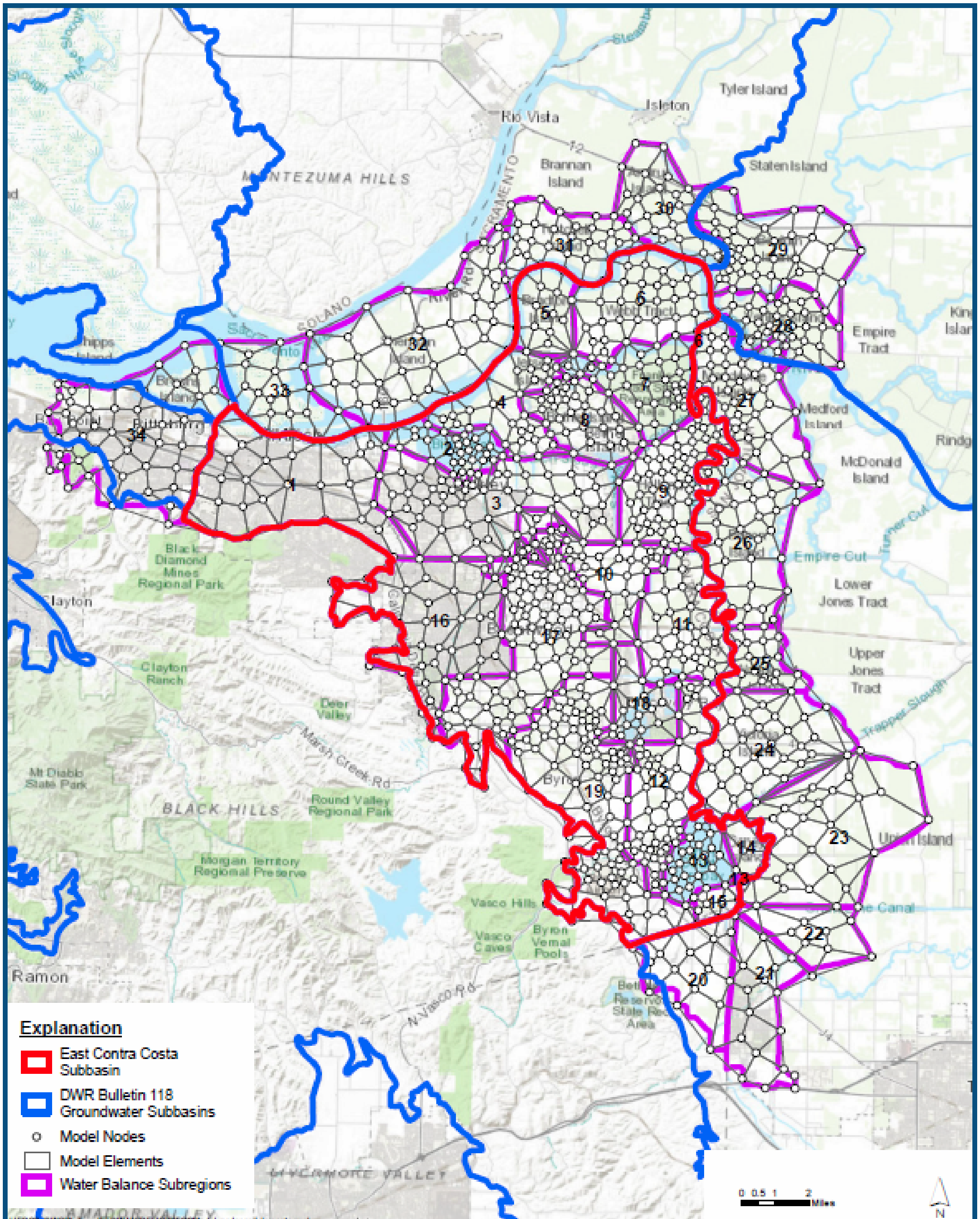
Several refinements were performed to the C2VSim-FG Beta2 model during development of ECCSim. These refinements produce a clearer, more comprehensive water budget model for future planning analyses and include the following:

- Model grid (node and element) refinements (**Figure 5-1a**)
    - The ECCSim grid contains 1,097 nodes and 1,209 elements that align with GSA boundaries, surface water features, and delta island geometry.
- Model subregion refinements (**Figure 5-1b** and **Table 5-2**)
    - The ECCSim model domain groups elements into subregions to assist in the summarization of model results and development of water budgets.
    - The ECCSim has 34 subregions; 19 of which are in the ECC Subbasin.
- Surface water bodies (**Figure 5-1c**)
    - CVHM and C2VSim-FG Beta2 only simulated the San Joaquin River and the Delta; ECCSim simulates Marsh Creek, Old River, Middle River, San Joaquin River, Big Break, Franks Tract, and Clifton Court Forebay.
- Model layers
    - The C2VSim-FG Beta2 model layering was adapted for ECCSim purposes to better represent the hydrogeological conceptual model (HCM) of the aquifer system through model layering.
    - The ECCSim model includes four aquifer layers (Shallow Aquifer in layers 1 and 2; Deep Aquifer in layers 3 and 4).
- Land use refinements
    - Due to changes in the model element and node configurations, the land use was updated and refined relative to C2VSim-FG Beta2 using land use surveys from 1995, 2014, and 2016 (DWR). The major land use types include irrigated agriculture crops, riparian and native vegetation, and urban.
- Aquifer parameter refinements
    - Due to differences in model layering and the more extensive calibration associated with ECCSim, aquifer parameters were refined by incorporating information about depositional environments for subsurface materials such as Alluvial Plain, Delta Islands, Fluvial Plain, and Marginal Delta Dune which are part of the basin setting (see **Section 3**).
- Model boundary conditions
    - General head boundaries were developed along the northern, eastern, and southern borders based on interpreted groundwater elevations from C2VSimFG Beta2 and calculated horizontal conductivity, distance between boundary nodes, aquifer layer thickness, and the distance from the model boundary.
- Groundwater pumping
    - Pumping within ECCSim is simulated using a combination of individual wells with assigned pumping and elemental pumping[14].

[14] The IWFM modeling platform allows for prescribed groundwater pumping from individual wells as time-series extraction data. Alternatively, for wells of known construction, water use type, and location, IWFM can estimate the amount of monthly pumping necessary to fulfill the water demands within each water balance subregion. These wells are assigned an extraction amount by the model itself, to the particular model element they are located within, and are therefore considered to be “elemental pumping”.

- Wells serving municipalities for which GSAs provided monthly pumping records were simulated directly.
- Elemental pumping is calculated internally by the Integrated Water Flow Model Demand Calculator component of the ECCSim model to meet both agricultural and domestic/urban demands after available surface water deliveries have been accounted for.
- The distribution of pumping by layer was modified based on well construction information in DWR's database of Well Completion Reports for wells within the model domain.

- Tile drains
  - Tile drains were incorporated in ECCSim based on historic drain maps and direct information from GSAs.
  - Information from GSAs indicate that tile drains occur at 5 to 8 feet below land surface.
- Surface water deliveries
  - Surface water deliveries for ECCSim were assigned as diversions from specified stream nodes with an assigned delivery destination (water balance subregion), and amounts were based on data received from individual GSAs as well as the State Water Resources Control Board Electronic Water Rights Information Management System (eWRIMS) database.

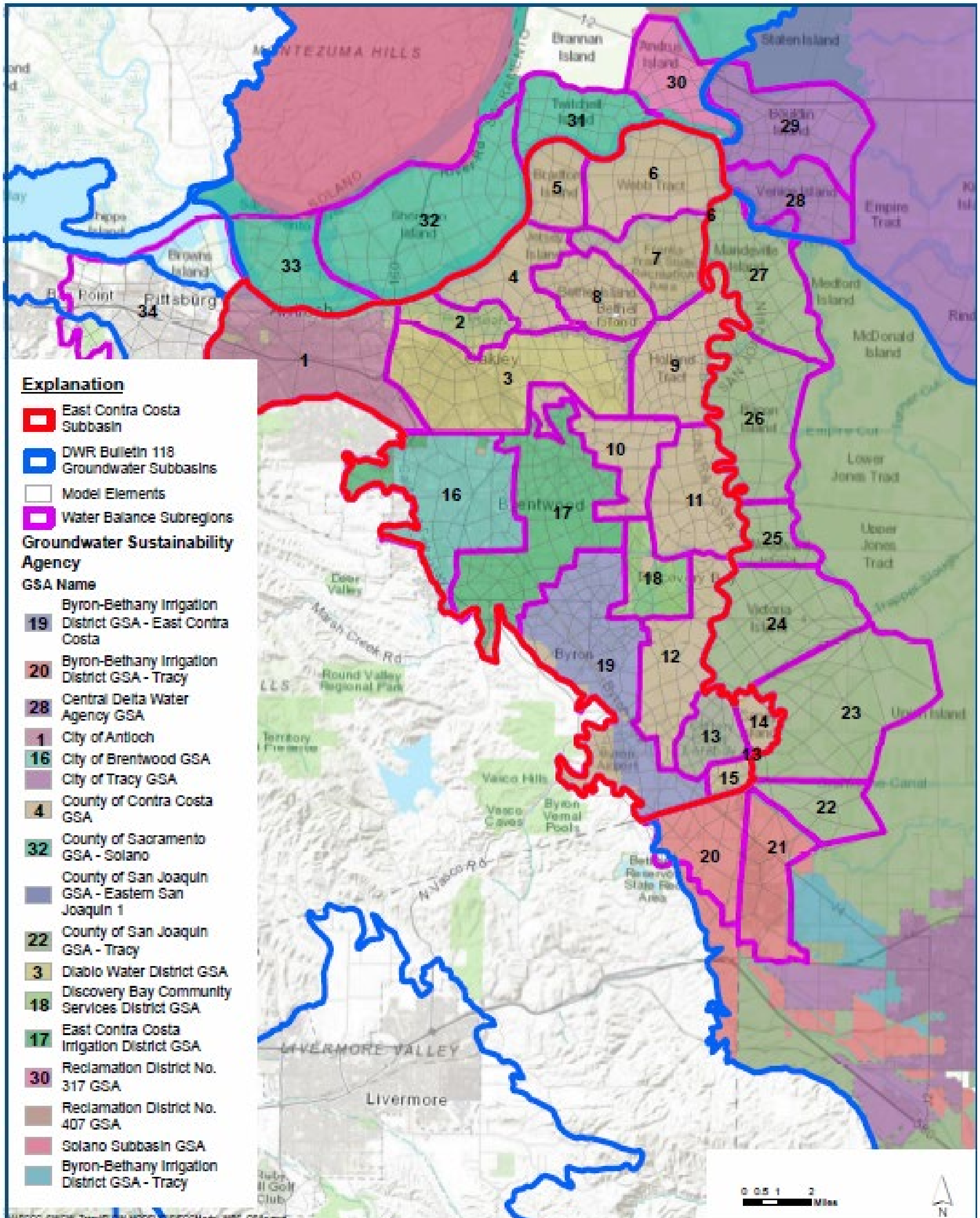


Luhdorff & Scalmanini Consulting Engineers

Model Grid and Node Refinement

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim)

Figure 5-1a

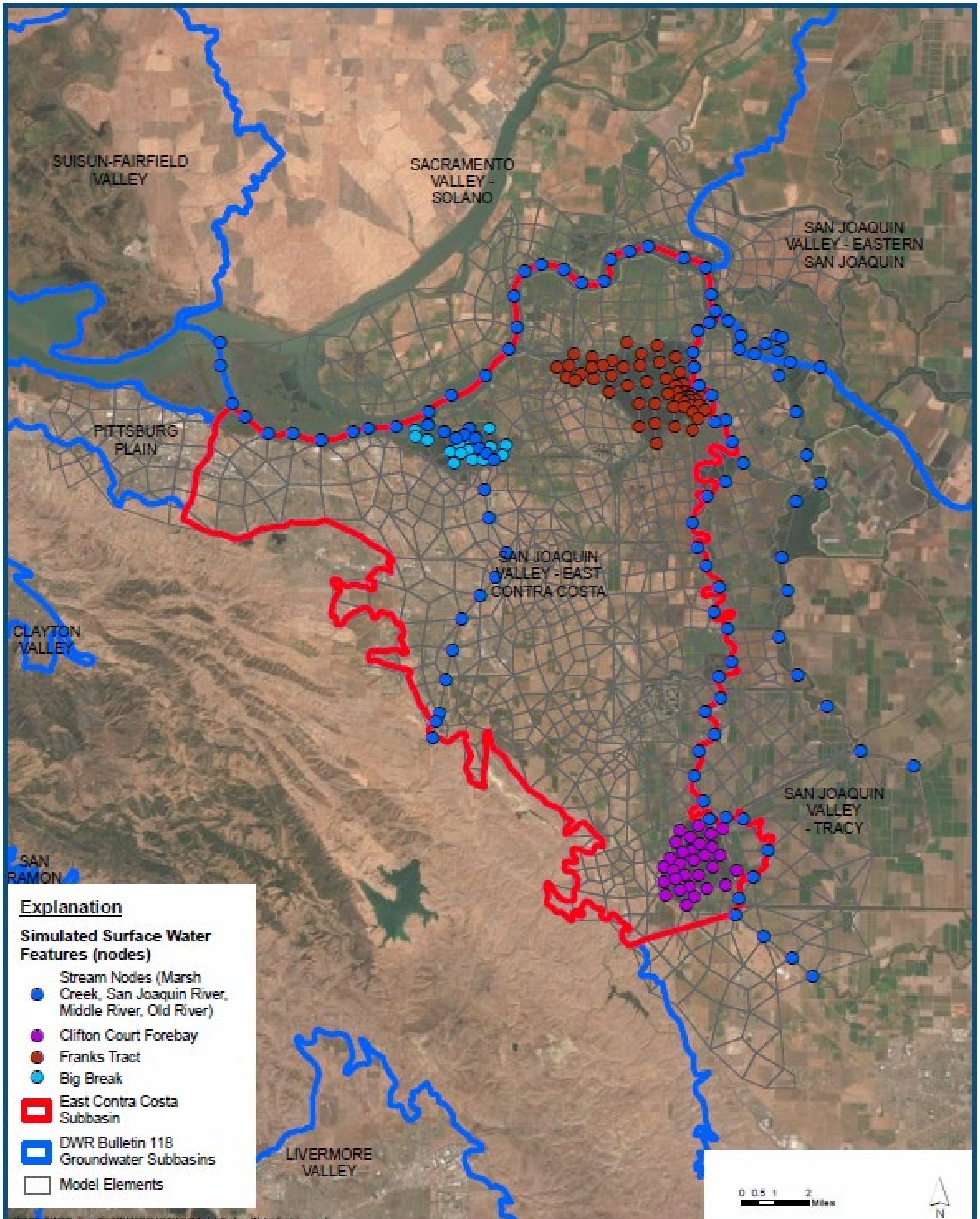


Luhdorff & Scalmanini
Consulting Engineers

Model Grid and Node Refinement

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim)

Figure 5-1b



Luhdorff & Scalmanini Consulting Engineers

Model Nodes for Simulated Surface Water Features

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim)

Figure 5-1c

Table 5-2 Water Balance Subregions

Subregion	Subbasin/Basin	GSA	Area
1	East Contra Costa	City of Antioch GSA	Antioch
2	East Contra Costa	Diablo Water District GSA	Big Break
3			Oakley
4	East Contra Costa	County of Contra Costa GSA	Jersey Island
5			Bradford Island
6			Webb Tract
7			Franks Tract
8			Bethel Island
9			Holland Tract
10			Knightsen
11			Orwood
12			South Discovery Bay
13			Clifton Court Forebay
14			Coney Island
15			South Clifton Court Forebay
16	East Contra Costa	City of Brentwood GSA	Brentwood
17	East Contra Costa	East Contra Costa Irrigation District GSA	ECCID
18	East Contra Costa	Discovery Bay Community Services District GSA	Town of Discovery Bay
19	East Contra Costa	Byron-Bethany Irrigation District GSA – East Contra Costa	BBID North (Byron Division)
20	Tracy	Byron-Bethany Irrigation District GSA - Tracy	BBID South (Bethany Division)
21			BBID Mountain House Division
22	Tracy	County of San Joaquin GSA – Tracy	Hammer Island
23			Union Island
24			Victoria Island
25			Woodward Island
26			Bacon Island
27			Mandeville Island
28	Eastern San Joaquin	Central Delta Water Agency GSA	Venice Island
29			Bouldin Island
30	Solano	Reclamation District No. 317 GSA	Andrus Island
31	Solano	County of Sacramento GSA - Solano	Twitchell Island
32			Sherman Island
33			Kimball Island
34	Pittsburg Plain	Not Applicable	Pittsburg

5.5.3 Projected (Future) Model Scenario(s)

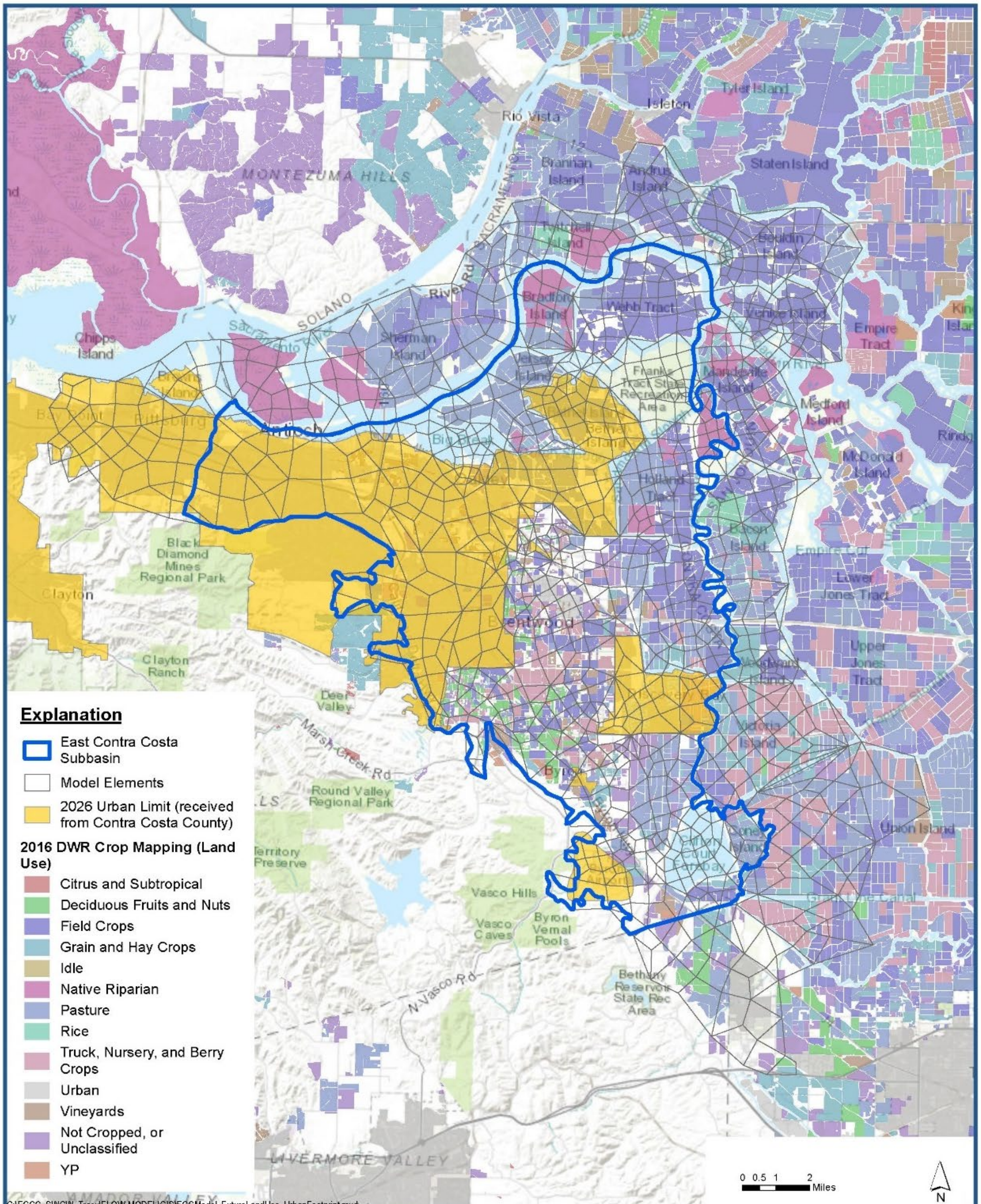
The projected future model scenarios involve simulating conditions in the ECC Subbasin from water year 2019 through water year 2068. Various future projected model scenarios were developed for this GSP document:

1) Future Land Use Change – this model scenario incorporates anticipated urban growth by 2026, as provided by Contra Costa County, with repeated hydrology;
2) Future Climate Change – this model scenario utilizes the land use change (urban growth) as well as the 2070 Central Tendency climate change adjustment factors to hydrologic conditions including evapotranspiration (ET), precipitation, surface water levels, and diversions;
3) Future Sea Level Rise – this model scenario utilizes the land use change (urban growth) in addition to incremental sea level rise on the northern surface water bodies in the ECCSim model domain, while using repeated hydrology;
4) Future Climate Change Plus Sea Level Rise – this model scenario incorporates land use change (urban growth), as well as both climate change and sea level rise adjustments to the hydrology;
5) Sustainable Yield – this model scenario incorporates land use change (urban growth) but was developed to increase groundwater pumping to determine an estimated sustainable yield of the ECC Subbasin.

The future land use scenario results in a larger urban footprint **(Figure 5-2)** based on planning information from the County[15]. Hydrology including evapotranspiration, precipitation, and surface water levels were adapted from values from previous years using the pattern of water year type associated with the historic 50-year time period (1954 to 2003). Development of the future climate change hydrology conditions inputs are based on DWR's Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development document (DWR, 2018). DWR provides climate change adjustment values for climate data, streamflow data, and sea-level rise information. These adjustments are applied to historical hydrology to achieve a future hydrologic period of 50 years that are representative of hydrology potentially occurring in the future. The 2070 central tendency climate change scenario was selected for this future climate scenario analysis.

Regarding sea level rise, DWR's Guidance Document mentions that sea-level rise estimates by the National Research Council (NRC) provide two values of expected sea-level rise as median predicted values for the years 2030 and 2070. These two values are 15 and 45 centimeters, respectively, or about 0.5 to 1.4 feet of sea-level rise. Values were assigned on an annual basis through linear interpolation of these projections.

[15] Contra Costa County provided a GIS shapefile representing the 2030 urban footprint via email (pers. comm. Ryan Hernandez, February 18, 2021).



Luhdorff & Scalmanini Consulting Engineers

Future Urban Footprint (2026) & Land Use (2016)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim)

Figure 5–2

5.6 Subbasin Water Budget Results (§354.18(a) to (d))

This section includes a description of the accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored.

5.6.1 Inflows and Outflows Entering and Leaving the Basin

The various water budget components of inflows and outflows including surface water entering and leaving the basin occurs through various locations along the border of the ECC Subbasin. Using the integrated groundwater and surface water model, ECCSim, it is possible to quantify the amount of water entering and exiting the basin via various water budget components. Groundwater inflows include subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems (e.g., streams, rivers, canals, and conveyance systems). Groundwater outflows include evapotranspiration, groundwater extraction (pumping), groundwater discharge to surface water sources, and subsurface groundwater outflow.

Water budget components can be grouped or categorized into detailed water budget accounting centers to represent different mechanisms within the Subbasin:

1. land and water use activities (such as supply and demand for urban and agricultural land uses),
2. root zone activities (such as agricultural applied water, precipitation, evapotranspiration, and percolation), as well as
3. groundwater activities (such as surface water/groundwater interaction, tile drain flows, groundwater pumping, recharge via deep percolation, small watershed contributions, and subsurface lateral flow).

Water budget components for these three accounting centers are qualitatively described in **Table 5-3** below. Each water budget component listed in in the table is calculated on a monthly basis using ECCSim and summarized annually for each water year. The quantitative values are presented in both graphical and tabular form for the model Base Period (water years 1997 to 2018) depending on the detailed water budget accounting center.

Table 5-3. Water Budget Accounting Components Simulated Using ECCSim

Simulated Water Budget Accounting Center	Detailed Component	Category	Description
Land and Water Use (Agricultural and urban land use sectors)	Surface Water Deliveries	Inflow	Deliveries from conveyance systems to customers; includes diversions and surface water rights. This water component is separated for urban and agricultural water uses.
	Groundwater Extraction	Inflow	Groundwater pumping to meet water demands. This water component is separated for urban and agricultural water uses.
	Urban Demand	Outflow	Water demand associated with urban land use.
	Agricultural Demand	Outflow	Water demand associated with agricultural land use.
Root Zone (Agricultural, urban, and native/riparian vegetation land use sectors)	Agricultural Applied Water	Inflow	Applied water to satisfy agricultural water demand (may come from surface water deliveries and/or groundwater extraction).
	Agricultural Effective Precipitation	Inflow	Precipitation on agricultural land that helps meet agricultural demand.
	Agricultural Evapotranspiration	Outflow	Evapotranspiration associated with the variety of crops within the Subbasin.
	Agricultural Percolation	Outflow	Applied water and precipitation on agricultural land that is in excess of the evapotranspiration requirement and passes through the root zone to reach the groundwater water table.
	Urban Applied Water	Inflow	Water applied to landscaping within urban land use features (can come from surface water deliveries and/or groundwater pumping).
	Urban Effective Precipitation	Inflow	Water from precipitation that helps support outdoor urban land use demands such as landscaping.
	Urban Evapotranspiration	Outflow	Evapotranspiration associated with outdoor urban water demand.
	Urban Percolation	Outflow	Applied water and precipitation on urban land that is in excess of the evapotranspiration requirement and passes through the root zone to reach the groundwater water table.

Simulated Water Budget Accounting Center	Detailed Component	Category	Description
	Native/Riparian Vegetation Effective Precipitation	Inflow	Water from precipitation that supports native and riparian vegetation.
	Native/Riparian Vegetation Evapotranspiration	Outflow	Evapotranspiration associated with native and riparian vegetation within the Subbasin.
	Native/Riparian Vegetation Percolation	Outflow	Precipitation on native/riparian vegetation that is in excess of the evapotranspiration requirement and passes through the root zone to reach the groundwater water table.
Groundwater (all land use sectors including urban, agricultural, and native/riparian vegetation)	Groundwater flow to/from Surface Water Features	Inflow or Outflow	This is the surface water/groundwater interaction component that represents stream leakage (in the case of losing stream conditions) or groundwater contributions to surface water (during gaining stream conditions). Streams include Marsh Creek, Old River, and the San Joaquin River. For the ECC Subbasin, this component also includes surface water interaction with groundwater associated with delta island surface water features, such as Big Break and Franks Tract, but also Clifton Court Forebay to the south.
	Drains	Outflow	Tile drains historically and currently used to lower the water table in certain areas within the Subbasin.
	Diversion Recoverable Loss	Inflow	This water budget component represents leakage of surface water through conveyances within the Subbasin.
	Small Watershed Contributions	Inflow	Small watersheds along the western boundary of the Subbasin contribute some water to the groundwater system.
	Recharge via Deep Percolation	Inflow	Water that travels vertically through the root zone to reach the water table and enter the groundwater system.
	Groundwater Extraction (Pumping)	Outflow	Pumping of groundwater to satisfy urban and agricultural water demands.
	Subsurface Inflow and Outflow	Inflow or Outflow	Subsurface lateral flow into or out of the Subbasin.
	Groundwater Storage	Inflow minus Outflow = Change in Storage	This component is used to determine the change in aquifer storage over time and can help determine if a basin is in balance, is full, or is in overdraft.

The first simulated water budget accounting center, for land and water use, utilizes well pumping information developed for the GSP by the GSAs within the ECC Subbasin. Elemental groundwater pumping (where pumping rates are not directly input) is invoked when surface water deliveries (specified for urban, agricultural, or both land uses) are insufficient to meet water demands. Elemental groundwater pumping is based on well completion report (WCR) records for which well depths and well types are known or estimated. Surface water deliveries previously developed for the GSP as reported by GSAs within ECC Subbasin were supplemented by individual water rights adapted from eWRIMS. **Table 5-4** below shows the simulated land and water use for the Subbasin, as well as the average land and water use amounts associated with the model Base Period (water years 1997-2018). ECCSim simulates the majority of agricultural and urban demand being satisfied by surface water deliveries. The simulation indicates that during some years there are small amounts of surplus water supplies (agricultural or urban demand shortage term is negative), and other years there are small amounts of water demand shortage.

The simulated root zone budget details the movement of different water sources within agricultural, urban, and native/riparian vegetation land use sectors, the land surface, and the underlying groundwater aquifer system. Using the ECCSim monthly timestep simulated outputs, these components are summarized for water years during the model Base Period (water years 1997-2018). The annual values of simulated applied water, effective precipitation, evapotranspiration, and percolation that occur in the root zone are provided in **Table 5-5** for agricultural, urban, and native/riparian vegetation land uses.

Table 5-4. Simulated Land and Water Use Budget Components for Base Period, WY 1997-2018 (Units in Acre-Feet per Year, AFY)

Water Year	Ag. Supply Requirement	Ag. Pumping	Ag. Deliveries	Ag. Demand Shortage	Urban Supply Requirement	Urban Pumping	Urban Deliveries	Urban Water Demand Shortage
1997	173,948	35,436	138,553	-41	24,246	7,470	17,102	-325
1998	139,759	29,767	110,091	-99	25,303	8,980	15,356	967
1999	164,080	32,735	130,615	730	26,360	8,176	17,085	1,100
2000	166,727	34,359	132,094	275	27,393	7,612	18,403	1,377
2001	173,716	39,147	132,851	1,719	28,425	7,713	19,969	743
2002	174,548	42,841	131,694	13	29,458	8,794	20,389	274
2003	167,222	41,496	125,794	-68	30,490	9,349	20,583	558
2004	174,627	41,093	133,654	-120	31,523	9,798	21,708	17
2005	150,977	35,293	115,679	5	32,555	10,123	21,844	588
2006	162,067	42,915	119,338	-187	33,588	10,830	21,565	1,193
2007	182,393	42,027	139,957	410	34,620	10,213	24,181	226
2008	186,743	47,873	138,754	116	35,303	10,378	23,183	1,743
2009	174,105	45,618	129,367	-880	32,658	10,024	23,112	-477
2010	155,735	37,990	117,843	-98	33,084	10,080	22,931	73
2011	147,850	35,498	112,640	-289	33,509	9,467	23,847	195
2012	174,046	43,108	128,765	2,173	33,935	9,088	24,383	465
2013	191,902	21,655	169,710	537	33,982	10,849	21,663	1,470
2014	194,431	31,298	163,386	-253	34,407	11,017	22,070	1,320
2015	166,604	39,747	127,011	-155	25,924	7,893	17,768	264
2016	172,588	35,734	136,356	498	26,607	6,439	20,495	-327
2017	156,725	35,233	121,314	178	26,724	7,174	19,836	-285
2018	159,944	32,947	127,004	-7	26,724	6,733	20,170	-178
Average	168,670	37,446	131,021	203	30,310	9,009	20,802	499

Table 5-5. Simulated Root Zone Budget Components for Base Period, WY 1997-2018 (Units in Acre-Feet per Year, AFY)

Water Year	Agricultural Land Use Area (Acres)	Ag. Precip. (+)	Ag. Applied Water (+)	Ag. Et (-)	Ag. Perc. (-)	Urban Land Use Area (Acres)	Urban Precip (+)	Urban Applied Water (+)	Urban Et (-)	Urban Perc. (-)	Native & Riparian Veg. Land Use Area (Acres)	Native & Riparian Veg. Precip (+)	Native & Riparian Veg. Et (-)	Native & Riparian Veg. Perc. (-)
1997	50,035	67,815	173,990	179,806	61,747	19,396	25,436	24,571	16,831	33,165	39,719	52,569	36,907	15,679
1998	50,035	113,418	139,858	170,867	82,546	19,396	44,125	24,336	21,809	46,600	39,719	88,097	59,334	28,389
1999	50,035	51,736	163,350	173,000	41,955	19,396	19,096	25,260	18,297	26,083	39,719	39,688	34,648	5,331
2000	50,035	67,803	166,453	179,642	54,775	19,396	25,724	26,016	19,556	32,171	39,719	52,511	41,042	11,453
2001	50,035	50,060	171,997	182,790	39,257	19,396	18,350	27,682	19,440	26,596	39,719	39,294	35,012	4,296
2002	50,035	53,812	174,535	181,778	46,484	19,396	20,229	29,184	19,049	30,375	39,719	42,216	34,929	7,464
2003	50,035	60,586	167,289	179,842	48,083	19,396	22,172	29,932	20,183	31,909	39,719	47,479	38,591	8,699
2004	50,035	53,734	174,747	181,061	47,444	19,396	20,049	31,506	18,722	32,802	39,719	41,940	33,746	8,079
2005	50,035	89,122	150,972	177,575	62,718	19,396	35,331	31,967	24,160	43,133	39,719	69,438	54,484	15,051
2006	50,035	82,988	162,253	183,310	61,892	19,396	32,715	32,395	23,020	42,103	39,719	64,515	50,055	14,569
2007	50,035	34,448	181,984	180,444	36,028	19,396	12,766	34,394	19,289	27,840	39,719	26,252	23,110	3,194
2008	50,035	42,795	186,627	183,910	45,315	19,396	15,828	33,560	18,248	31,192	39,719	33,414	26,749	6,813
2009	50,035	51,320	174,985	185,103	41,132	19,396	21,119	33,135	21,764	32,480	39,719	40,184	34,840	5,031
2010	50,035	66,927	155,833	175,730	47,212	19,396	27,654	33,011	23,930	36,728	39,719	52,014	45,226	6,928
2011	50,035	81,377	148,138	173,735	55,812	19,396	31,783	33,314	24,446	40,655	39,719	63,282	51,093	12,048
2012	50,035	41,388	171,873	178,126	35,115	19,396	16,672	33,470	21,315	28,821	39,719	31,933	28,907	3,199
2013	41,730	39,117	191,365	181,222	48,381	21,454	19,479	32,512	22,012	35,438	45,965	42,132	33,445	6,708
2014	41,730	29,643	194,684	183,458	40,737	21,454	15,859	33,087	20,758	28,235	45,965	32,179	29,069	3,252
2015	41,329	42,671	166,759	163,801	46,733	22,585	24,714	25,660	18,676	32,463	45,236	46,561	35,228	11,194
2016	41,329	20,731	172,090	161,966	30,947	22,585	11,211	26,934	16,102	22,038	45,236	21,969	19,246	2,789
2017	41,329	63,558	156,547	168,560	51,785	22,585	33,834	27,009	21,803	39,012	45,236	68,607	53,525	14,773
2018	41,329	41,399	159,951	165,665	35,596	22,585	21,522	26,903	20,655	27,783	45,236	44,783	39,796	5,051
Average	47,697	56,657	168,467	176,881	48,259	20,163	23,439	29,811	20,458	33,074	41,290	47,321	38,135	9,090

The simulated groundwater budget embodies the movement of water within the groundwater aquifer. Using the ECCSim monthly timestep simulated outputs, these components are summarized for water years during the model Base Period (water years 1997-2018). Simulated values of groundwater leaving the subsurface via drains, the movement, or exchange, of water between surface water features, contributions from small watersheds in the western portion of the Subbasin, contributions from unlined conveyances (diversion recoverable loss), groundwater leaving the aquifer via groundwater extraction (pumping), and subsurface lateral flow are presented in **Table 5-6**. These groundwater budget terms provide the inflows and outflows from which the change in storage can be calculated (inflow minus outflow = change in storage). The annual changes in groundwater storage and the cumulative change in groundwater storage are also presented in **Table 5-6**.

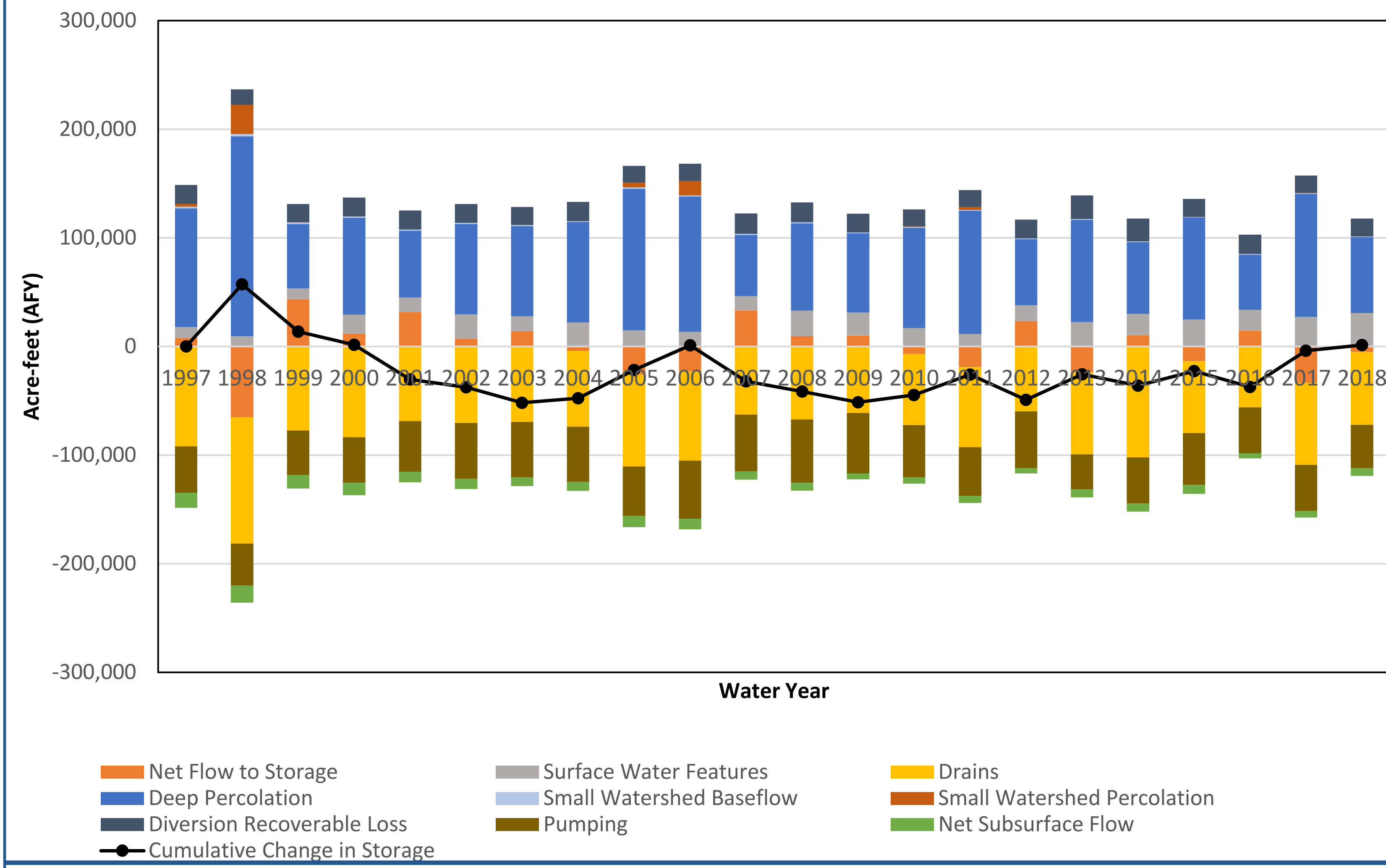
5.6.2 ECC Subbasin Water Balance

Generally, water leaves the groundwater system within ECC Subbasin through drains, groundwater extraction (pumping), and through subsurface lateral flow (leaving the subbasin). Water enters the groundwater body via surface water features, deep percolation (recharge), small watershed contributions, and diversion recoverable loss. The change in storage term along with the cumulative change in storage term indicate that the ECC Subbasin is in balance. If the subbasin was depleting groundwater storage, or in overdraft, the change in storage and the cumulative change in storage would be negative and growing more negative over time. The simulation results indicate that this is not the case in the ECC Subbasin. The simulated groundwater budget timeseries components are plotted along with the cumulative change in storage in order to illustrate the proportions of the various components and to see that the basin is operating within its sustainable yield during the model Base Period (water year 1997-2018) (**Figure 5-3**).

The following sections discuss groundwater inflows and outflows in the ECC Subbasin and the resultant changes in storage.

Table 5-6. Simulated Groundwater Budget Components for Base Period, WY 1997-2018 (Units in Acre-Feet per Year, AFY)

WATER YEAR	DRAINS	SURFACE WATER FEATURES	DEEP PERCOLATION	SMALL WATERSHED BASEFLOW	SMALL WATERSHED PERCOLATION	DIVERSION RECOVERABLE LOSS	PUMPING	NET SUBSURFACE FLOW	NET STORAGE CHANGE	CUMULATIVE CHANGE IN STORAGE
1997	-91,890	9,843	109,296	1,417	2,499	17,688	-42,906	-13,738	-8,095	0
1998	-116,071	9,481	184,027	2,320	26,702	14,255	-38,747	-15,817	65,310	57,214
1999	-77,389	10,075	58,923	1,617	110	16,784	-40,910	-12,461	-43,556	13,659
2000	-83,593	17,343	89,128	1,340	85	17,102	-41,971	-11,243	-12,012	1,647
2001	-68,650	13,188	61,586	1,160	0	17,366	-46,860	-9,614	-31,853	-30,206
2002	-70,279	22,222	83,420	1,034	0	17,282	-51,636	-9,302	-7,272	-37,478
2003	-69,411	13,556	83,001	949	0	16,634	-50,844	-8,204	-14,293	-51,771
2004	-69,792	22,056	92,525	853	0	17,655	-50,891	-8,218	4,180	-47,591
2005	-84,609	14,873	130,479	1,102	4,232	15,628	-45,417	-10,363	25,834	-21,757
2006	-82,001	13,348	124,671	1,172	13,094	16,012	-53,745	-9,590	22,896	1,139
2007	-62,782	13,268	56,414	965	0	18,652	-52,240	-7,426	-33,147	-32,008
2008	-67,260	23,472	80,468	860	0	18,402	-58,251	-7,163	-9,469	-41,477
2009	-61,145	21,351	72,929	764	0	17,327	-55,642	-5,523	-9,933	-51,410
2010	-65,629	16,888	92,632	730	71	15,997	-48,070	-5,897	6,732	-44,679
2011	-73,746	11,409	113,521	850	2,717	15,510	-44,965	-6,426	18,871	-25,807
2012	-59,777	14,511	60,715	768	0	17,403	-52,196	-4,888	-23,432	-49,239
2013	-75,616	22,718	93,805	695	0	21,747	-32,504	-7,131	23,716	-25,523
2014	-101,955	19,546	66,114	612	0	21,075	-42,315	-7,768	-10,493	-36,016
2015	-66,415	24,787	93,960	572	0	16,452	-47,640	-8,290	13,411	-22,605
2016	-56,081	19,034	50,799	498	0	17,824	-42,173	-4,664	-14,713	-37,319
2017	-75,304	27,194	113,293	682	212	16,040	-42,407	-6,123	33,549	-3,769
2018	-66,938	30,852	69,813	518	0	16,724	-39,680	-7,161	5,216	1,447
Average	-74,833	17,773	90,069	976	2,260	17,253	-46,455	-8,500	66	-21,980



Luhdorff & Scalmanini Consulting Engineers

Groundwater Budget for East Contra Costa Subbasin Historical Calibration Period (1997-2018)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

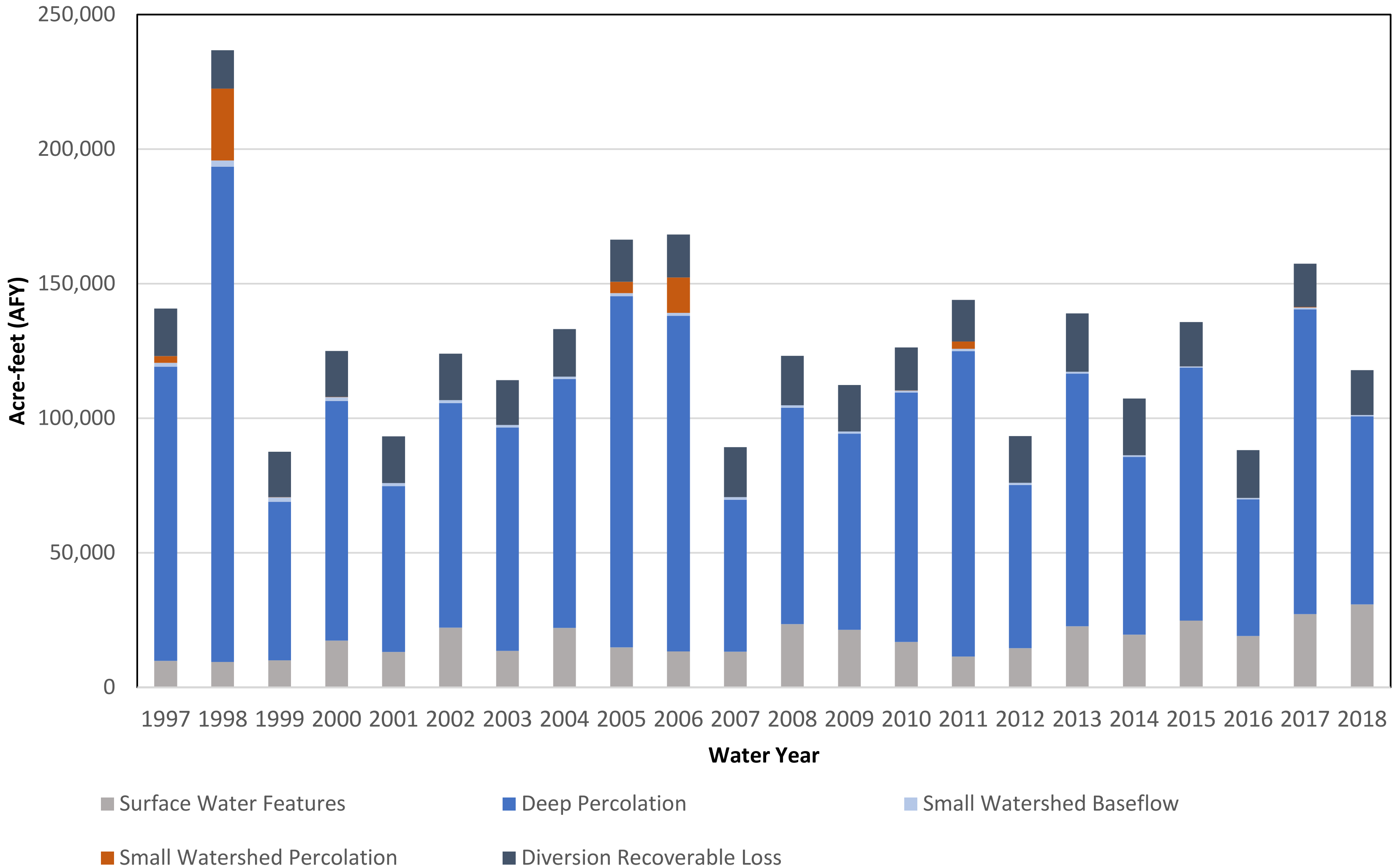
Figure 5-3

5.6.3 Quantification of Groundwater Inflow

The simulated groundwater budget described and quantified above indicate that the groundwater inflow components of the water budget include contributions from surface water features, deep percolation (recharge), small watershed contributions, and diversion recoverable loss (conveyance systems). These groundwater inflows are presented in tabular form in **Table 5-7** and graphically in **Figure 5-4**. The largest groundwater inflow component is groundwater recharge through deep percolation. Deep percolation includes water reaching past the root zone to the water table from precipitation and excess applied water. Surface water features and diversion recoverable losses account for most of the remaining groundwater inflows, with a very small proportion contributed by the small watersheds to the west of the Subbasin.

Table 5-7. Simulated Groundwater Inflow Components for Base Period, WY 1997-2018 (Units are in Acre-Feet per Year, AFY)

Water Year	Surface Water Features	Deep Percolation	Small Watershed Baseflow	Small Watershed Percolation	Diversion Recoverable Loss
1997	9,843	109,296	1,417	2,499	17,688
1998	9,481	184,027	2,320	26,702	14,255
1999	10,075	58,923	1,617	110	16,784
2000	17,343	89,128	1,340	85	17,102
2001	13,188	61,586	1,160	0	17,366
2002	22,222	83,420	1,034	0	17,282
2003	13,556	83,001	949	0	16,634
2004	22,056	92,525	853	0	17,655
2005	14,873	130,479	1,102	4,232	15,628
2006	13,348	124,671	1,172	13,094	16,012
2007	13,268	56,414	965	0	18,652
2008	23,472	80,468	860	0	18,402
2009	21,351	72,929	764	0	17,327
2010	16,888	92,632	730	71	15,997
2011	11,409	113,521	850	2,717	15,510
2012	14,511	60,715	768	0	17,403
2013	22,718	93,805	695	0	21,747
2014	19,546	66,114	612	0	21,075
2015	24,787	93,960	572	0	16,452
2016	19,034	50,799	498	0	17,824
2017	27,194	113,293	682	212	16,040
2018	30,852	69,813	518	0	16,724
Average	17,773	90,069	976	2,260	17,253



Luhdorff & Scalmanini Consulting Engineers

Groundwater Budget Inflow Components
East Contra Costa Subbasin Base Period (1997-2018)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

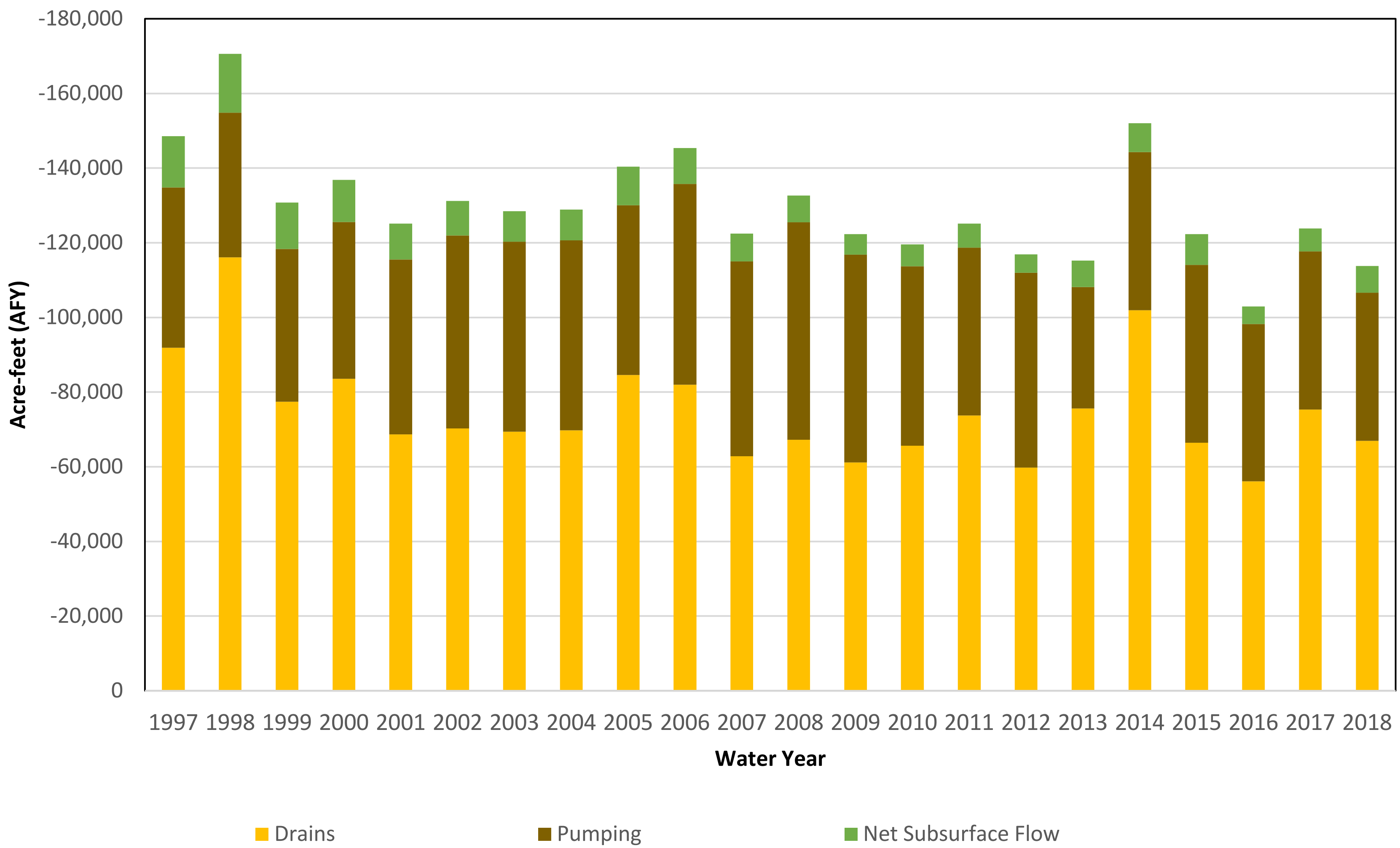
Figure 5-4

5.6.4 Quantification of Groundwater Outflow

The simulated groundwater budget described and quantified in **Section 5.6.3** indicates that the groundwater outflow components of the water budget consist of drains, groundwater pumping, and the net of subsurface lateral flow. These groundwater outflows are presented in tabular form in **Table 5-8** and graphically in **Figure 5-5**. The largest groundwater outflow components are tile drains and pumping. Net subsurface lateral flow makes up the remaining groundwater outflow components.

Table 5-8. Simulated Groundwater Outflows for Base Period, WY 1997-2018 (Units are in Acre-Feet per Year, AFY)

Water Year	Drains	Pumping	Net Subsurface Flow
1997	-91,890	-42,906	-13,738
1998	-116,071	-38,747	-15,817
1999	-77,389	-40,910	-12,461
2000	-83,593	-41,971	-11,243
2001	-68,650	-46,860	-9,614
2002	-70,279	-51,636	-9,302
2003	-69,411	-50,844	-8,204
2004	-69,792	-50,891	-8,218
2005	-84,609	-45,417	-10,363
2006	-82,001	-53,745	-9,590
2007	-62,782	-52,240	-7,426
2008	-67,260	-58,251	-7,163
2009	-61,145	-55,642	-5,523
2010	-65,629	-48,070	-5,897
2011	-73,746	-44,965	-6,426
2012	-59,777	-52,196	-4,888
2013	-75,616	-32,504	-7,131
2014	-101,955	-42,315	-7,768
2015	-66,415	-47,640	-8,290
2016	-56,081	-42,173	-4,664
2017	-75,304	-42,407	-6,123
2018	-66,938	-39,680	-7,161
Average	-74,833	-46,455	-8,500



Luhdorff & Scalmanini
Consulting Engineers

Groundwater Budget Outflow Components
East Contra Costa Subbasin Base Period (1997-2018)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

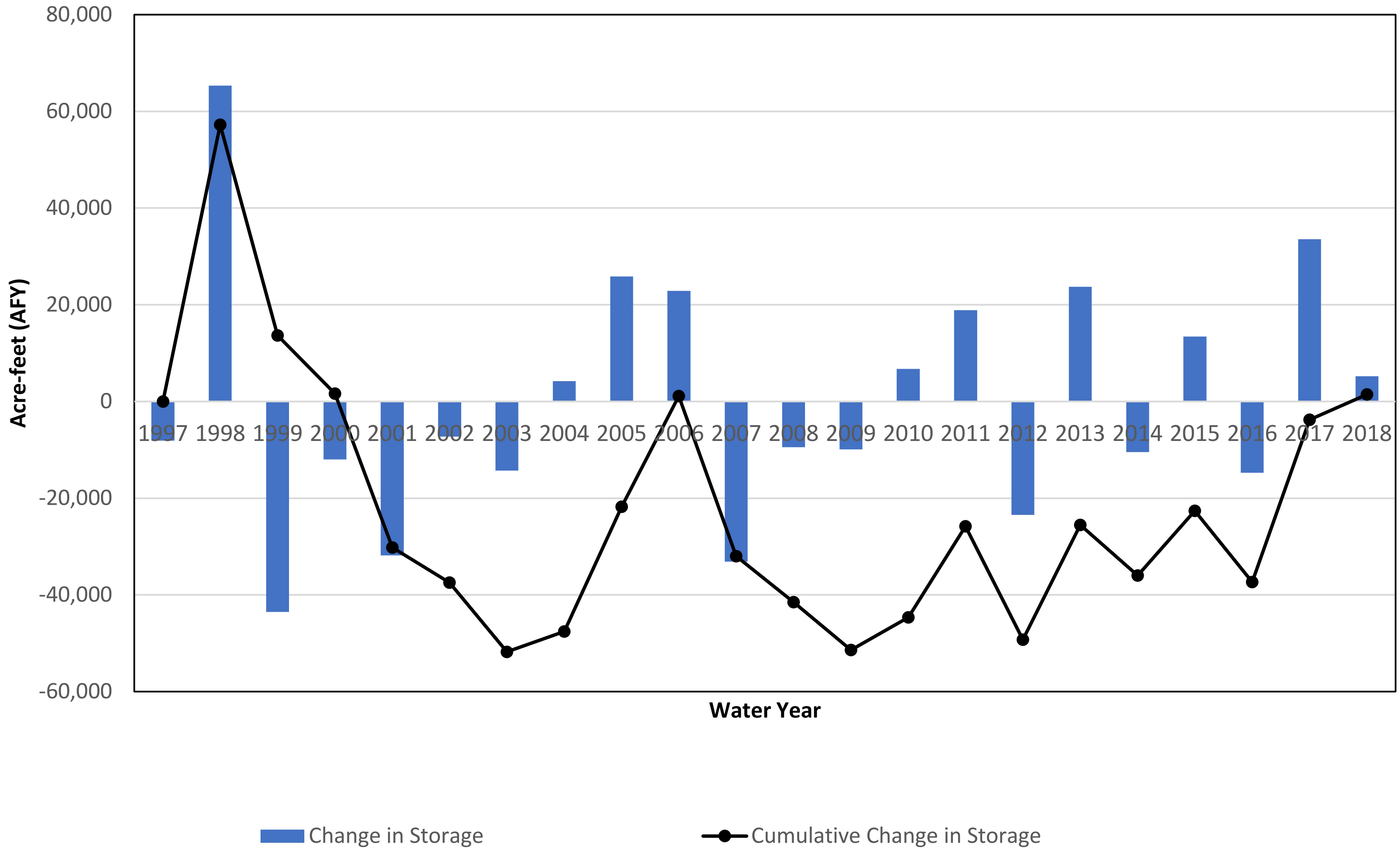
Figure 5-5

5.6.5 Change in Groundwater Storage

Quantification of the change in annual groundwater storage is presented on a water year annual basis in **Table 5-9**. The net annual simulated change in storage and the cumulative change in storage are plotted graphically in **Figure 5-6**. This figure illustrates that the basin is not in overdraft over the model Base Period (water years 1997-2018). The average change in storage over this period is almost 70 AFY. This represents 0.05% of the groundwater inflows and outflows that comprise the groundwater budget for the groundwater Subbasin.

Table 5-9. Simulated Groundwater Storage Component for Base Period,WY 1997-2018 (Units are in Acre-Feet per Year, AFY)

Water Year	Net Storage Change	Cumulative Change In Storage
1997	-8,095	0
1998	65,310	57,214
1999	-43,556	13,659
2000	-12,012	1,647
2001	-31,853	-30,206
2002	-7,272	-37,478
2003	-14,293	-51,771
2004	4,180	-47,591
2005	25,834	-21,757
2006	22,896	1,139
2007	-33,147	-32,008
2008	-9,469	-41,477
2009	-9,933	-51,410
2010	6,732	-44,679
2011	18,871	-25,807
2012	-23,432	-49,239
2013	23,716	-25,523
2014	-10,493	-36,016
2015	13,411	-22,605
2016	-14,713	-37,319
2017	33,549	-3,769
2018	5,216	1,447
Average	66	



Luhdorff & Scalmanini
Consulting Engineers

Groundwater Budget Storage Component
East Contra Costa Subbasin Base Period (1997-2018)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-6

5.6.6 Water Year Types

The ECCSim model Base Period of water years 1997 through 2018 contain wet, above normal, below normal, dry, and critical water year types (see **Table 5-10** below). This modeling tool can be used to quantify water budget components according to water year types. Water budget components including the annual supply, demand, and change in groundwater storage can vary according to water year type. The simulated agricultural and urban supply and demand amounts are averaged for the various water year types that occur during the base period. These values are quantified in **Table 5-11**, and show that during drier years, agricultural and urban demand is higher than in wetter years. Due to the reliably available agricultural surface water deliveries in the Subbasin, surface water supplies have not been impacted during dry years. The reliability of surface water is reflected in the fact that over half the available supply is based on pre-1914 water rights owned by City of Antioch, ECCID, and BBID (see **Section 4**, **Table 4-5**).

The change in groundwater storage can also be quantified based on water year type using the ECCSim tool. There is variability associated with groundwater storage changes that are not directly attributable to water year types. Changes in land use and supply mechanisms can have an impact on groundwater storage that may or may not have to do with the water year type. The box plot of average change in groundwater storage by water year type (**Figure 5-7)** shows that there is a general relationship of replenishing groundwater storage in wet years, and storage depletion in drier years. However, these relationships are not completely consistent. For example, in 1999 and 2000, storage depletion is indicated by the simulation (negative change in storage), despite being categorized as "above normal" water year type. Similarly, 2013 and 2015, which are considered "critical" water year types, have storage replenishment being simulated. These exceptions are due to the amount of surface water deliveries reported during those years and the amount of groundwater pumping needed to satisfy the demand.

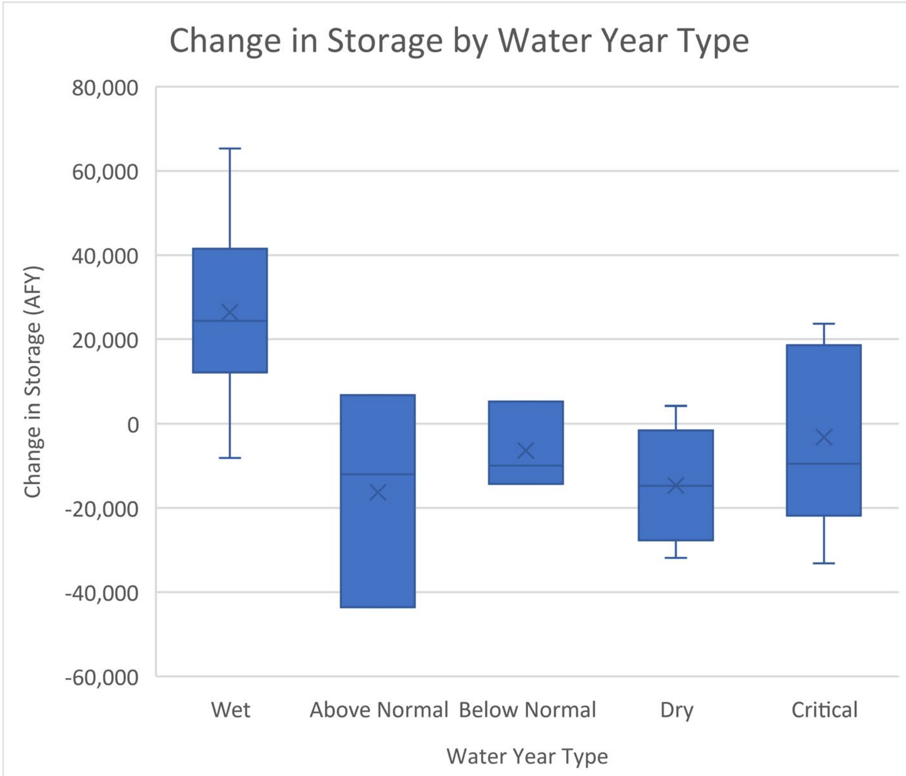
Table 5-10. Water Year Types During the Base Period

Water Year	Water Year Type	Water Year	Water Year Type
1997	W	2013	C
1998	W	2014	C
1999	AN	2015	C
2000	AN	2016	D
2001	D	2017	W
2002	D	2018	BN
2003	BN		
2004	D	W = Wet	
2005	W		
2006	W	D = Dry	
2007	C		
2008	C	AN = Above Normal	
2009	BN		
2010	AN	BN = Below Normal	
2011	W		
2012	D	C = Critical	

Table 5-11. Simulated Agricultural and Urban Supply and Demand (Units in Acre-Feet Per Year, AFY)

Water Year Type	Average Agricultural Demand	Average Agricultural Pumping	Average Agricultural Sw Deliveries	Average Agricultural Effective Precipitation	Average Urban Demand	Average Urban Pumping	Average Urban Sw Deliveries
Wet (6 simulated years in the base period)	155,221	35,690	119,603	46,141	29,321	9,007	19,925
Above Normal (3 simulated years in the base period)	162,181	35,028	126,851	41,878	28,946	8,623	19,473
Below Norma (3 simulated years in the base period)	167,090	40,020	127,388	36,044	29,958	8,702	21,288
Dry (5 simulated years in the base period)	173,905	40,385	132,664	32,680	29,990	8,367	21,389
Critical (5 simulated years in the base period)	184,415	36,520	147,764	27,339	32,847	10,070	21,773

Figure 5-7. Average Simulated Change in Storage by Water Year Type



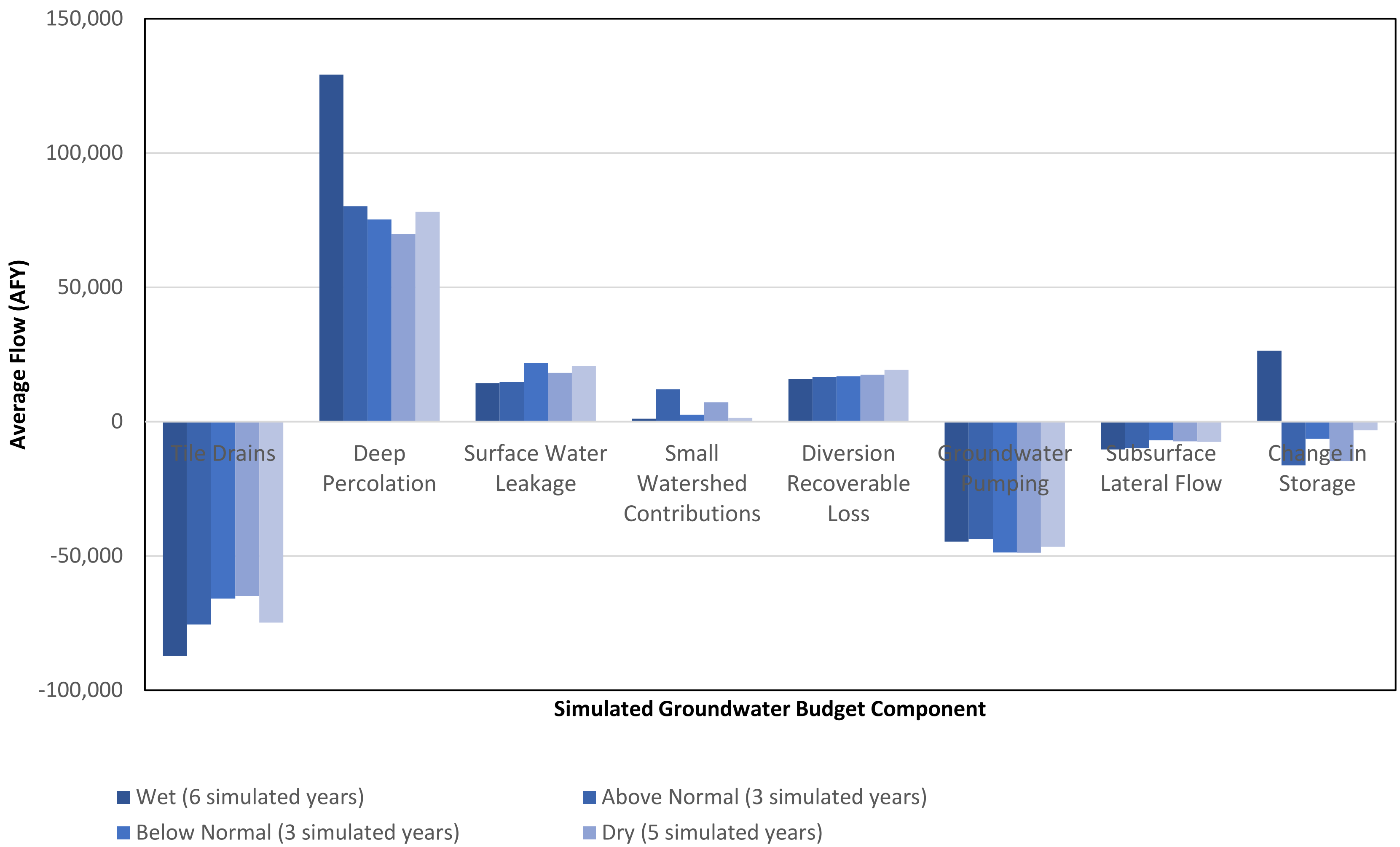
5.6.7 Historical Water Budget

The historical water budget quantified during the model Base Period extends from the most recently available information (water year 2018) to 1997, or 22 years. This period is sufficient to calibrate and reduce uncertainty with the ECCSim model, and therefore reduce the uncertainty of the future aquifer response to planned or anticipated changes in land use or hydrology (e.g., climate change or sea level rise). Historical conditions of hydrology, water demand, and surface water supply availability and reliability are the factors that have enabled the ECC Subbasin to operate well within the sustainable yield. In fact, the Subbasin has had stable groundwater levels with no apparent undesirable results as discussed in **Section 3**, **Basin Setting**.

The historical water budget can be summarized based on water year type, as quantified in the above section and further detailed below. **Table 5-12** quantifies the average groundwater budget components based on water year type. These values are also plotted in **Figure 5-8**. The historical groundwater budget by water year type indicates that tile drains increase the amount of flow leaving the Subbasin during wetter years. The data also show that deep percolation (groundwater recharge) typically increases during wetter years. Surface water leakage (downward migration of surface water) and recoverable losses from diversions increase during drier years as the hydraulic gradient between the water table and surface water bodies increases. The contribution from small watersheds decreases during drier years. Groundwater pumping remains relatively constant regardless of water year type. Subsurface lateral flow also remains generally constant between water year types but shows a slight increase in the amount of water leaving the Subbasin during wetter years. The change in storage does not seem to be directly correlated with water year type, as the basin is full, with stable groundwater levels, and thus operating sustainably.

Table 5-12. Average Simulated Groundwater Budget Components by Water Year Type (Units in Acre-Feet Per Year, AFY)

Water Year Type	Tile Drains	Deep Percolation	Surface Water Leakage	Small Watershed Contributions	Diversion Recoverable Loss	Groundwater Pumping	Subsurface Lateral Flow	Change In Storage
Wet (6 simulated years)	-87,270	129,214	14,358	1,101	15,855	-44,698	-10,343	26,394
Above Normal (3 simulated years)	-75,537	80,228	14,769	12,067	16,628	-43,651	-9,867	-16,279
Below Normal (3 simulated years)	-65,831	75,248	21,920	2,558	16,895	-48,722	-6,963	-6,337
Dry (5 simulated years)	-64,916	69,809	18,202	7,198	17,506	-48,751	-7,337	-14,618
Critical (5 simulated years)	-74,806	78,152	20,758	1,387	19,266	-46,590	-7,556	-3,196



Luhdorff & Scalmanini Consulting Engineers

Average Groundwater Budget Components During the Base Period (1997-2018) by Water Type

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-8

5.6.8 Summary of Water Year 2015 Water Budget Results

For the representative recent water year 2015, the following simulated water budget results are presented. The groundwater budget components for the entire ECC Subbasin are presented in **Table 5-13**; the root zone budget components are presented in **Table 5-14**; and the land and water use budget components are presented in **Table 5-15**.

Table 5-13. Groundwater Budget Components for Water Year 2015 (AFY)

Water Year	Change In Storage	Inflow Components					Outflow Components		
		Surface Water Features	Deep Percolation	Small Watershed Baseflow	Small Watershed Percolation	Diversion Recoverable Loss	Drains	Pumping	Net Subsurface Flow
2015	13,411	24,787	93,960	572	0	16,452	-66,415	-47,640	-8,290

Table 5-14. Root Zone Budget for Water Year 2015

Land Use Type	Land Use Area (Acres)	Precipitation (Afy)	Applied Water (Afy)	Evapotranspiration (Afy)	Percolation (Afy)
Agricultural	41,329	42,671	166,759	163,801	46,733
Urban	22,585	24,714	25,660	18,676	32,463
Native and Riparian Vegetation	45,236	46,561	0	35,228	11,194

Table 5-15. Land and Water Use Budget Components for Water Year 2015

Agricultural Supply Requirement	Agricultural Pumping	Agricultural Deliveries	Agricultural Shortage	Urban Supply Requirement	Urban Pumping	Urban Deliveries	Urban Shortage
166,604	39,747	127,011	-155	25,924	7,893	17,768	264

5.6.9 Projected 50-Year Water Budget

Six different future scenarios were developed to estimate the projected 50-year water budget as follows:

- The first future scenario relies on county-provided land use changes to accommodate anticipated urban growth for the year 2036. This future condition is maintained for all the projected 50-year scenarios, refer to **Figure 5-9**.
- The second future scenario uses both the anticipated land use change as well as adjustments for climate change. Following DWR's guidance document (DWR, 2018), climate adjustments were made to simulated evapotranspiration, precipitation, and surface water levels and delivery model input files using the 2070 central tendency climate change model, refer to **Figure 5-10**.
- The third future scenario uses the anticipated land use change and sea level rise based on repeated hydrology (no climate change) and sea level rise adjustments based on DWR's guidance documentation. Sea level rise is only applied to model elements in the northern surface water body areas that are below sea level, refer to **Figure 5-11**.
- The fourth future scenario combines all three changes; land use change to accommodate urban growth, climate change (using the 2070 central tendency), and sea level rise, refer to **Figure 5-12**.
- The fifth and sixth future scenarios incorporate the anticipated land use change as well as two extreme climate change models, using climate adjustments for evapotranspiration, precipitation, and surface water levels and delivery model input files. The two scenarios were developed to test the effects of 1) the 2070 wetter with moderate warming climate scenario, and 2) the 2070 drier with extreme warming climate scenario, refer to **Figure 5-13**, and **Figure 5-14**, respectively.

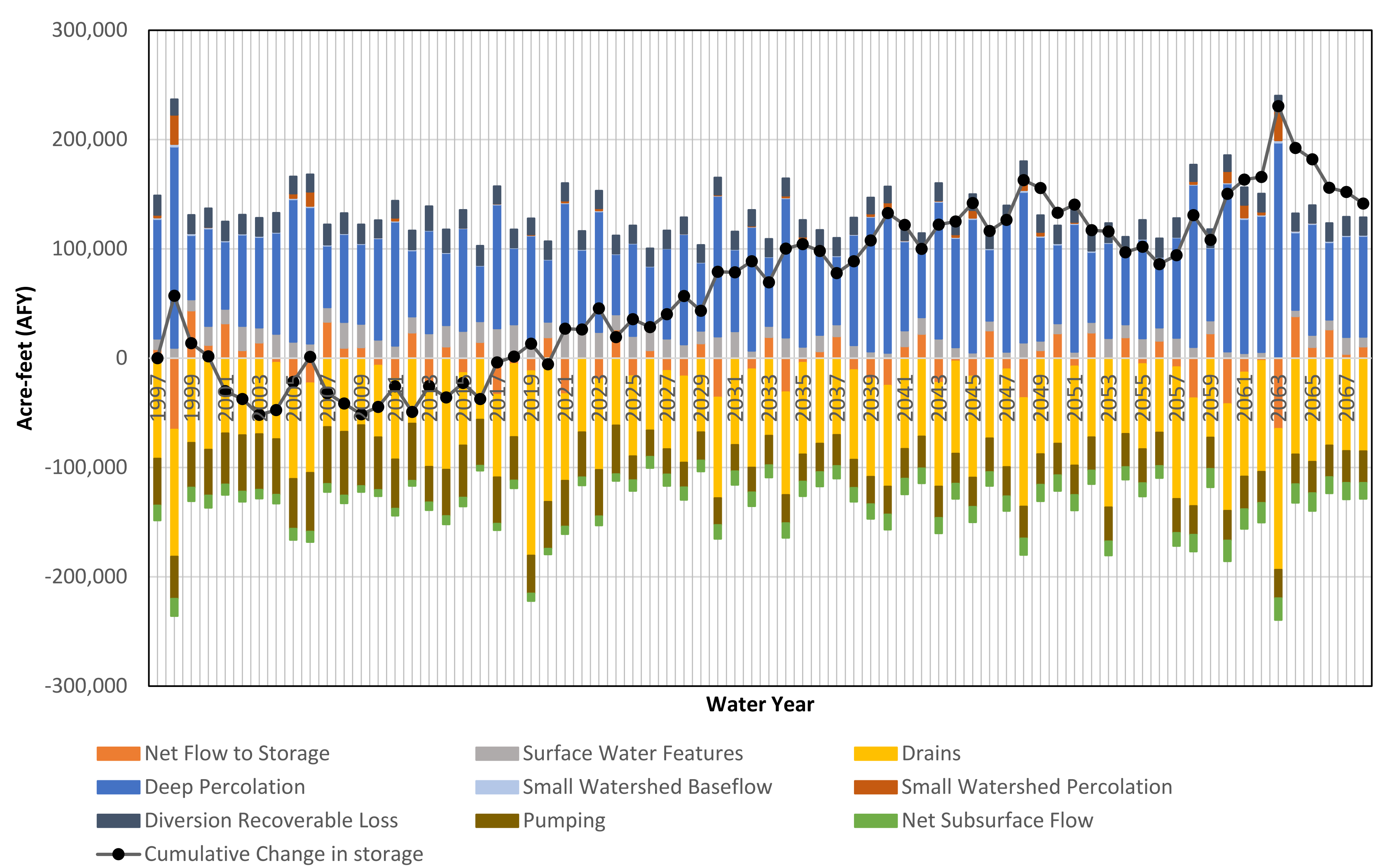
Projected water demand, surface water supply, and metered urban pumping were based on previously developed amounts presented in **Section 4**, **Table 4-5**. ECCSim was used to estimate agricultural and urban demands based on population growth and land use changes and estimated groundwater pumping that would be necessary to meet demands that anticipated surface water deliveries were unable to supply. Hydrology was repeated (or adjusted for climate change) using existing base period model inputs from the historic period of 1954 to 2003. Water year types and patterns of preceding water year types were developed to repeat base period hydrology for the 50-year time period and applying those hydrology values to the future period of 2019-2068 (**Table 5-16**).

Table 5-16. Future Scenario Water Year Types for Repeated and Adjusted Hydrology

Future Scenario Water Year	Assigned Historic Simulated Water Year	DWR Reference Year for Adjusted Hydrology	Projected Water Year Type[16]
2019	2011	1954	W
2020	2012	1955	D
2021	2017	1956	W
2022	2018	1957	BN
2023	2017	1958	W
2024	2012	1959	D
2025	2013	1960	C
2026	2014	1961	C
2027	2009	1962	BN
2028	2010	1963	AN
2029	2012	1964	D
2030	2017	1965	W
2031	2018	1966	BN
2032	2011	1967	W
2033	2012	1968	D
2034	2017	1969	W
2035	2010	1970	AN
2036	2009	1971	BN
2037	2012	1972	D
2038	2010	1973	AN
2039	2011	1974	W
2040	2011	1975	W
2041	2013	1976	C
2042	2014	1977	C
2043	2017	1978	W
2044	2010	1979	AN
2045	2011	1980	W
2046	2012	1981	D
2047	2011	1982	W

[16] W indicates “wet”, AN indicates “above normal”, BN indicates “below normal”, D indicates “dry”, and C indicates “critical.”

Future Scenario Water Year	Assigned Historic Simulated Water Year	DWR Reference Year for Adjusted Hydrology	Projected Water Year Type[16]
2048	2017	1983	W
2049	2010	1984	AN
2050	2001	1985	D
2051	2011	1986	W
2052	2007	1987	C
2053	2008	1988	C
2054	2007	1989	C
2055	2008	1990	C
2056	2007	1991	C
2057	2008	1992	C
2058	2005	1993	W
2059	1994	1994	C
2060	1995	1995	W
2061	1996	1996	W
2062	1997	1997	W
2063	1998	1998	W
2064	1999	1999	AN
2065	2000	2000	AN
2066	2001	2001	D
2067	2002	2002	D
2068	2003	2003	BN

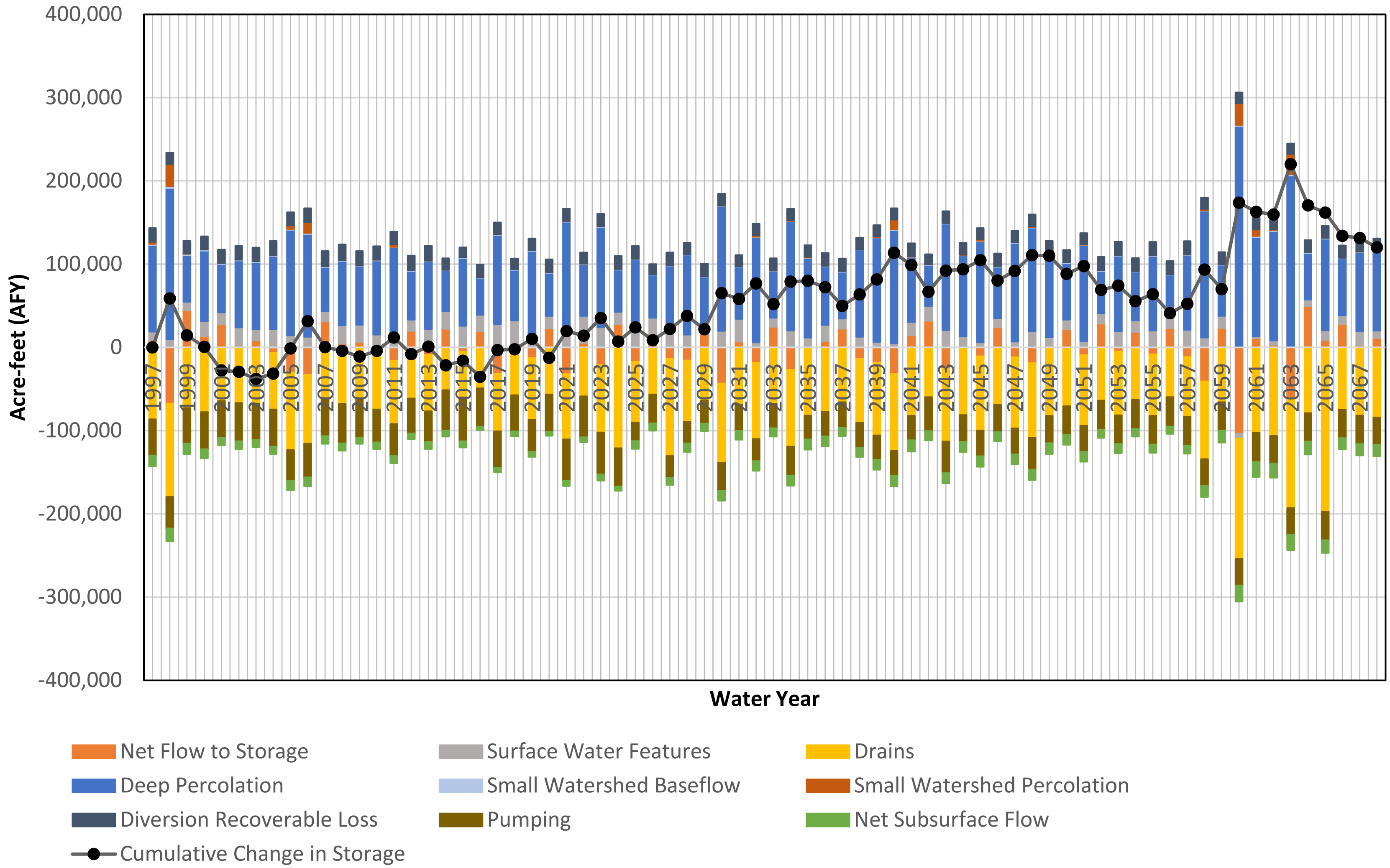


Luhdorff & Scalmanini
Consulting Engineers

Groundwater Budget for East Contra Costa Subbasin Future Land Use Scenario (1997-2068)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-9

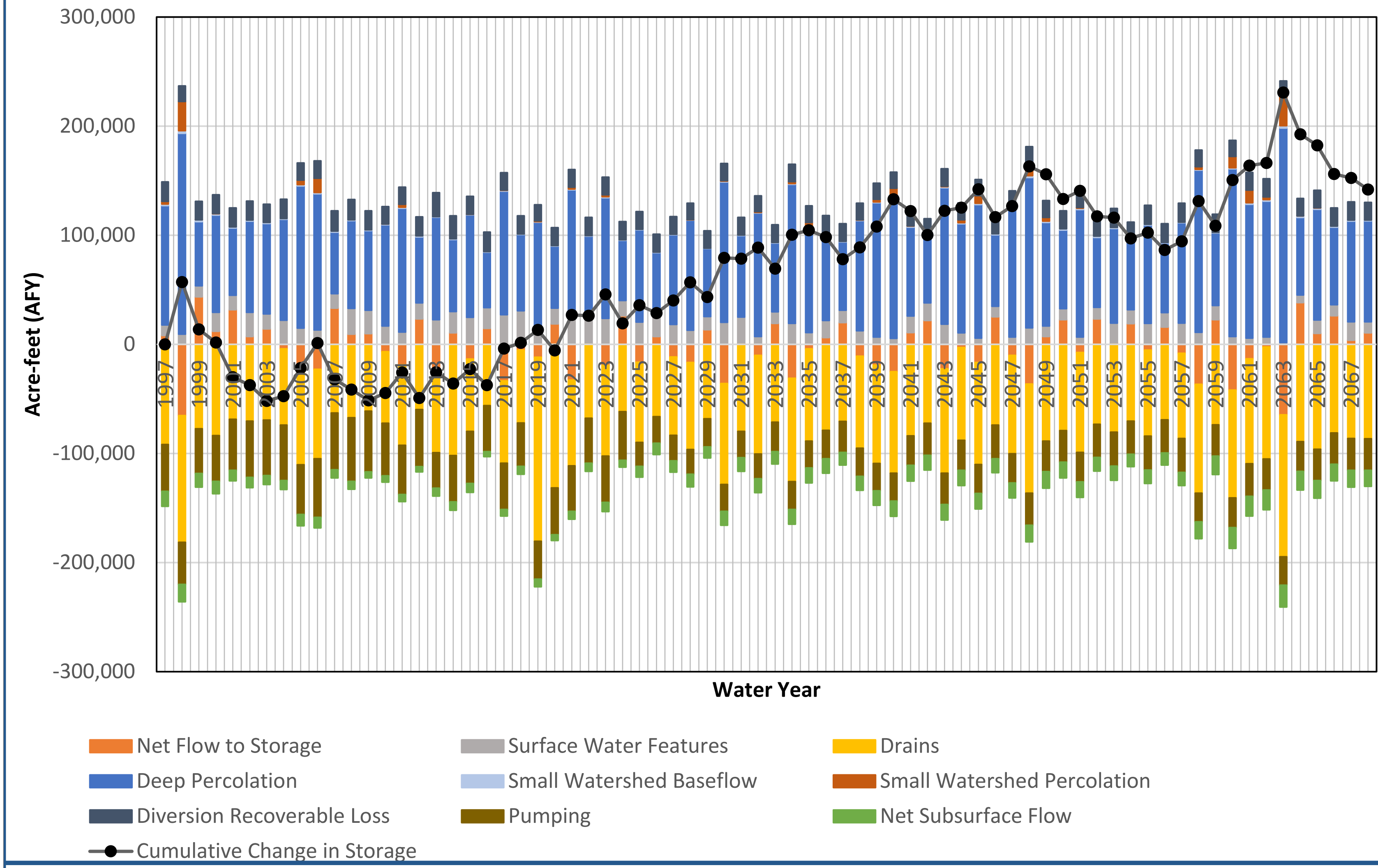


Luhdorff & Scalmanini
Consulting Engineers

Groundwater Budget for East Contra Costa Subbasin
Future Land Use and Climate Change Scenario (1997-2068)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-10

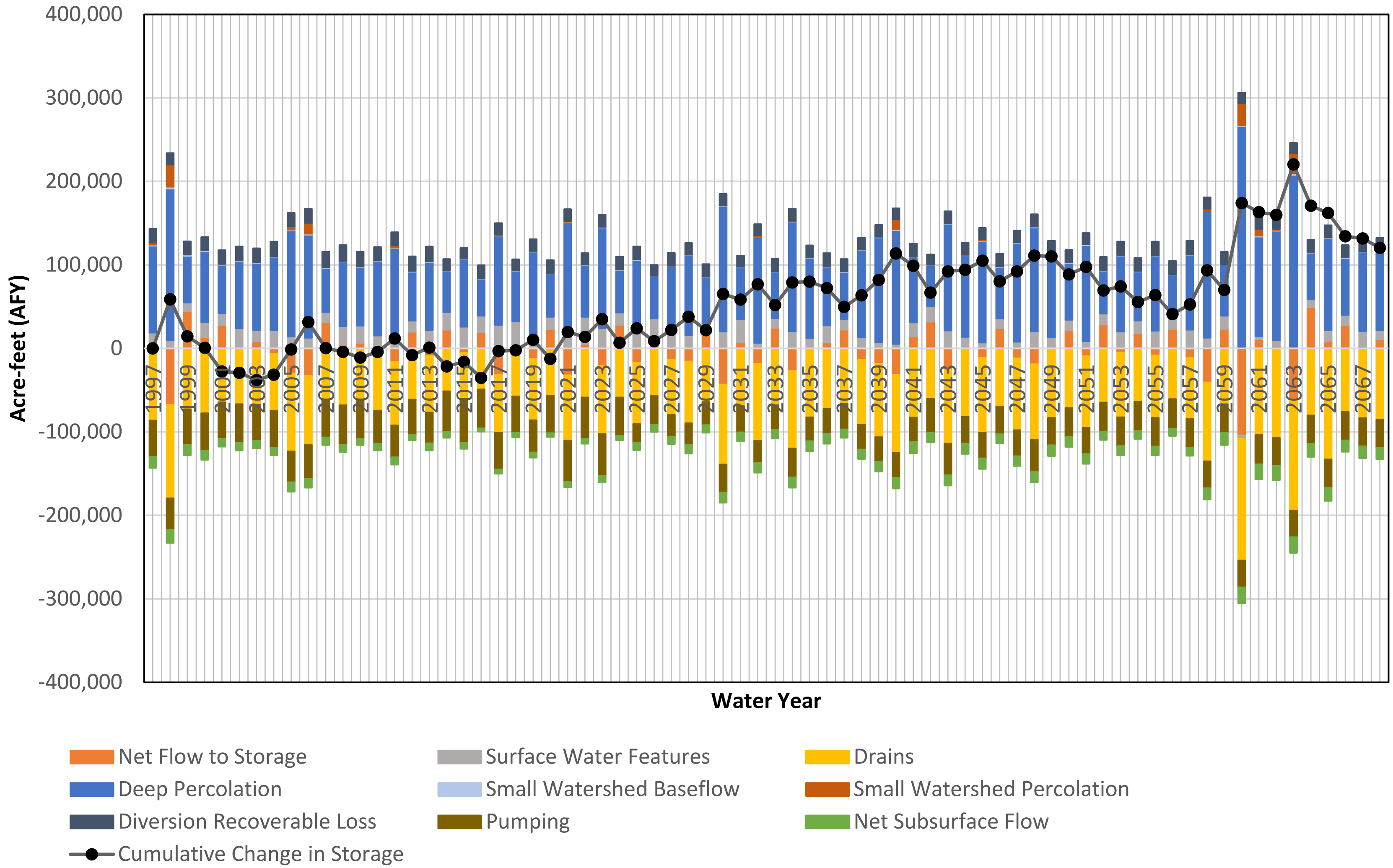


Luhdorff & Scalmanini
Consulting Engineers

Groundwater Budget for East Contra Costa Subbasin
Future Land Use and Sea Level Rise Scenario (1997-2068)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-11

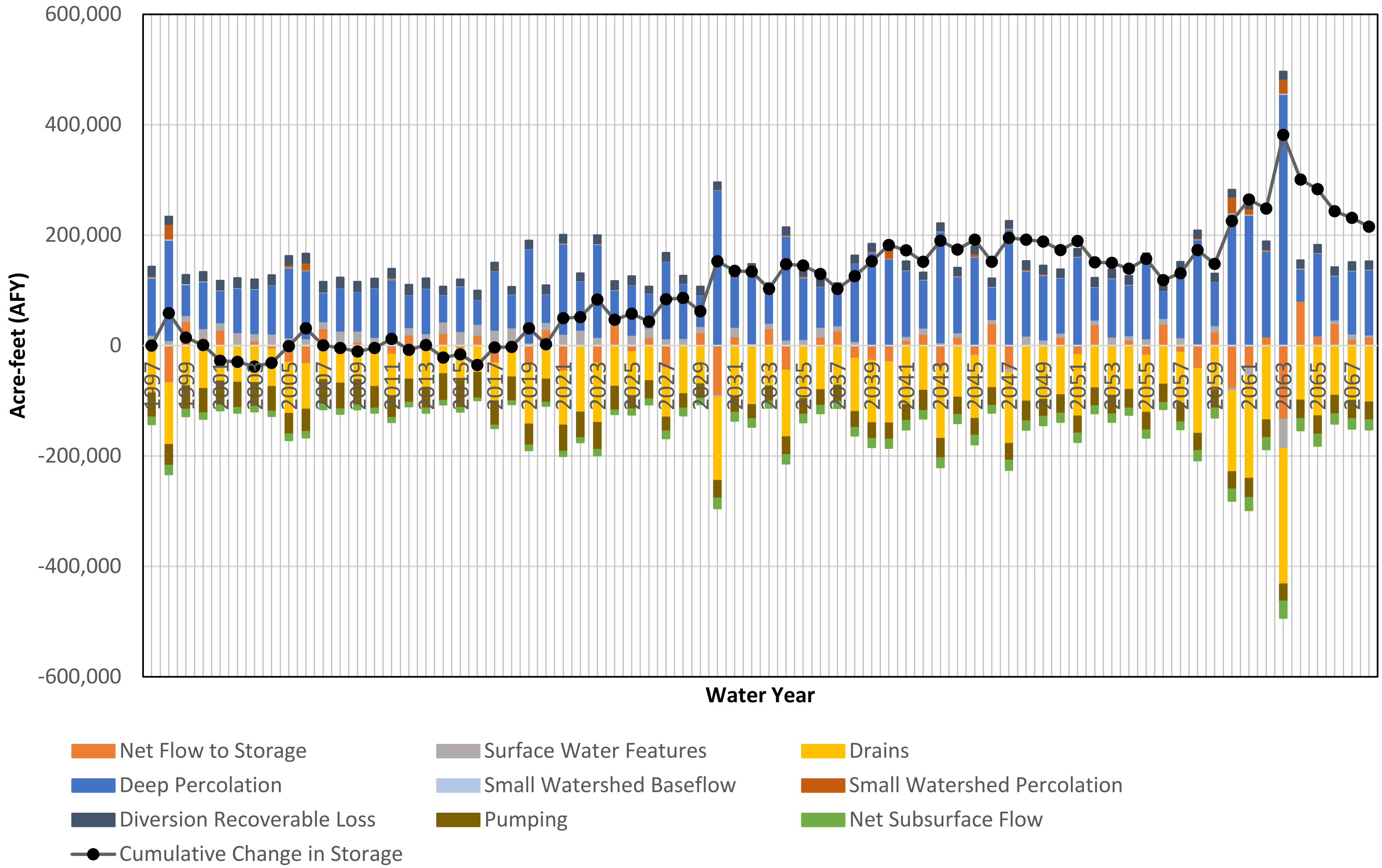


Luhdorff & Scalmanini Consulting Engineers

Groundwater Budget for East Contra Costa Subbasin
Future Land Use, Climate Change, and Sea Level Rise Scenario (1997-2068)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-12

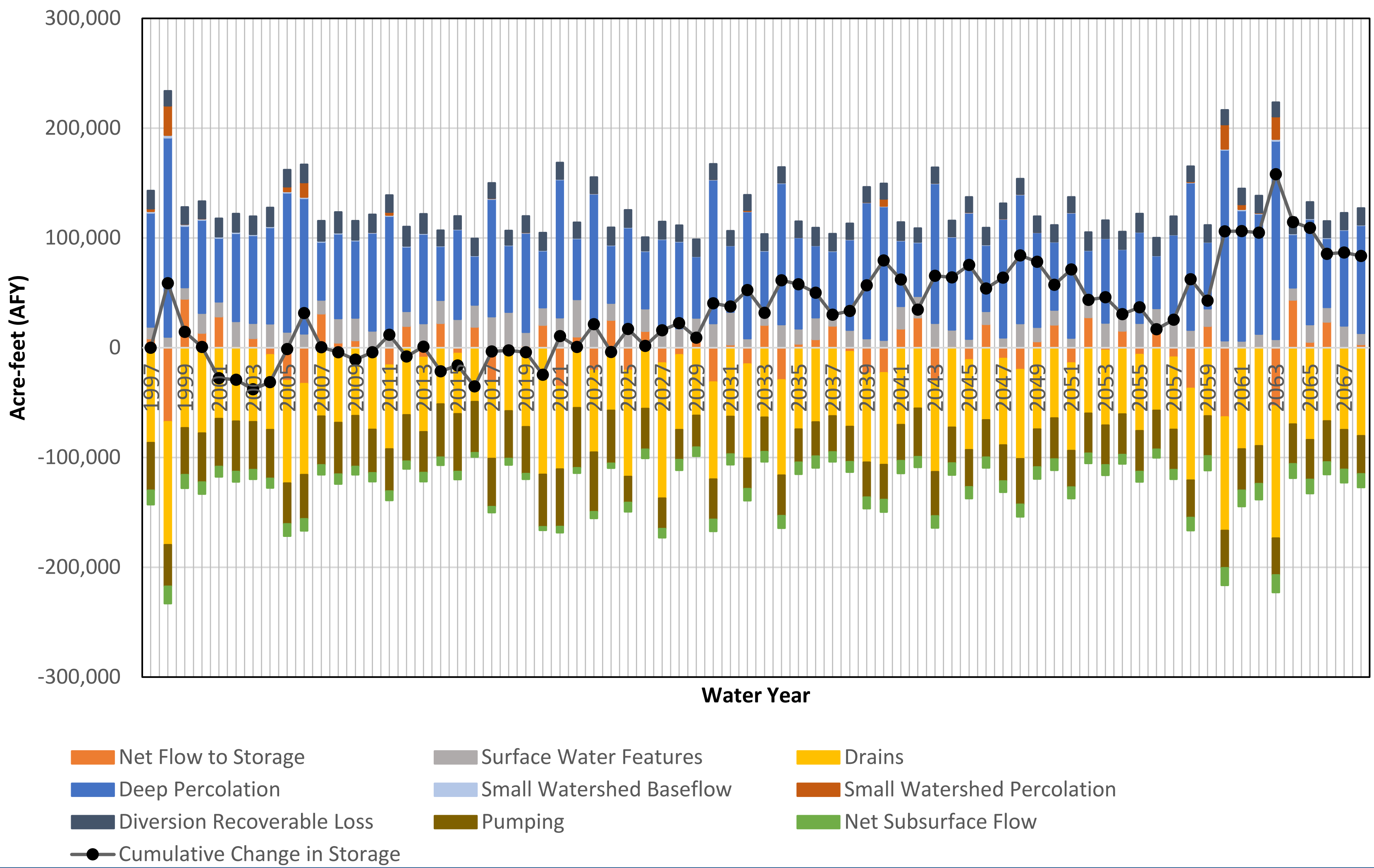


Luhdorff & Scalmanini Consulting Engineers

Groundwater Budget for East Contra Costa Subbasin Future Land Use and Climate Change (Wet) Scenario (1997-2068)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-13



Luhdorff & Scalmanini
Consulting Engineers

Groundwater Budget for East Contra Costa Subbasin
Future Land Use and Climate Change (Dry) Scenario (1997-2068)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-14

5.6.10 Water Budget Summaries for Future Scenarios

The average simulated land and water use budget components are presented in **Table 5-17** for the four 50-year future scenarios and the model Base Period. The simulated root zone water budget components are presented in **Table 5-18**, and the simulated average groundwater budget components are presented in **Table 5-19**. These tables indicate that land use changes have the most impact on water budget components relative to the Base Period. The future land use change (urban growth), climate change, and sea level rise result in changes in the water budget as follows:

- Groundwater pumping is lower on average during the future scenarios due to less agricultural demand as urban growth replaces agricultural land.
- There are less surface water contributions to groundwater, but more water leaving the groundwater systems via drains in the future scenarios compared to the baseline scenario.
- There is slightly more precipitation during the climate change scenarios, which reduces the amount of applied water for agricultural and outdoor landscaping urban demands.
- Sea level rise has very little impact to the groundwater budget, causing a slight decrease in the amount of groundwater exiting the system through drains; increasing the contribution of surface water to groundwater; no major changes to groundwater storage or subsurface lateral flow result from this scenario of sea level rise.

Table 5-17. Simulated Average Future Land and Water Use Budget Components (Units in Acre-Feet per Year, AFY)

Land And Water Use Budget Flow Component	Base Period (Wy 1997-2018)	Future Land Use Scenario (Wy 2019-2068)	Future Land Use and Climate Change Scenario (Wy 2019-2068)	Future Land Use and Sea Level Rise Scenario (Wy 2019-2068)	Future Land Use, Climate Change, And Sea Level Rise (Wy 2019-2068)	Future Land Use and Wet Climate Change Scenario (Wy 2019-2068)	Future Land Use and Dry Climate Change Scenario (Wy 2019-2068)
Ag. Supply Requirement	162,135	133,678	152,255	133,678	151,626	146,011	161,986
Ag. Pumping	35,742	14,627	12,832	14,627	12,829	11,488	13,120
Ag. Deliveries	126,223	117,735	110,862	117,735	110,236	108,385	120,305
Ag. Demand Shortage	170	1,315	28,561	1,315	28,561	26,138	28,561
Urban Supply Requirement	28,268	35,543	35,543	35,543	35,543	35,543	35,543
Urban Pumping	8,449	14,339	21,124	14,339	21,124	21,111	21,124
Urban Deliveries	19,352	22,759	15,843	22,759	15,843	15,883	15,843
Urban Water Demand Shortage	468	-1,554	-1,424	-1,554	-1,424	-1,450	-1,424

Table 5-18. Simulated Average Root Zone Budget Components (Area in acres, Flows in AFY)

Root Zone Budget Flow Component	Base Period (Wy 1997-2018)	Water Year 2015	Future Land Use Scenario (Wy 2019-2068)	Future Land Use and Climate Change Scenario (Wy 2019-2068)	Future Land Use and Sea Level Rise Scenario (Wy 2019-2068)	Future Land Use, Climate Change, And Sea Level Rise (Wy 2019-2068)	Future Land Use and Wet Climate Change Scenario (Wy 2019-2068)	Future Land Use and Dry Climate Change Scenario (Wy 2019-2068)
Agricultural Land Use Area (acres)	48,057	41,329	36,171	36,171	36,171	36,171	36,171	36,171
Ag. Precipitation (+)	55,998	42,671	43,681	46,131	43,681	46,131	57,301	40,900
Ag. Applied Water (+)	161,965	166,759	132,363	123,694	132,363	123,065	119,872	129,561
Ag. ET (-)	170,998	163,801	137,764	134,522	137,764	133,841	131,369	137,784
Ag. Percolation (-)	47,182	46,733	38,275	35,302	38,275	35,354	45,803	32,678
Urban Land Use Area (acres)	20,045	22,585	36,038	36,038	36,038	36,038	36,038	36,038
Urban Precipitation (+)	22,929	24,714	43,088	45,517	43,088	45,517	58,384	40,416
Urban Applied Water (Landscaping) (+)	27,800	25,660	37,098	36,967	37,098	36,967	36,993	36,558
Urban ET (-)	19,516	18,676	31,714	31,638	31,714	31,638	31,823	30,143
Urban Percolation (-)	31,539	32,463	48,654	51,029	48,654	51,029	63,737	47,014

Root Zone Budget Flow Component	Base Period (Wy 1997-2018)	Water Year 2015	Future Land Use Scenario (Wy 2019-2068)	Future Land Use and Climate Change Scenario (Wy 2019-2068)	Future Land Use and Sea Level Rise Scenario (Wy 2019-2068)	Future Land Use, Climate Change, And Sea Level Rise (Wy 2019-2068)	Future Land Use and Wet Climate Change Scenario (Wy 2019-2068)	Future Land Use and Dry Climate Change Scenario (Wy 2019-2068)
Native & Riparian Veg. Land Use Area (acres)	41,048	45,236	36,942	36,942	36,942	36,942	36,942	36,942
Native & Riparian Veg. Precipitation (+)	46,290	46,561	44,317	46,669	44,317	46,669	58,689	41,146
Native & Riparian Veg. ET (-)	37,142	35,228	35,783	36,255	35,783	36,255	39,236	32,700
Sum of Native & Riparian Veg. Percolation (-)	9,042	11,194	8,535	10,414	8,535	10,414	19,454	8,447

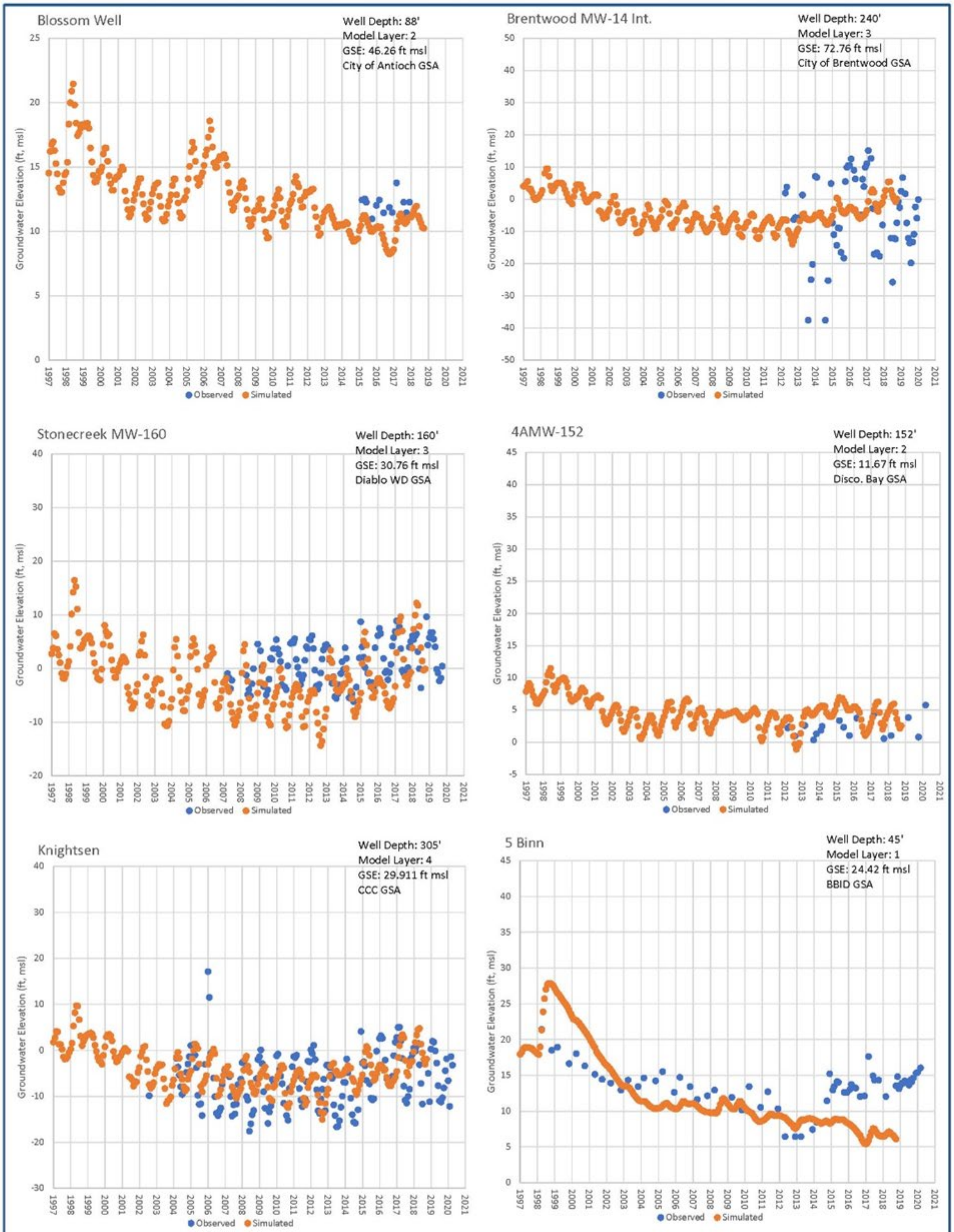
Table 5-19. Simulated Average Groundwater Budget Component Flows (Units in Acre-Feet per Year, AFY)

Groundwater Budget Flow Component	Base Period (Wy 1997-2018)	Water Year 2015	Future Land Use Scenario (Wy 2019-2068)	Future Land Use and Climate Change Scenario (Wy 2019-2068)	Future Land Use and Sea Level Rise Scenario (Wy 2019-2068)	Future Land Use, Climate Change, and Sea Level Rise (Wy 2019-2068)	Future Land Use and Wet Climate Change Scenario (Wy 2019-2068)	Future Land Use and Dry Climate Change Scenario (Wy 2019-2068)
Drains	-74,833	-87,732	-87,732	-84,026	-86,521	-81,068	-103,007	-75,807
Surface Water Features	17,773	12,517	12,517	13,859	13,300	14,644	6,880	16,148
Deep Percolation	90,069	95,701	95,701	97,002	95,702	97,054	129,520	88,301
Small Watershed Baseflow	976	880	880	647	880	647	787	452
Small Watershed Percolation	2,260	2,051	2,051	1,645	2,051	1,645	2,124	1,132
Diversion Recoverable Loss	17,253	15,965	15,965	14,398	15,965	14,327	14,121	14,774
Pumping	-46,455	-28,966	-28,966	-33,956	-28,966	-33,952	-32,599	-36,106
Net Subsurface Flow	-8,500	-12,975	-12,975	-11,423	-12,985	-11,432	-14,847	-10,013
Net Storage Change	66	2,799	2,799	2,451	2,807	2,457	4,360	1,721

5.7 Model Calibration and Uncertainty

The ECCSim model was calibrated to match measured groundwater levels at various monitoring locations and depths throughout the model domain and Subbasin area. Due to the engineered nature of surface water features in this area and therefore their simulation, calibration using surface water elevations and flows were not performed. Matching simulated groundwater levels to actual observed groundwater levels in specific wells with known depths is a useful measure of the appropriateness of the model to be used as a tool for determining sustainability under various stresses. Thirty-three wells were used to calibrate the model. Most wells were calibrated to match measured water levels within 10 feet. Many wells were calibrated to match with even less uncertainty. Some wells have better matches than others, and attempts were made to adjust aquifer parameters to accommodate better matches on a regional scale. Local changes to aquifer parameters just to improve those results were avoided; rather, the best assessment of hydrogeologic conditions was made leaving the opportunity for future data acquisition to update the model and possibly improve calibration in those areas.

The full set of simulated and observed groundwater levels for all calibration wells is provided in the model report found in **Appendix 5a**. A subset of these calibration plots are provided here (**Figure 5-15**) to illustrate favorable matches throughout the model domain both vertically and laterally. Another plot that shows the scatter plot of measured versus simulated groundwater levels using all measurements over the entire simulation period (**Figure 5-16**).

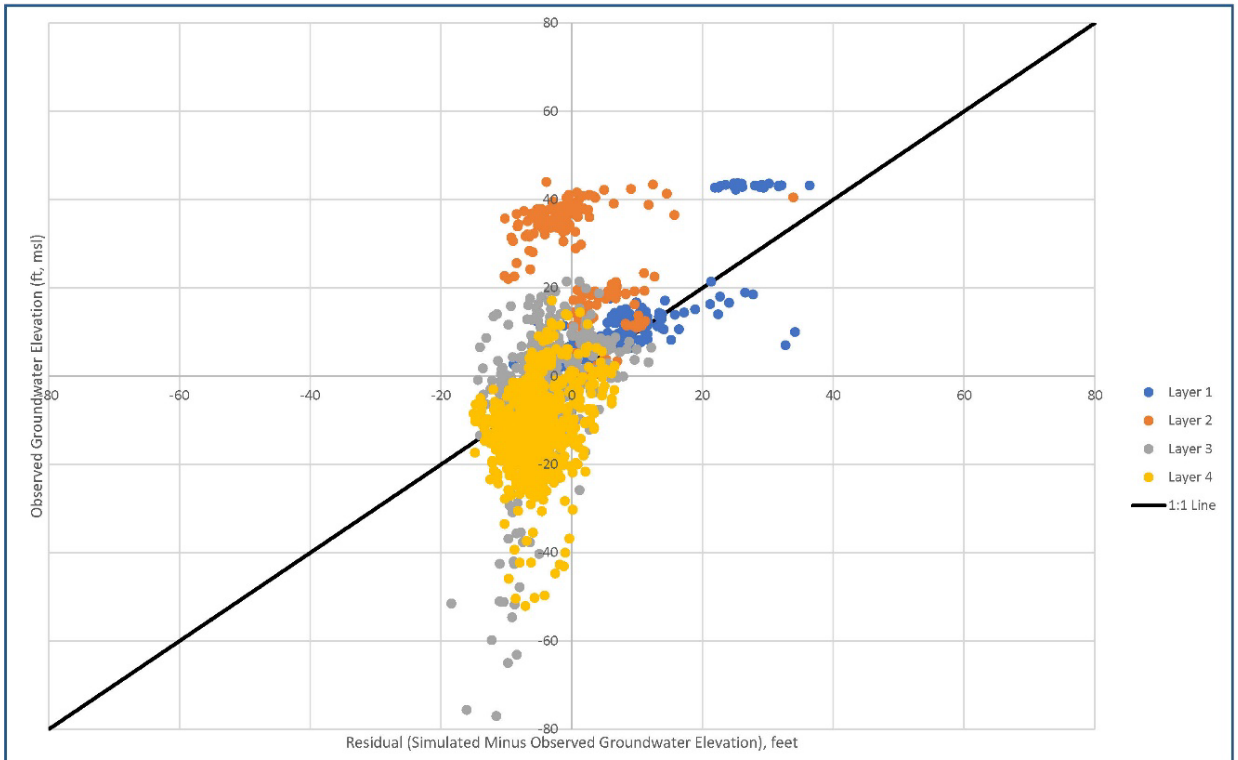


Luhdorff & Scalmanini Consulting Engineers

Subset of Calibration Plots from ECCSim

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-15



Luhdorff & Scalmanini Consulting Engineers

Simulated vs. Observed Groundwater Elevations, By Layer

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-16

5.7.1 Verification of Shallow Zone Results

- Examination of DuPont site data as requested by DWD (TBD)

5.8 Sensitivity Analysis (TBD)

- Development and explanation of model sensitivity runs for the integrated hydrologic model in order to help determine sustainable yield.
- Testing the hydraulic connectivity between layers during a high pumping scenario (the sustainable yield model run) by decreasing the vertical hydraulic conductivity.
- Results of sensitivity runs.

5.9 Sustainable Yield Scenario

In order to estimate the sustainable yield of the ECC Subbasin, the future land use change scenario was utilized with the ECCSim tool. Surface water diversions were reduced and substituted with increased groundwater extraction. This trial-and-error process was repeated until the following negative impacts occurred in relation to the historical baseline:

- The average change in storage indicated aquifer depletion;
- The surface water contributions to groundwater indicated stream depletion;
- The gradient for subsurface lateral flow changed such that flow out of the Subbasin reversed with flow into the ECC Subbasin from neighboring subbasins.

With regard to surface water interactions, it is possible to identify the range of stream depletion that has been occurring in the past and use those quantities to identify a significant change in the sustainability scenario. This does not necessarily mean that a change from the historic baseline represents undesirable results, only that greater pumping is offset by a contribution from the stream depletion source that is outside the historic range. The range of historical surface water contribution to the ECC Subbasin in the Base Period was estimated at between: 9,481 to 30,852 AFY. Here, a positive value indicates a contribution to groundwater storage from stream surface water sources.

Similar to the stream depletion factor, the range of historic simulated annual flow to other basins, or subsurface lateral flow, is between -4,664 to -15,817 AFY. Here, a negative value indicates flow out of the ECC Subbasin. To estimate sustainable yield, the average surface water contribution water budget component and subsurface lateral flow attempted to be within the range of approximate simulated historic values.

The quantification of cumulative change in storage combined with the criteria for surface water contribution and subsurface lateral flow, allow for a better understanding of what levels of groundwater pumping amounts could result in adverse effects such as storage depletion. Average annual groundwater pumping in the model Base Period accounts was approximately 46,500 AFY.

As a perspective on historic and current basin conditions, this annual average pumping rate has occurred with no apparent undesirable results as defined under SGMA. In fact, the Subbasin relies heavily on drains to remove excess groundwater which is a function of the Delta setting in which land is largely near sea level, groundwater is encountered at shallow depths, sometimes only a few feet, and streams and rivers are hydraulically connected to the aquifer system. Reducing the surface water deliveries and increasing groundwater pumping allows the basin to be stressed in a manner that alters the historic balance in the water budget components.

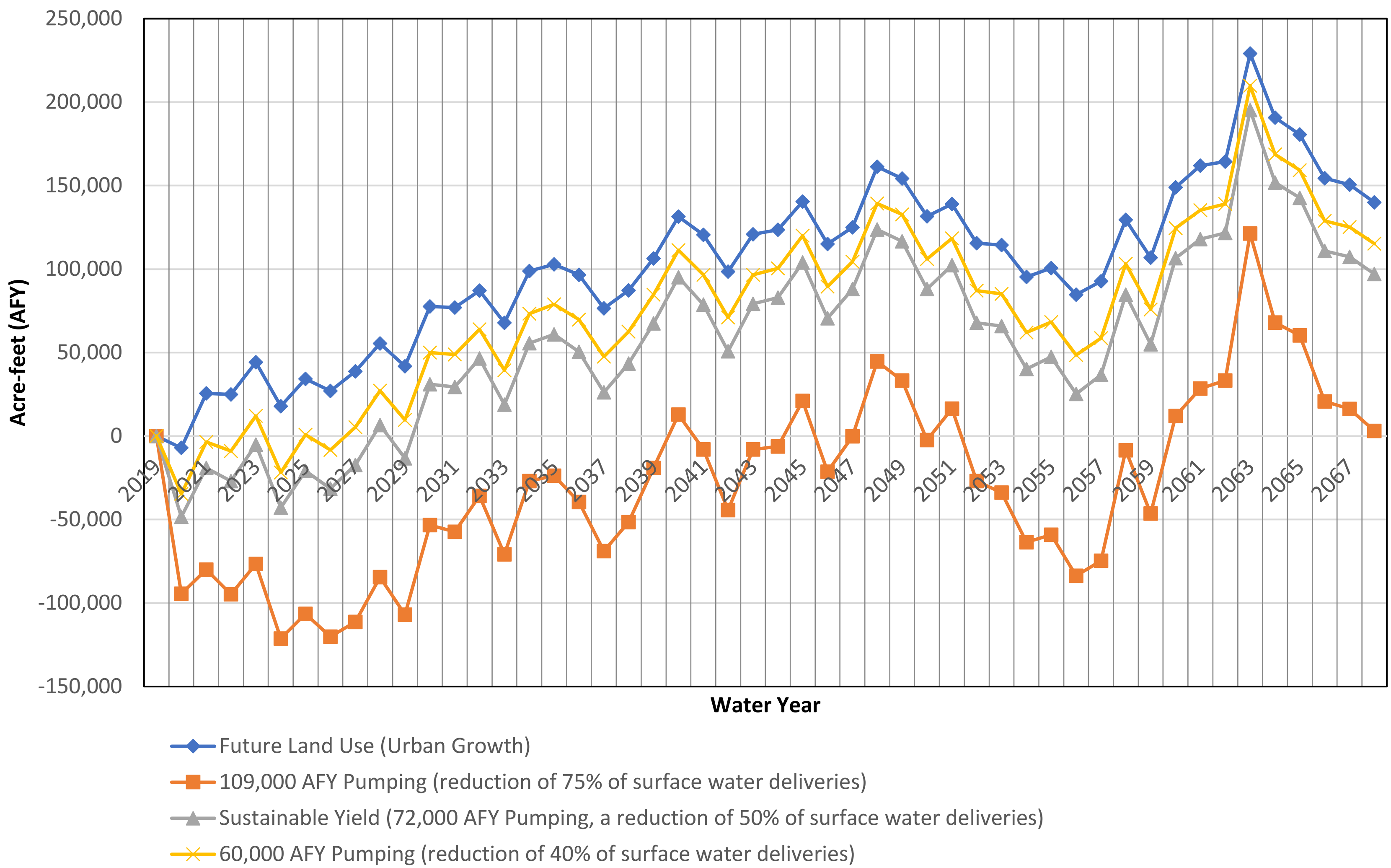
Table 5-20 shows average groundwater budget components for a subset of the sustainable yield model runs used to develop an estimate of sustainable yield, using groundwater budget terms within the range of values seen during the Base Period. The cumulative change in storage is plotted for selected sustainable yield scenario runs to test the Increased pumping to levels to aquifer storage depletion or replenishment (**Figure 5-17**). The sustainable yield value of 72,000 AFY satisfies the criteria for not negatively impacting surface water features or altering flow patterns between neighboring subbasins, but still results in aquifer replenishment over time. Sustained pumping of 72,000 AFY will result in slightly less reliance on drains, while maintaining a cumulative change in storage above zero without depleting surface water or negatively impacting neighboring subbasins.

5.9.1 ECC Subbasin Sustainable Yield

In summary, the sustainable yield for the ECC Subbasin is approximately 72,000 AFY. This amount of groundwater extraction does not result in storage depletion, does not result in surface water depletion beyond levels seen in the model Base Period, reduces the drain outflow, and reduces reliance on surface water deliveries. At higher levels of pumping, the modeling indicates the potential to increase streamflow depletion and inter-basin flow beyond historical baselines. Like the Base Period scenario, a chronic decline in groundwater storage was not a factor in the sustainable yield threshold. The margin between the average pumping rate in the subbasin during the base period (46,455 AFY) and the quantified sustainable yield of 72,000 AFY provides an ability to meet short-term surface water supply shortages in dry to critically dry years through increased groundwater pumping. This margin is a hallmark of effective conjunctive use of surface water and groundwater resources which is based on the fact that surface water and groundwater resources vary in availability, quality, and costs. In the ECC Subbasin, the margin between sustainable yield and average pumping provides a storage buffer in critically dry years. Some GSAs have implemented groundwater exchanges (East Contra Costa Irrigation District) and supplemental groundwater capacity (Diablo Water District). These and similar programs can mitigate impacts to overall water supply in not only dry and critically dry periods, but also as a result of unforeseen climate change consequences.

Table 5-20. Average Simulated Groundwater Budget Components Used to Develop the Sustainable Yield of the ECC Subbasin

Groundwater Budget Flow Component	Base Period (Wy 1997-2018)	Water Year 2015	Minimum Annual Base Period Value	Maximum Base Period Value	Future Land Use Scenario (Wy 2019-2068)	Sustainable Yield Run: Reduce Sw Deliveries By 75%	Sustainable Yield Run: Reduce Sw Deliveries By 50%	Sustainable Yield Run: Reduce SW Deliveries By 45%	Sustainable Yield Run: Reduce SW Deliveries By 40%
Drains	-74,833	-66,415	-116,071	-56,081	-87,732	-34,458	-56,883	-59,623	-61,157
Surface Water Features	17,773	24,787	9,481	30,852	12,517	26,851	19,167	18,096	17,081
Deep Percolation	90,069	93,960	50,799	184,027	95,701	95,567	95,982	96,023	96,057
Small Watershed Baseflow	976	572	498	2,320	880	880	880	880	880
Small Watershed Percolation	2,260	0	0	26,702	2,051	2,051	2,051	2,051	2,051
Diversion Recoverable Loss	17,253	16,452	14,255	21,747	15,965	6,879	11,132	11,824	12,490
Pumping	-46,455	-47,640	-58,251	-32,504	-28,966	-109,353	-71,992	-65,915	-60,064
Net Subsurface Flow	-8,500	-8,290	-15,817	-4,664	-12,975	8,313	-3,658	-5,189	-6,594
Net Storage Change	66	13,411	-43,556	65,310	2,799	63	1,940	2,130	2,303



Luhdorff & Scalmanini
Consulting Engineers

Simulated Cumulative Change in Groundwater Storage for Sustainable Yield Development

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-17

5.10 GSA Area Water Budget Results

The seven GSAs that comprise the ECC Subbasin have their own water budgets as simulated using the ECCSim tool. The average groundwater budget terms are quantified for each GSA for the model Base Period (water years 1997-2018) in **Table 5-21**. The average simulated groundwater budget components are illustrated graphically in **Figure 5-18**.

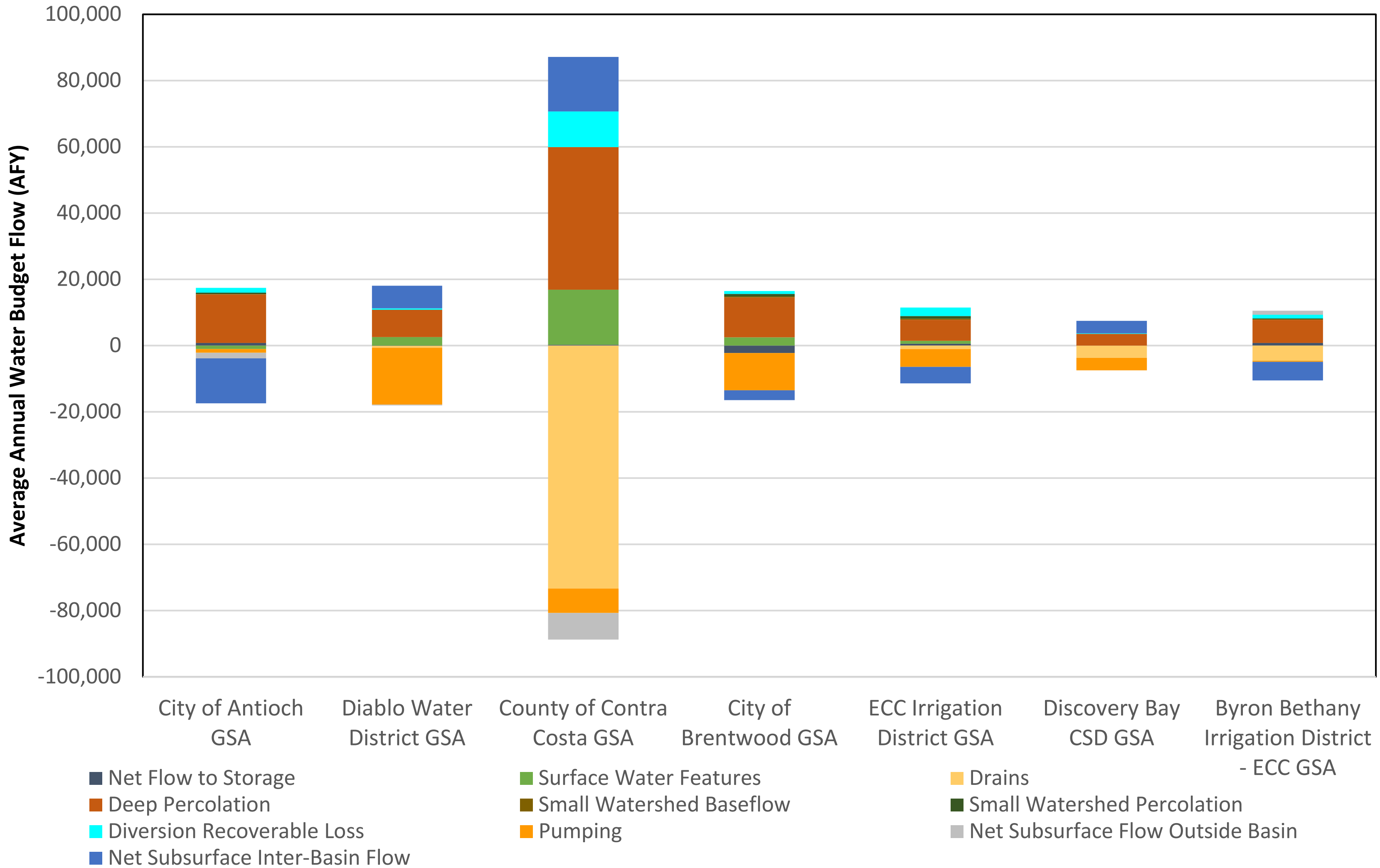
The projected water budgets for GSA areas were determined for the four 50-year water budget scenarios:

- future land use scenario (repeated hydrology);
- future land use plus climate change scenario (using 2070 central tendency climate change adjustments, the 2070 wet climate change adjustments, and the 2070 dry climate change adjustments);
- future land use plus sea level rise scenario; and
- future land use plus climate change and sea level rise scenario.

Simulated groundwater budget components are presented below in **Table 5-22**.

Table 5-21. Simulated Groundwater Budget Components for GSAs in the ECC Subbasin for Base Period, WY 1997-2018 (Units are in Acre-Feet per Year, AFY)

GSAS	Net Storage Change	Drains	Surface Water Features	Deep Percolation	Small Watershed Baseflow	Small Watershed Percolation	Diversion Recoverable Loss	Pumping	Net Subsurface Flow Outside Basin	Net Subsurface Inter-Basin Flow
City of Antioch GSA	-785	0	-1,036	14,663	129	406	1,472	-1,152	-1,647	-13,621
Diablo Water District GSA	86	-559	2,572	8,151	0	82	423	-17,216	-208	6,836
County of Contra Costa GSA	-210	-73,302	16,665	43,071	0	0	10,699	-7,408	-8,021	16,533
City of Brentwood GSA	2,276	0	2,478	12,036	330	741	915	-11,226	0	-2,999
ECC Irrigation District GSA	-524	-1,083	900	6,363	348	773	2,536	-5,370	0	-4,991
Discovery Bay CSD GSA	-9	-3,735	0	3,540	0	0	111	-3,747	0	3,822
Byron Bethany Irrigation District - ECC GSA	-806	-4,582	0	6,994	168	258	1,096	-334	1,196	-5,580



Luhdorff & Scalmanini Consulting Engineers

Average Water Budget Components During the Historical Calibration Period (1997-2018)

East Contra Costa Groundwater-Surface Water Simulation Model (ECCSim) Report

Figure 5-18

Table 5-22. Simulated Future Scenario Groundwater Budgets for Individual GSAs

GSA Groundwater Budget Component Flows Summary					
City of Antioch GSA					
	Base Period (WY 1997-2018)	Future Land Use Scenario (WY 2019-2068)	Future Land Use and Climate Change Scenario[17] (WY 2019-2068)	Future Land Use and Sea Level Rise Scenario (WY 2019-2068)	Future Land Use, Climate Change[18], and Sea Level Rise (WY 2019-2068)
Net Storage Change	-785	142	171	142	171
Drains	0	0	0	0	0
Surface Water Features	-1,036	-1,920	-1,833	-1,923	-1,836
Deep Percolation	14,663	14,914	15,630	14,914	15,630
Small Watershed Baseflow	129	99	76	99	76
Small Watershed Percolation	406	327	279	327	279
Diversion Recoverable Loss	1,472	1,322	1,313	1,322	1,313
Pumping	-1,152	-255	-278	-255	-278
Net Subsurface Flow Outside Basin	-1,647	-3,261	-2,864	-3,259	-2,863
Net Subsurface Inter-Basin Flow	-13,621	-11,084	-12,152	-11,083	-12,150

[17] 2070 Central Tendency Climate Change Scenario
[18] 2070 Central Tendency Climate Change Scenario

GSA Groundwater Budget Component Flows Summary					
Diablo Water District GSA					
	Base Period (WY 1997-2018)	Future Land Use Scenario (WY 2019-2068)	Future Land Use and Climate Change Scenario (WY 2019-2068)	Future Land Use and Sea Level Rise Scenario (WY 2019-2068)	Future Land Use, Climate Change, and Sea Level Rise (WY 2019-2068)
Net Storage Change	86	176	151	176	151
Drains	-559	-2,495	-2,255	-2,492	-2,262
Surface Water Features	2,572	-321	389	-338	372
Deep Percolation	8,151	10,224	10,881	10,224	10,881
Small Watershed Baseflow	0	0	0	0	0
Small Watershed Percolation	82	42	70	42	70
Diversion Recoverable Loss	423	404	398	404	398
Pumping	-17,216	-6,141	-6,465	-6,141	-6,465
Net Subsurface Flow Outside Basin	-208	-677	-613	-675	-612
Net Subsurface Inter-Basin Flow	6,836	-861	-2,255	-847	-2,233

GSA Groundwater Budget Component Flows Summary					
County of Contra Costa GSA					
	Base Period (WY 1997-2018)	Future Land Use Scenario (WY 2019-2068)	Future Land Use and Climate Change Scenario (WY 2019-2068)	Future Land Use and Sea Level Rise Scenario (WY 2019-2068)	Future Land Use, Climate Change, and Sea Level Rise (WY 2019-2068)
Net Storage Change	-210	90	115	99	124
Drains	-73,302	-80,933	-76,509	-79,771	-73,513
Surface Water Features	16,665	14,906	15,740	15,721	16,556
Deep Percolation	43,071	42,783	40,623	42,784	40,624
Small Watershed Baseflow	0	0	0	0	0
Small Watershed Percolation	0	0	0	0	0
Diversion Recoverable Loss	10,699	10,399	9,373	10,399	9,373
Pumping	-7,408	-10,137	-7,693	-10,137	-7,693
Net Subsurface Flow Outside Basin	-8,021	-11,880	-11,567	-11,892	-11,619
Net Subsurface Inter-Basin Flow	16,533	29,466	25,726	29,449	25,691

GSA Groundwater Budget Component Flows Summary					
City of Brentwood GSA					
	Base Period (WY 1997-2018)	Future Land Use Scenario (WY 2019-2068)	Future Land Use and Climate Change Scenario (WY 2019-2068)	Future Land Use and Sea Level Rise Scenario (WY 2019-2068)	Future Land Use, Climate Change, and Sea Level Rise (WY 2019-2068)
Net Storage Change	2,276	2,078	1,728	2,079	1,729
Drains	0	0	0	0	0
Surface Water Features	2,478	1,982	2,035	1,982	2,035
Deep Percolation	12,036	14,213	14,738	14,213	14,738
Small Watershed Baseflow	330	278	199	278	199
Small Watershed Percolation	741	604	475	604	475
Diversion Recoverable Loss	915	902	117	902	117
Pumping	-11,226	-4,605	-11,592	-4,605	-11,592
Net Subsurface Flow Outside Basin	0	0	0	0	0
Net Subsurface Inter-Basin Flow	-2,999	-11,295	-4,245	-11,294	-4,244

GSA Groundwater Budget Component Flows Summary					
ECCID GSA					
	Base Period (WY 1997-2018)	Future Land Use Scenario (WY 2019-2068)	Future Land Use and Climate Change Scenario (WY 2019-2068)	Future Land Use and Sea Level Rise Scenario (WY 2019-2068)	Future Land Use, Climate Change, and Sea Level Rise (WY 2019-2068)
Net Storage Change	-524	116	48	116	48
Drains	-1,083	-1,512	-1,696	-1,513	-1,698
Surface Water Features	900	666	740	666	740
Deep Percolation	6,363	5,337	5,988	5,337	5,988
Small Watershed Baseflow	348	332	241	332	241
Small Watershed Percolation	773	924	607	924	607
Diversion Recoverable Loss	2,536	2,106	2,284	2,106	2,284
Pumping	-5,370	-794	-869	-794	-869
Net Subsurface Flow Outside Basin	0	0	0	0	0
Net Subsurface Inter-Basin Flow	-4,991	-6,942	-7,246	-6,941	-7,245

GSA Groundwater Budget Component Flows Summary					
Discovery Bay CSD GSA					
	Base Period (WY 1997-2018)	Future Land Use Scenario (WY 2019-2068)	Future Land Use and Climate Change Scenario (WY 2019-2068)	Future Land Use and Sea Level Rise Scenario (WY 2019-2068)	Future Land Use, Climate Change, and Sea Level Rise (WY 2019-2068)
Net Storage Change	-9	14	17	14	17
Drains	-3,735	-4,969	-5,268	-4,969	-5,267
Surface Water Features	0	0	0	0	0
Deep Percolation	3,540	5,743	6,149	5,743	6,149
Small Watershed Baseflow	0	0	0	0	0
Small Watershed Percolation	0	0	0	0	0
Diversion Recoverable Loss	111	1	1	1	1
Pumping	-3,747	-6,626	-6,626	-6,626	-6,626
Net Subsurface Flow Outside Basin	0	0	0	0	0
Net Subsurface Inter-Basin Flow	3,822	5,866	5,761	5,866	5,760

GSA Groundwater Budget Component Flows Summary					
Byron Bethany Irrigation District - ECC GSA					
	Base Period (WY 1997-2018)	Future Land Use Scenario (WY 2019-2068)	Future Land Use and Climate Change Scenario (WY 2019-2068)	Future Land Use and Sea Level Rise Scenario (WY 2019-2068)	Future Land Use, Climate Change, and Sea Level Rise (WY 2019-2068)
Net Storage Change	-806	194	232	194	230
Drains	-4,582	-4,220	-4,764	-4,220	-4,747
Surface Water Features	0	0	0	0	0
Deep Percolation	6,994	7,399	8,223	7,399	8,273
Small Watershed Baseflow	168	171	131	171	131
Small Watershed Percolation	258	154	214	154	214
Diversion Recoverable Loss	1,096	831	912	831	841
Pumping	-334	-407	-433	-407	-429
Net Subsurface Flow Outside Basin	1,196	1,475	1,598	1,475	1,599
Net Subsurface Inter-Basin Flow	-5,580	-5,149	-5,589	-5,149	-5,579

5.11 Model Documentation

Appendix 5a contains model documentation and complete scenario results.

5.12 References

California Department of Water Resources (DWR). December 2016. Guidance Document for the Sustainable Management of Groundwater: Modeling.

California Department of Water Resources (DWR). December 2016. Guidance Document for the Sustainable Management of Groundwater: Water Budget.

California Department of Water Resources (DWR). July 2018. Sustainable Groundwater Management Program: Guidance for Climate Change Data Use During Groundwater Sustainability Plan Development.

California Department of Water Resources (DWR). July 2018. Sustainable Groundwater Management Program: Resource Guide DWR-Provided Climate Change Data and Guidance for Use During Groundwater Sustainability Plan Development.

California Department of Water Resources (DWR). January 2021. Sustainable Groundwater Management Act Water Year Type Dataset Development Report.

California Department of Water Resources (DWR). July 2018. Sustainable Groundwater Management Program: Resource Guide DWR-Provided Climate Change Data and Guidance for Use During Groundwater Sustainability Plan Development.

SECTION 6 CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

6. MONITORING NETWORK AND DATA MANAGEMENT SYSTEM

SGMA regulations require that each GSP develop a monitoring network to collect data of sufficient accuracy and quantity to evaluate changing conditions and trends in groundwater and related surface water, as well as to provide representative information about groundwater conditions. The monitoring network and associated data shall be used to demonstrate that the basin is sustainably managed. SGMA also requires that monitoring networks specifically target the six sustainability indicators[1] either directly or indirectly through a proxy monitoring parameter. The six sustainability indicators are: chronic lowering of groundwater levels, reduction in groundwater storage, seawater intrusion, degraded water quality, land subsidence, and depletion of interconnected surface water. This section describes the monitoring networks, monitoring protocols, data management system, and data reporting requirements for the ECC Subbasin GSP.

The ECC Subbasin monitoring networks shall be assessed every five years. Through these assessments, needed changes and/or data gaps may be identified. The GSAs shall adaptively manage and modify the monitoring networks, projects, management actions, and/or interim milestones to achieve the sustainability objectives for the Subbasin. This process is intended to conform to Monitoring Networks and Identification of Data Gaps, Best Management Practices, (DWR, 2016).

6.1. Monitoring Network Objectives (CCR § 354.34, § 354.38)

In accordance with GSP Regulations, monitoring networks shall be developed to produce a data set of sufficient accuracy, measurement frequency, and spatial distribution to characterize groundwater and related surface water conditions in the plan area and to evaluate conditions through implementation of the GSP all with the purpose of sustainable groundwater management. The monitoring network shall accomplish the following (GSP Reg. § 354.34(b)(1)-(4)):

(1) Demonstrate progress towards achieving measurable objectives described in the GSP.

(2) Monitor impacts to the beneficial uses and users of groundwater.

(3) Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.

(4) Quantify annual changes in water budget components.

The ECC GSP monitoring network is designed to meet the above regulatory requirements through implementation of monitoring described in this section. As discussed in this section, designated monitoring sites throughout the Subbasin, with appropriate monitoring protocols and measurement frequency, will provide a means to quantify current and future hydrogeological conditions of the ECC Subbasin, as well as within individual GSA jurisdictions.

[1] Sustainability indicator in SGMA refers to "any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results…" (DWR, BMP, 2016)

6.2. Monitoring Networks

Under SGMA, monitoring networks shall be established for each of six sustainability indicators as applicable. The six sustainability indicators are: chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded water quality, land subsidence, and depletion of interconnected surface water. The groundwater level monitoring network will act as a proxy for the groundwater storage sustainability indicator. Existing groundwater, surface water and subsidence monitoring programs conducted by DWR, SWCRB, DDW, USGS and UNAVCO, are described in **Section 2.2**. In addition to these programs, five ECC GSAs (City of Brentwood, BBID, TODB and DWD, and ECCID) have independent groundwater monitoring programs. These existing programs are integrated into the GSP monitoring program where applicable to the monitoring objectives. **Table 6-1**, below, summarizes the sustainability indicators and related monitoring in the ECC GSP.

Table 6-1. Sustainability Indicators and Applicable Representative Monitoring Network

Sustainability Indicator	Representative Monitoring Network	Proxy Network
Chronic Lowering of Groundwater Levels	Groundwater Levels	NA
Reduction of Groundwater Storage	See Proxy	Groundwater Levels
Seawater Intrusion	Groundwater Quality	NA
Degraded Groundwater Quality	Groundwater Quality	NA
Land Subsidence	PBO Station	Groundwater Levels
Surface Water Depletion due to Groundwater Pumping	Stream Flow	Groundwater Levels

NA = Not Applicable

6.2.1. Basin-Wide and Representative Monitoring Networks

The GSP monitoring program includes basin-wide and representative networks. The basin-wide network provides a broad source of relevant data by which to evaluate conditions in the Subbasin. The representative network is a subset of the basin-wide network for which minimum thresholds and measurable objectives shall be defined in accordance with *CCR §354.36 (a)* (see **Section 7** of this GSP). For each monitoring network (i.e., basin-wide, and representative monitoring site), the following information is discussed below: the site locations, spatial density, monitoring frequency, monitoring protocols, data gaps, and a plan to fill the data gaps.

6.2.2. Groundwater Level Monitoring Network

Groundwater level monitoring is a fundamental component of data collection for sustainable groundwater management. Groundwater level data from a network of groundwater monitoring wells serve to show groundwater occurrence, flow direction, hydraulic gradients between principal aquifers, and interaction between groundwater and surface water features (*CCR §354.34 (C)*). Each GSA has dedicated monitoring wells in its area of jurisdiction. GSA monitoring wells have existing historical records dating to the 1950s (e.g., ECCID monitoring network for shallow groundwater). The various GSA networks were initially coordinated through the State CASGEM program in 2013. The basin-wide and representative groundwater level networks are summarized below and enumerated in **Table 6-2**:

- **Basin-wide Monitoring Network** - The basin-wide monitoring network for groundwater level evaluation provides a broad dataset for basin evaluation.
- **Representative Monitoring Network** - A subset of basin-wide monitoring wells is selected to monitor sustainability indicators in the Subbasin and to demonstrate sustainable management in accordance with defined minimum thresholds and measurable objectives for the chronic lowering of groundwater levels sustainability indicator.

Table 6-2. GSA Groundwater Level Monitoring Network

GSA	Number of Wells			
	Basin-Wide Network			Representative Network
	Existing	New	Total	
BBID	5		5	1
City of Antioch		3	3	2
City of Brentwood	6		6	2
Contra Costa County		2	2	1
Diablo Water District	10	2	12	3
Town of Discovery Bay	9	2	11	2
ECCID	16		16	1
Total	**46**	**9**	**55**	**12**

Note: multiple completion monitoring wells are counted as separate wells for each depth.

6.2.2.1. Basin-wide Groundwater Level Monitoring Network

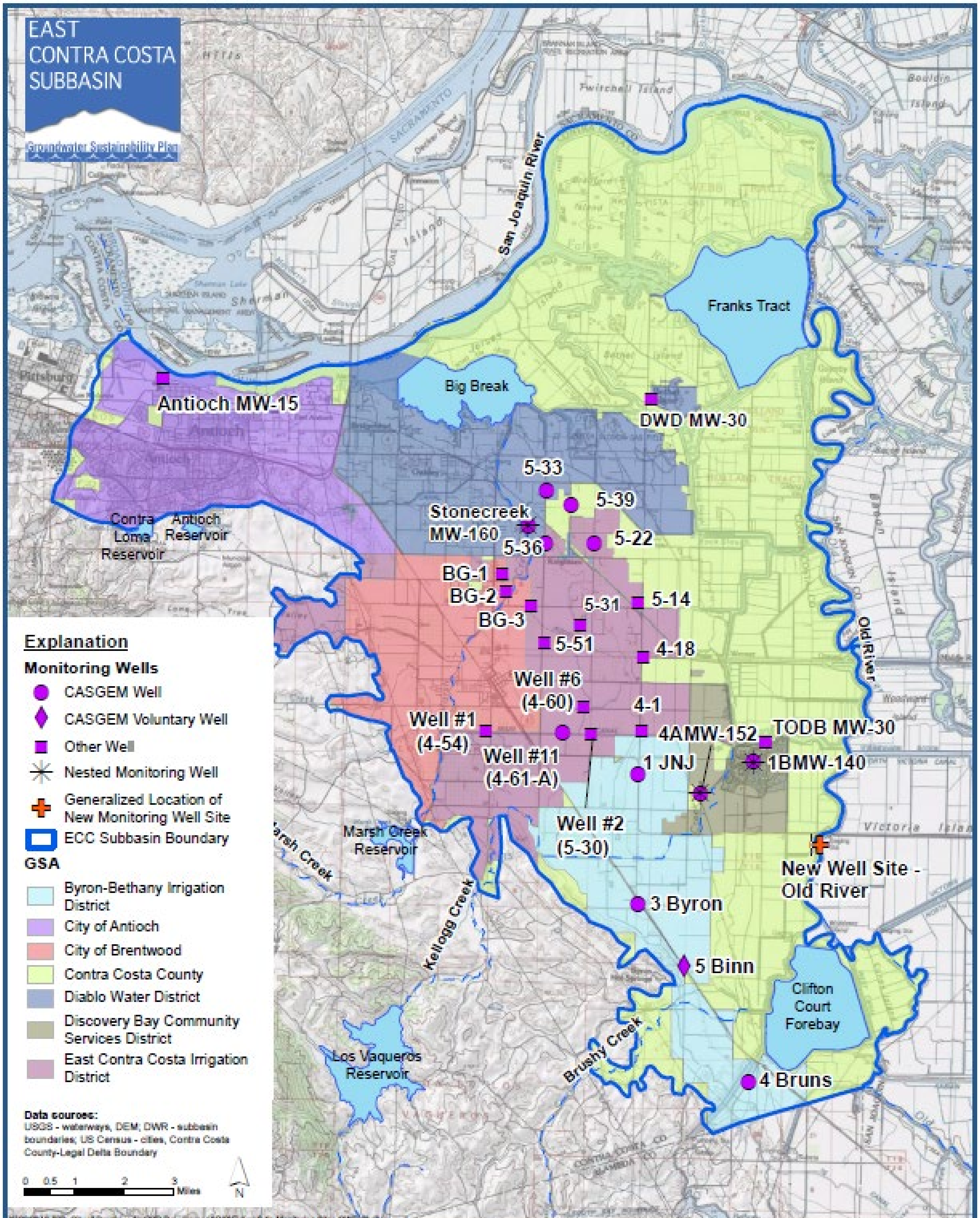
As indicated in **Table 6-2**, 55 wells are included in the basin-wide monitoring network. Well selection criteria included the following:

1. Are representative of groundwater level conditions in the Subbasin and provide monitoring in the two principal aquifers in the Subbasin: Shallow Zone and Deep Zone.
2. GSAs are committed to semiannual monitoring and are typically part of an existing monitoring program.
3. A historical data record exists.

Well locations for the basin-wide groundwater level monitoring network are shown on **Figures 6-1a** and **6-1b**. **Figure 6-1a** show wells that monitor the Shallow Zone aquifer and **Figure 6-1b** shows wells that monitor the Deep Zone. These principal aquifers are described under Basin Setting **Section 3.2.5** and reflect the vertical discretization of groundwater occurrence in the ECC Subbasin.

Figures 6-1a and **6-1b** include new wells to be installed as part of the GSP implementation. These wells are intended to fill data gaps and are discussed in **Section 6.2.3**.

Details of the monitoring network are provided in **Table 6-3** including name, owner, coordinates, reference point elevation (RPE), and perforation depths. Of the 55 basin-wide monitoring wells, 31 are perforated in the Shallow Zone and 19 wells are perforated in the Deep Zone. In addition, 14 nested (two or more casings within the same borehole) or multi-completion, monitoring wells located at 6 different sites are in the network (**Figure 6-1b**). CASGEM wells form a substantial part of monitoring network with 26 wells from this program. With a few exceptions, basin-wide network wells are dedicated groundwater monitoring wells with known construction features and screened only in the designated aquifer zone. Wells that are perforated through both the shallow and deep aquifer zones are not included in the monitoring network nor are wells with unknown construction features. The exceptions to this are three composite wells listed in **Table 6-3** and show on **Figure 6-1b** that are included to improve groundwater level contouring in areas lacking well control.

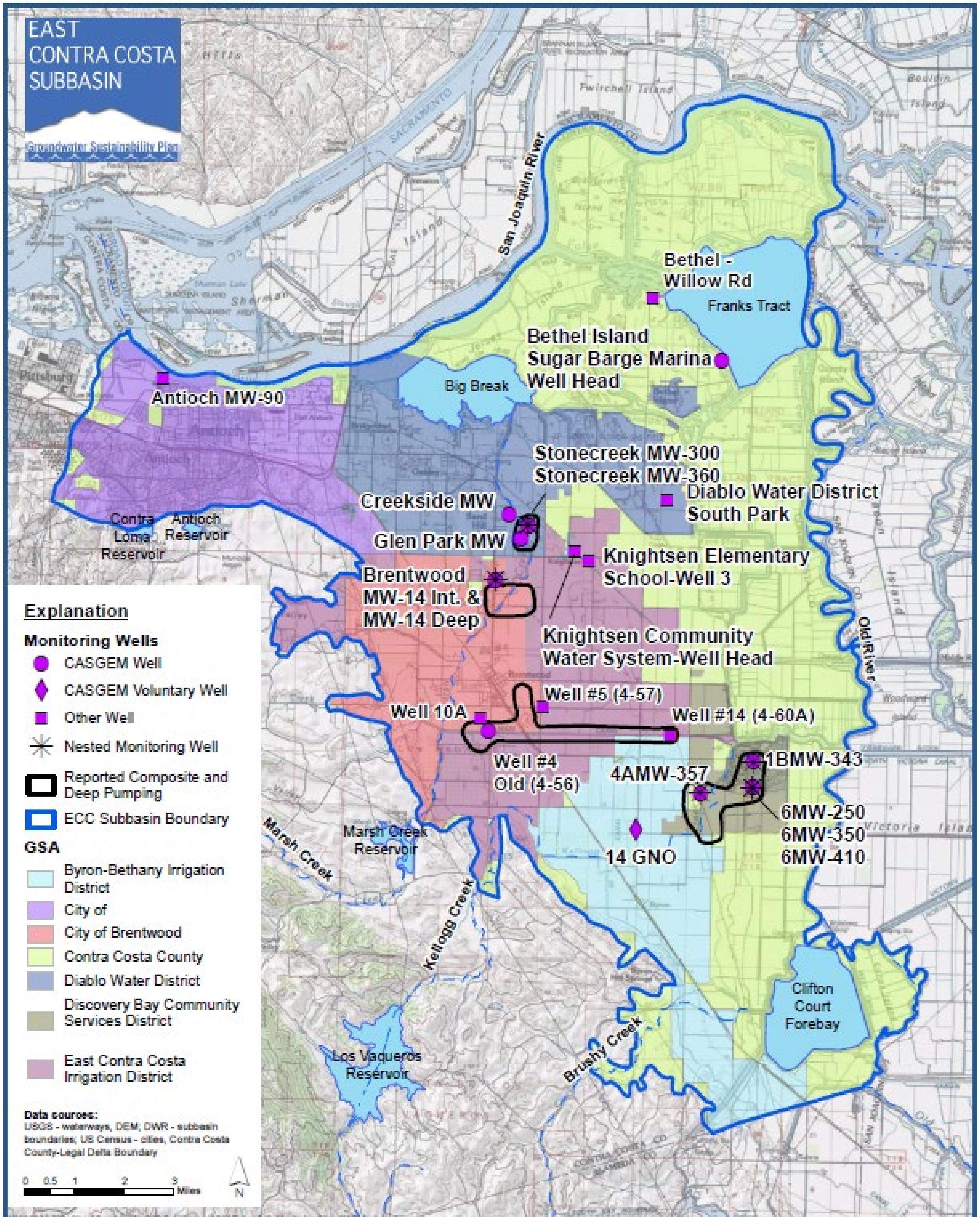


Luhdorff & Scalmanini
Consulting Engineers

Basin-wide Groundwater Level Monitoring Network - Shallow Zone

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 6-1a



Luhdorff & Scalmanini Consulting Engineers

Basin-wide Groundwater Level Monitoring Network-Deep Zone

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 6-1b

Table 6-3. Basin-wide and Representative Groundwater Level Monitoring

Local Well Name	Well Owner/GSA	Latitude	Longitude	Reference Point Elevation (ft)	Perforation Depths (ft bgs)	CASGEM Well	Frequency	Representative Well
Shallow Zone Wells								
Antioch MW-15[‡]	Antioch	38.018901	-121.819755	4.12	5-15	No	daily*	X
Antioch MW-30[‡]	Antioch	38.018887	-121.819753	4.12	20-30	No	daily*	
1 JNJ	BBID	37.906128	-121.6419204	26.63	105-120	Yes	monthly	
3 Byron	BBID	37.8684118	-121.6412186	32.28	50-70	Yes	monthly	
4 Bruns	BBID	37.8168913	-121.5991577	35.87	45-65	Yes	monthly	
5 Binn	BBID	37.8506993	-121.6238007	24.42	45 (TD)	Yes-Vol-untary	monthly	X
New Well	CCC/CCWD					No	daily*	X
New Well	CCC/CCWD					No	daily*	
BG-1	CofB	37.9638969	-121.6933943	71.22	40-55	No	monthly	
BG-2	CofB	37.9589412	-121.6917498	62.09	22.5-37.5	No	monthly	X
BG-3	CofB	37.9546062	-121.6824842	55.6	20-35	No	monthly	
DWD MW-15[‡]	DWD	38.015495	-121.639343	7.31	5-15	No	daily*	
DWD MW-30[‡]	DWD	38.015531	-121.639343	7.26	20-30	No	daily*	X
Stonecreek MW-160	DWD	37.978122	-121.683968	30.76	100-110, 140-150	Yes	monthly?	
4-1	ECCID	37.91888889	-121.6408333	13	0-10	No	semi-annual	
4-18	ECCID	37.94027778	-121.6408333	24.6	NA	No	semi-annual	
5-14	ECCID	37.96527778	-121.6455556	18.7	NA	No	semi-annual	
5-22	ECCID	37.97305556	-121.6594444	17.2	0-10	Yes	semi-annual	
5-31	ECCID	37.94944444	-121.6641667	45.5	0-10	No	semi-annual	
5-33	ECCID	37.98833333	-121.6775	13.3	0.01 - 20	Yes	monthly	
5-36	ECCID	37.97277778	-121.6775	27.4	0-10	Yes	monthly	
5-39	ECCID	37.98444444	-121.6683333	12.5	0.01 - 20	Yes	monthly	
5-51	ECCID	37.95777778	-121.6777778	54.1	0-11	No	semi-annual	
Well #1 (4-54)	ECCID	37.91805556	-121.6983333	85.9	85-165	No	monthly	
Well # 2 (5-30)	ECCID	37.91777778	-121.6594444	40.3	0-30	No	monthly	
Well #6 (4-60)	ECCID	37.92555556	-121.6625	49.5	30-50	No	monthly	
Well #11 (4-61-A)	ECCID	37.91777778	-121.67	55.5	50-100	Yes	monthly	X
TODB MW-15	TODB				5-15	No	daily*	
TODB MW-30	TODB				20-30	No	daily*	X
1BMW-140	TODB	37.9102996	-121.5993985	4.31	100-130	Yes	semi-annual	
4AMW-152	TODB	37.9009991	-121.6187989	11.67	122-142	Yes		

Local Well Name	Well Owner/GSA	Latitude	Longitude	Reference Point Elevation (ft)	Perforation Depths (ft bgs)	CASGEM Well	Frequency	Representative Well
Deep Zone Wells								
Antioch MW-90‡	Antioch	38.01887	-121.819748	4.77	78-88	No	daily*	X
14 GNO	BBID	37.889861	-121.642331	30.32	207-212, 229-238, 244-253, 273-279, 349-356	Yes - Vol-untary	monthly	
Brentwood MW-14 Deep	CofB	37.9620001	-121.6957004	72.76	284-315	Yes	monthly	
Brentwood MW-14 Int.	CofB	37.9620001	-121.6957004	72.76	200-210, 220-230	Yes	monthly	X
Bethel-Willow Rd	DWD	38.045117	-121.639464	4.69	230-260	No	semi-annual	X
Creekside MW	DWD	37.9812138	-121.6911215	29.54	230-240	Yes	monthly	
Diablo Water District-South Park	DWD	37.9860934	-121.6330831	-3.5	204-264, 284-299	No	monthly	
Glen Park MW	DWD	37.9740743	-121.6866247	35.54	220-230, 260-290	Yes	monthly	
Stonecreek MW-300	DWD	37.978122	-121.683968	30.47	230-240, 280-290	Yes	monthly	X
Stonecreek MW-360	DWD	37.978122	-121.683968	30.7	340-350	Yes	monthly	
Knightsen Community Water System-Well Head	DWD	37.9709328	-121.6667157	29.911	235-255, 275-295	No	monthly	
Knightsen Elementary School-Well 3	DWD	37.9679868	-121.6613267	29.59	395-415	No	monthly	
Bethel Island (Sugar Barge Marina-Well Head)	DWD	38.027155	-121.613661	-6	317-333	Yes	monthly	
Well #14 (4-60A)	ECCID	37.92526	-121.67739	55.5	200-330	No	monthly	
1BMW-343	TODB	37.9102996	-121.5993985	4.38	270-289, 309-338	Yes	daily	
4AMW-357	TODB	37.9009991	-121.6187989	11.54	307-347	Yes	daily	X
6MW-250	TODB	37.9028008	-121.5994988	6.6	200-210, 230-240	Yes	daily	
6MW-350	TODB	37.9028008	-121.5994988	6.6	280-290, 330-340	Yes	daily	
6MW-410	TODB	37.9028008	-121.5994988	6.54	390-400	Yes	semi-annual	
Composite Wells								
Well 10A	CofB	37.92166667	-121.7008333	91.85	52-72, 135-182	No	monthly	
Well #4 Old (4-56)	ECCID	37.9178	-121.697222	83.8	68-125, 175-195	Yes	monthly	
Well #5 (4-57)	ECCID	37.92526	-121.67722	60.9	115-125, 170-175, 195-200, 220-245, 270-290	No	monthly	

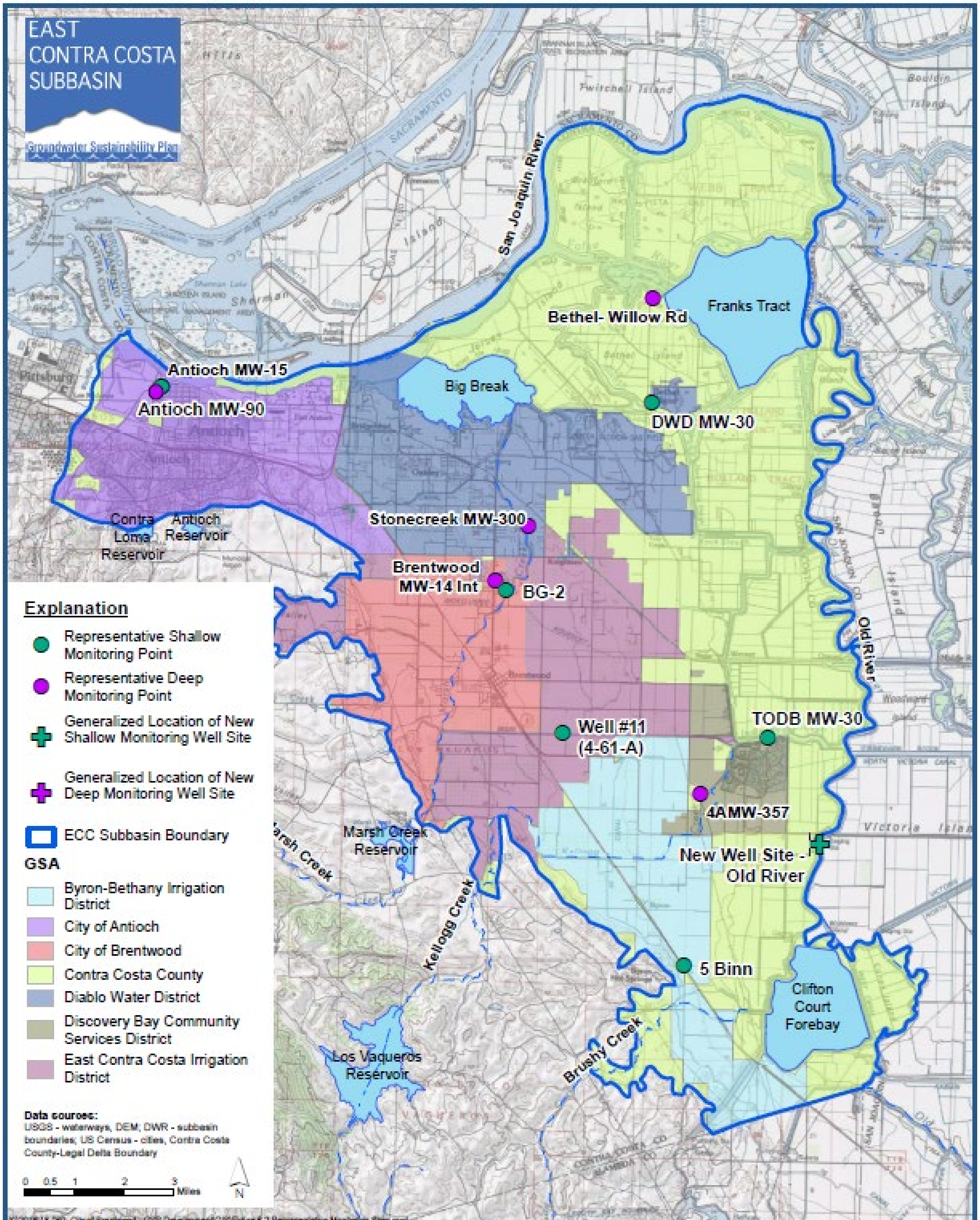
Blue indicates New Monitoring Well

‡Well installed August 2021

* New wells will be fitted with a SCADA system that will record water level measurements at least daily.

A subset of wells in the basin-wide groundwater level monitoring network was selected for the representative groundwater level monitoring network. The representative wells are intended to represent regional conditions with respect to chronic lowering of groundwater levels (sustainability indicator) and for which minimum thresholds and measurable objectives are defined. The representative monitoring wells for groundwater levels are shown on **Figure 6-2** for the Shallow Zone and Deep Zone, respectively. **Table 6-3** identifies the representative monitoring wells which are a subset of the basin-wide wells. The representative monitoring wells were selected based on the following criteria:

a. Show long term, regional trends (good historical record).
b. Dedicated monitoring wells (no production wells).
c. Known well construction features (construction date, well depth, perforation depths).
d. Monitored monthly or continuously (i.e., with transducers and data loggers).
e. Good horizontal and vertical spatial distribution.
f. Greater number for high pumping areas (i.e., representative of conditions in vicinity of high municipal and agricultural pumpage).
g. Professional judgment used where more than one suitable well is present.
h. Include areas of domestic wells and disadvantaged communities.



Luhdorff & Scalmanini Consulting Engineers

Representative Groundwater Level Monitoring Network

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 6-2

6.2.2.2. Spatial Density of Groundwater Level Monitoring Network

The ECC Subbasin monitoring networks have a well density that exceeds recommended practices contained in Monitoring Networks and Identification of Data Gaps, Best Management Practices, (DWR, 2016). This BMP states that "the network should contain an adequate number of wells to observe the overall static conditions and the specific project effects." It also states that there is no rule for the density of monitoring points but does provide a table of existing references (see **Table 6-4**, below**)** that lists density of monitoring wells per hundred square miles with ranges between 0.2 to 10 monitoring wells per 100 square miles. Given a maximum estimated ECC Subbasin groundwater pumping of approximately 14,000 af in the drought year of 2009 (12,700 af metered and 1,100 af unmetered), this converts to 8,300 acre-feet/year per 100 square miles resulting in about 2 monitoring wells per 100 square miles per the Hopkins (1984) guidance.

Table 6-4. Groundwater Level Monitoring Well Density Considerations[2]

Reference	Monitoring Well Density (wells per 100 miles^2)
Heath (1976)	0.2 - 10
Sophocleous (1983)	6.3
Hopkins (1984) Basins pumping more than 10,000 acre-feet/year per 100 miles^2	4.0
Basins pumping between 1,000 and 10,000 acre-feet/year per 100 miles^2	2.0
Basins pumping between 250 and 1,000 acre-feet/year per 100 miles^2	1.0
Basins pumping between 100 and 250 acre-feet/year per 100 miles^2	0.7

For a subbasin area of approximately 168 square miles and with 55 basin-wide monitoring wells and 12 representative monitoring network wells, the ECC basin-wide and representative monitoring well densities are 33 wells per 100 square miles and 7 wells per 100 square miles, respectively (see **Table 6-5**, below). These well densities exceed the Sophocleous and Hopkins recommendations and exceed or falls within the Heath recommendations in the BMP technical guidance represented in **Table 6-4**, above.

[2] Table 6-4 is a reproduction of Table 1 in the DWR BMP Monitoring *Networks and Identification of Data Gaps*.

Table 6-5. ECC Subbasin Groundwater Level Monitoring Networks Density

Monitoring Network	No. of Wells	Well Density (Wells per 100 square miles^2)
Basin-wide Monitoring Network	55	33
Representative Monitoring Network	12	7

6.2.2.3. Frequency and Timing of Groundwater Level Monitoring

Groundwater elevation measurements will be made at a minimum of semi-annually to capture seasonal high and seasonal low levels. Historic groundwater monitoring data indicate that seasonal high elevations occur in winter to spring months (February-April) and seasonal low elevations occur in the fall (September-October). **Table 6-3** includes the frequency of monitoring for each well in the basin-wide network. Historically through the present, chronic lowering of groundwater levels has not been observed in the ECC Subbasin; however, if conditions change in the future, the semi-annual monitoring frequency will be reevaluated to ensure that monitoring of this sustainability indicator complies with SGMA regulations.

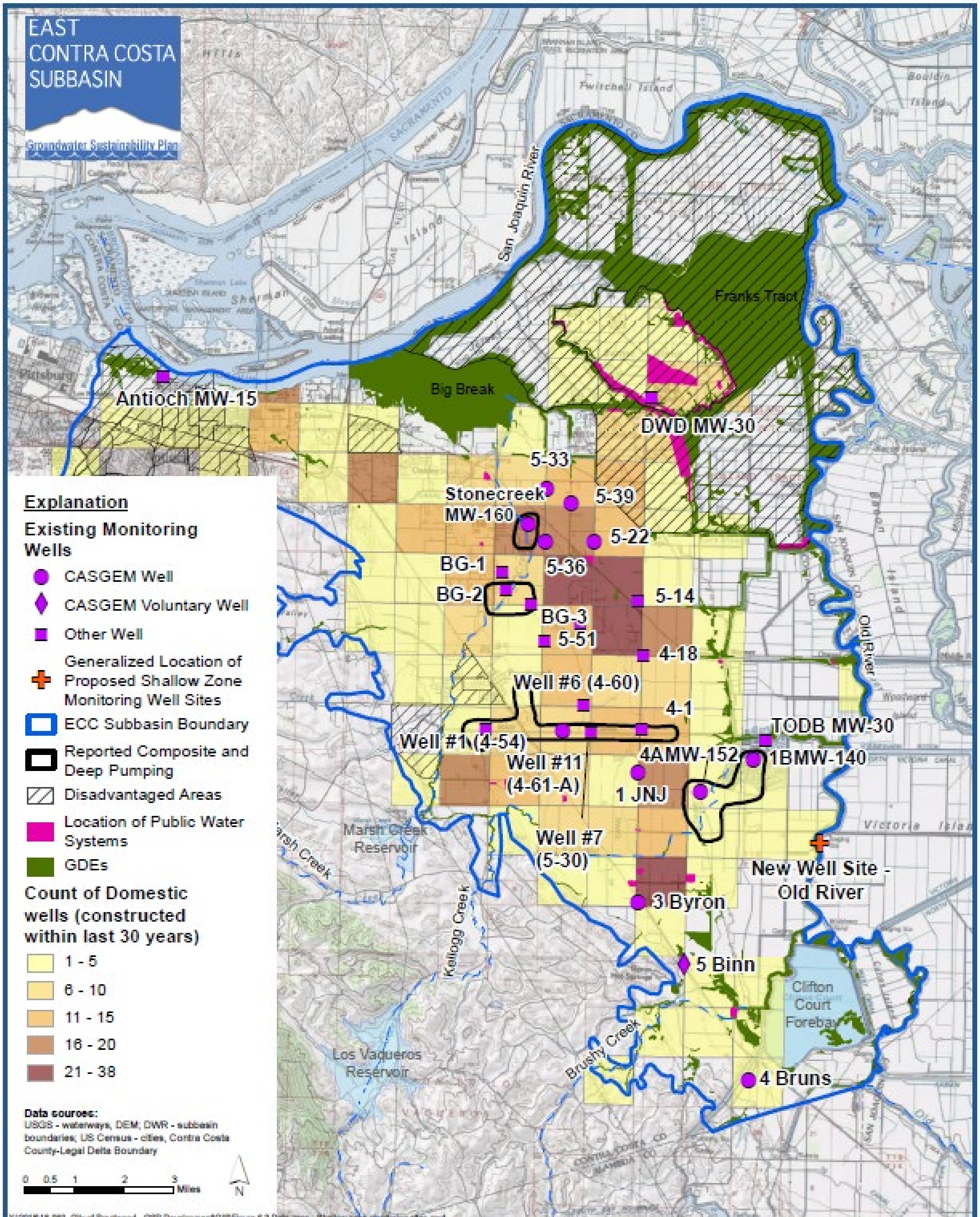
6.2.2.4. Groundwater Level Data Gaps

The existing ECC groundwater level monitoring network is sufficient to monitor areas near the major municipal pumping. However, data gaps were identified in areas where groundwater pumping is limited to only domestic and small water systems. Additional Shallow Zone wells will be installed to accomplish the following objectives:

- Increase density of groundwater level monitoring wells.
- Provide information on surface water and groundwater interaction and conditions near groundwater dependent ecosystems (GDEs).
- Provide information on boundary conditions.
- Ensure that long-term monitoring results are consistent and reliable.
- Improve understanding of impact of groundwater management to beneficial users.
- Improve characterization of groundwater flow regimes.

6.2.2.5. Plan to Fill Groundwater Level Data Gaps

The installation and instrumentation of 9 Shallow Zone groundwater level monitoring wells at four sites are planned as part of the preparation of this GSP and will be implemented under a Proposition 68 grant from DWR. **Figure 6-3** shows the new monitoring wells and existing Shallow Zone monitoring network in relation to other beneficial users of groundwater in the ECC Subbasin: Disadvantaged Areas, small public water systems, GDEs, and de minimis users (domestic well owners). These beneficial users were considered in siting the new monitoring wells. **Figure 6-1b** shows the deep monitoring well network in relation to the one new deep zone monitoring well location (Antioch) and areas of larger-scale pumping by municipal and agricultural users. The following **Table 6-6** lists the data gaps filled by each new well. The new monitoring wells will increase the density of the groundwater level monitoring network and enhance coverage of groundwater level data. It is recognized that additional data gaps may become evident during and after GSP implementation. As supported by data from the monitoring networks, such data gaps will be filled to ensure sustainable management of the Subbasin.



Data Gap - Shallow Zone Groundwater Level Monitoring Network

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 6-3

Table 6-6. Proposed New Monitoring Wells to Fill Data Gaps

Data Gap	Antioch[1] Shallow/Deep	Bethel Island[2] Shallow	TODB[3] Shallow	CCC/CCWD Shallow
Climate Change: Monitor Sea Level Rise, Increase in Chloride/TDS	x	x		
Expand Shallow Zone Network	x	x	x	x
Expand Deep Zone Network	x			
Groundwater Quality	x (esp. Cl and TDS)	x (esp. Cl and TDS)	x	x
Near GDEs and Monitors for Shallow Groundwater/Surface Water Interaction.	x	x	x	x
Located near Small Public Water Systems and Domestic Wells	x	x		
Located near Disadvantaged Areas	x	x		
Adjacent to Municipal Well Pumping			x	
Subbasin Boundary Conditions	x	x		x
Construction: Perforations (ft bgs)	10-15, 20-30, 85-95	5-10, 20-30	10-15, 20-30	5-15, 25-35

1. City of Antioch does not pump groundwater for municipal supply. Domestic supply source is surface water only.
2. Bethel Island is served by public water systems and domestic wells.
3. TODB pumps only groundwater for municipal supply.

6.2.3. Groundwater Quality Monitoring Network

The groundwater quality monitoring network includes municipal production wells that report groundwater quality as regulated by the State Division of Drinking Water under Drinking Water Programs. The objectives of the groundwater quality monitoring program for the ECC Subbasin include the following:

- Evaluate and determined a baseline of groundwater quality conditions in both Shallow Zone and Deep Zone aquifers in the Subbasin and in areas of higher groundwater use.
- Assess changes and trends in groundwater quality (seasonal, short- and long-term trends).
- Incorporate existing groundwater quality monitoring programs (i.e., monitoring of Public Water Systems under the state Drinking Water Programs).
- Provide means to assess groundwater quality impacts to beneficial uses and users including but not limited to effects on primary and secondary drinking water standards for domestic users, crop suitability for agricultural users, and groundwater dependent ecosystems.

- Identify natural (e.g., climate change) and anthropogenic factors that affect groundwater quality including the potential for mobilization of contamination through groundwater flow patterns that may be altered by sustainable management activities.

This section describes the basin-wide and representative monitoring networks, monitoring frequency, spatial density, and monitoring protocols for the degraded groundwater quality sustainability indicator. The monitoring networks are enumerated in **Table 6-7**, below. As discussed in **Section 7**, only representative monitoring wells are used to determine compliance with minimum thresholds or measurable objectives for the degraded water quality sustainability indicator.

Table 6-7. GSA Groundwater Quality Monitoring Network

GSA	Number of Wells				
	Basin-Wide Network				Total Representative Monitoring Network
	Existing Monitoring Wells	New Monitoring Wells	Production Wells	Total Basin-Wide	
BBID					
City of Antioch		2		2	2
City of Brentwood	1		8	9	3
Contra Costa County/CCWD		1		1	1
Diablo Water District	1	1	2	4	3
Town of Discovery Bay		1	5	6	2
ECCID					
Total	2	5	15	22	11

Note: Multiple completion monitoring wells are counted as separate wells for each depth.

6.2.3.1. Basin-wide Groundwater Quality Monitoring Network

The Basin-wide groundwater quality monitoring network is summarized in **Table 6-7**. Details of the basin-wide monitoring network are provided in **Table 6-8** including well name, owner, perforation depths, and monitoring frequency. The wells are grouped according to aquifer zone (Shallow Zone and Deep Zone). The network consists of consists of 22 wells of which 5 are completed in the Shallow Zone and 17 in the Deep Zone. The Shallow Zone and Deep Zone well locations are shown on **Figure 6-4**.

Other agencies track groundwater contamination including GeoTracker (online resource). **Section 3.3.6** discusses the groundwater contamination sites in the ECC Subbasin and **Appendix 3h** lists the 35 open sites and the 105 closed sites in the Subbasin. The lists and locations will be updated to identify any changes in plume movement

Table 6-8. Basin-wide and Representative Groundwater Quality Monitoring Network

Local Well Name	Owner/ GSA	Perforation	Data: First Date	Data: Last Date	Frequency	Seawater Intrusion Monitoring Network	Representative Monitoring Wells
Shallow Zone							
BG-1	Brentwood	40-55	2/17/2008	2/15/2015	Annual[1]		x
Antioch MW-15‡	Antioch	5-15			Annual[1]	x	x
DWD MW-30‡	DWD	20-30			Annual[1]	x	x
TODB MW-30	TODB	20-30			Annual[1]	x	x
New Well Old River 1 of 2	CCC/CCWD				Annual[1]	x	x
Deep Zone							
Antioch MW-90‡	Antioch	78-88			Annual[1]		x
City of Brentwood-Well 06	Brentwood	250-300	8/16/1990	8/7/2019	Variable[2]		
City of Brentwood-Well 07	Brentwood	265-295	5/5/1988	5/6/2019	Variable[2]		
City of Brentwood-Well 08	Brentwood	225-315	6/14/1993	5/6/2019	Variable[2]		
City of Brentwood-Well 09	Brentwood	210-230	7/19/2004	6/1/2016	Variable[2]		
City of Brentwood-Well 12	Brentwood	350-380, 430-450	12/18/1997	6/1/2016	Variable[2]		
City of Brentwood-Well 13	Brentwood	350-380, 430-480	12/17/1997	5/9/2019	Variable[2]		x
City of Brentwood-Well 14	Brentwood	285-315	11/3/2000	5/9/2019	Variable[2]		x
City of Brentwood-Well 15	Brentwood	239-259 289-324	7/26/2006	12/9/2019	Variable[2]		
Glen Park Well	DWD	230-245, 260-300	5/4/2004	6/19/2019	Variable[2]		x
Stonecreek Well	DWD	220-295	5/10/2010	6/19/2019	Variable[2]		

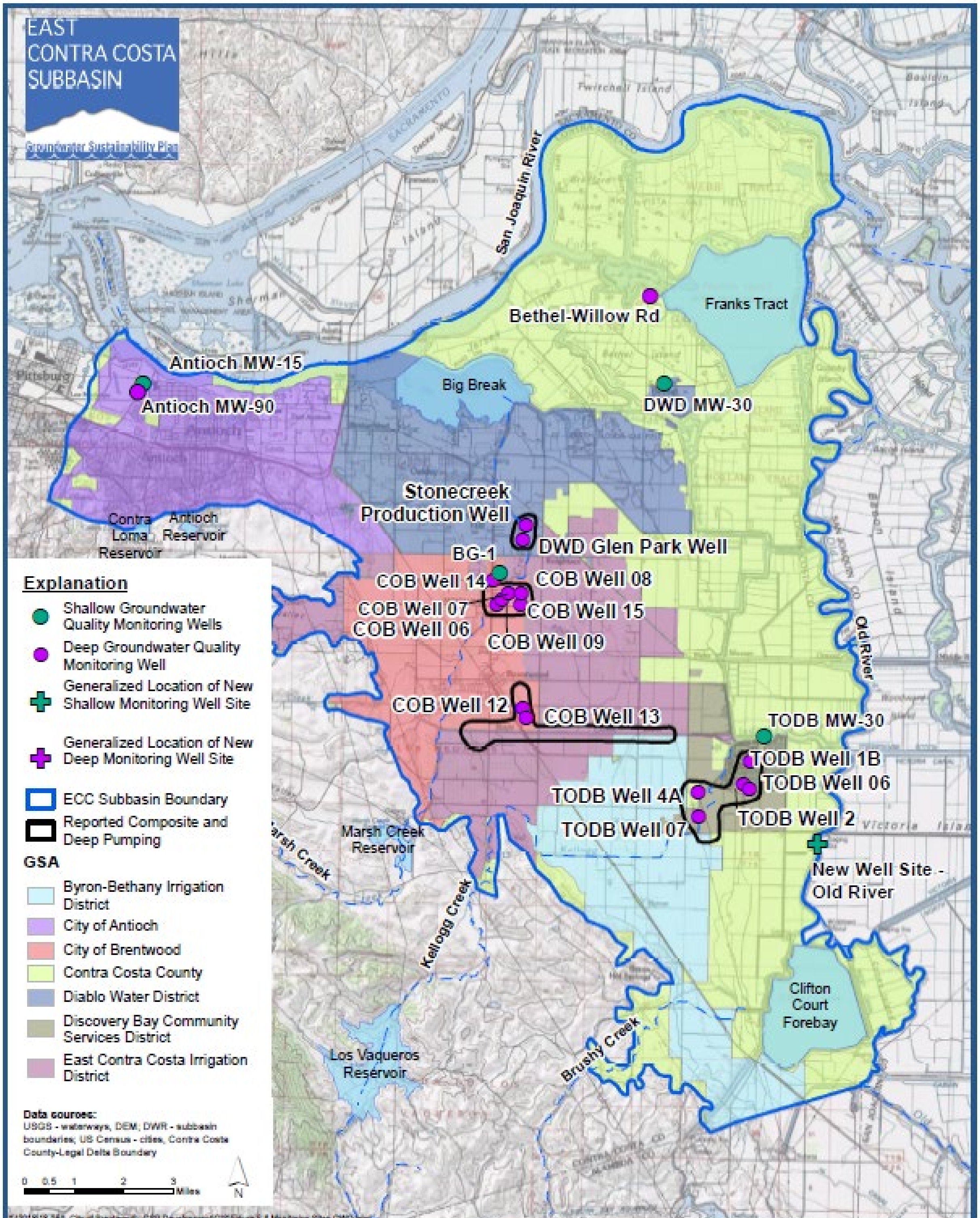
Local Well Name	Owner/ GSA	Perforation	Data: First Date	Data: Last Date	Frequency	Seawater Intrusion Monitoring Network	Representative Monitoring Wells
Bethel-Willow Rd	DWD	230-260			Annual[1]		x
Town of Discovery Bay Well 1B	TODB	271-289, 308-340	3/28/1995	5/23/2019	Variable[2]		
Town of Discovery Bay Well 2	TODB	245-335	11/19/1986	5/23/2019	Variable[2]		
Town of Discovery Bay Well 4A	TODB	307-347	8/1/1996	5/23/2019	Variable[2]		x
Town of Discovery Bay-Well 06	TODB	270-295, 305-350	8/24/2009	5/23/2019	Variable[2]		
Town of Discovery Bay-Well 07	TODB	282-292	7/30/2015	7/9/2019	Variable[2]		

Blue indicates New Monitoring Well

‡ Well installed August 2021

1. Sampling frequency is annual for first five years at which time it will be evaluated and potentially changed to align with typical compliance monitoring (e.g., 3 or 5 years depending on constituent).

2. Variable as per current compliance monitoring under state drinking water programs.



Luhdorff & Scalmanini Consulting Engineers

Basin-wide Groundwater Quality Monitoring Network

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 6-4

6.2.3.2. Representative Groundwater Quality Monitoring Network

The representative monitoring network for the Shallow Zone is the same as the Basin-wide monitoring network (see **Figure 6-4**). The Deep Zone representative monitoring network is a subset of the Basin-wide Monitoring Network and consists of 4 existing wells in the zones of municipal pumping plus one new well (Antioch) and an existing deep well on Bethel Island (DWD) that are both areas of data gaps discussed under groundwater level monitoring (see **Figure 6-5**). **Table 6-8** lists features of the representative monitoring wells in both Shallow Zone and Deep Zone aquifers. For the Deep Zone, the selected representative wells in areas of high production are municipal wells that are completed solely in the deep aquifer zone and for which historical and ongoing water quality testing data are available.

6.2.3.3. Spatial Density, Frequency, and Data Gaps of Groundwater Quality Monitoring Network

Monitoring wells are distributed in both principal aquifer zones in the ECC Subbasin. Monitoring in the Deep Zone aquifer is focused on areas of highest groundwater production plus data gap areas in Antioch and on Bethel Island (see **Figure 6-5**). Sampling frequency will be consistent with typical compliance monitoring for municipal wells to provide sufficient data to evaluate groundwater quality trends over time in each aquifer zone. No additional monitoring wells are required at this time and the network will be reevaluated for the 5-year report. The groundwater quality monitoring network may be expanded if any of the following occurs: changes to groundwater quality restricting beneficial use, increase in groundwater development and/or shifts in pumping patterns, or if there is a change in groundwater management actions or projects. In such cases, the need to adapt monitoring frequency and/or sites shall be determined from the monitoring record.

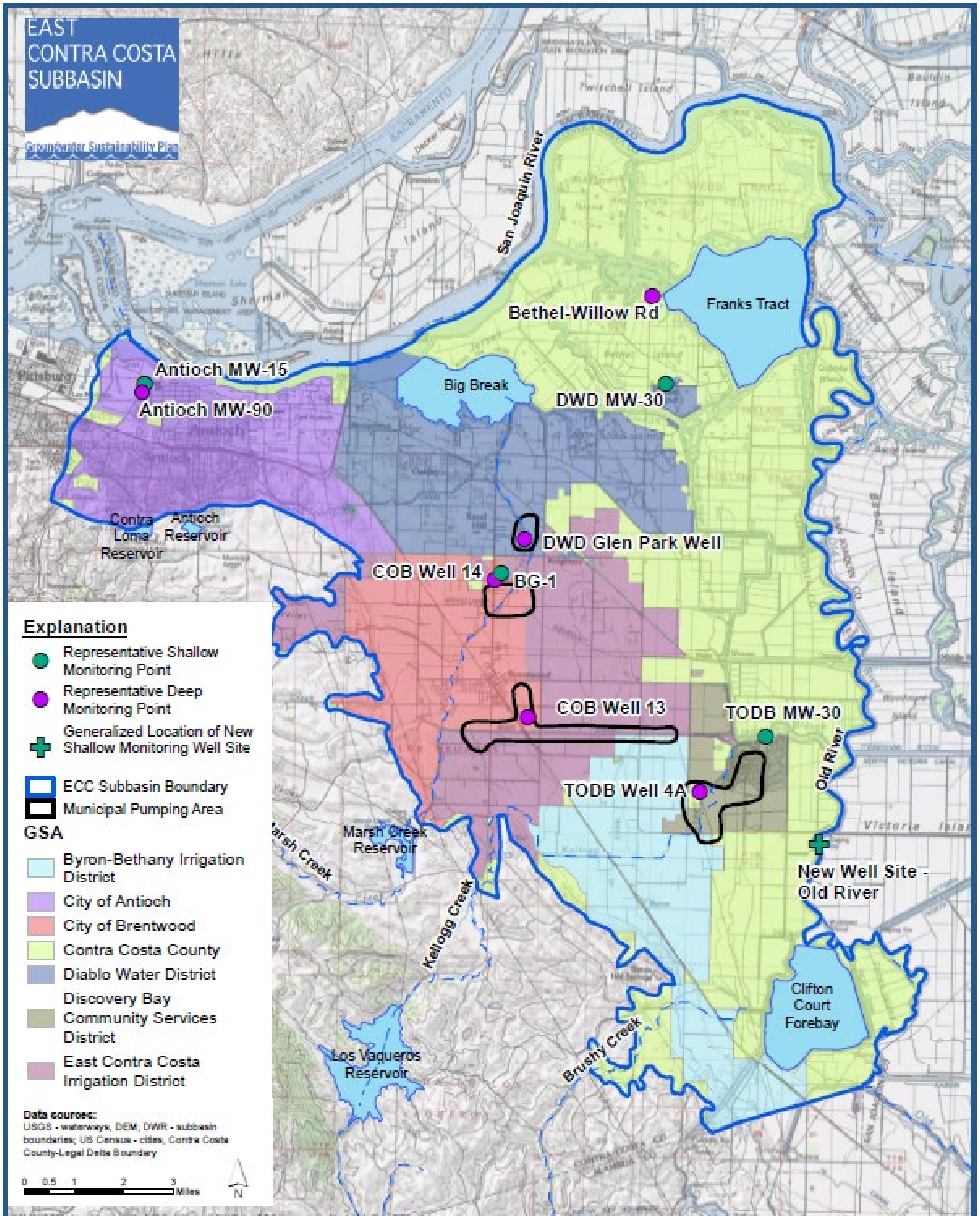
6.2.4. Seawater Intrusion Monitoring Network

The seawater intrusion monitoring network is designed to address a mechanism by which Delta baywater migrates into shallow groundwater (see discussion in **Section 3.3.4**). The potential for intrusion of saline water into the shallow zone may be exacerbated by sea level rise. These intrusion mechanisms could impact groundwater sustainability if saline water in the Shallow Zone migrated vertically into the Deep Zone supply source. At present, there is no evidence that saline intrusion from Delta baywaters has occurred or adversely affected groundwater resources in the ECC Subbasin.

The sustainability indicator for Seawater Intrusion (baywater for this Subbasin) is evaluated using a chloride concentration map that will include a new dedicated Shallow Zone monitoring wells that will act as sentinels for baywater intrusion and degradation. **Table 6-8** lists the Shallow and Deep Zone Wells used to monitor chloride concentration and **Figure 6-5** shows the locations of these wells. There is currently no Shallow Zone chloride concentration contour map since the four new monitoring well results are not yet available to provide the necessary well control. However, **Figure 3-16d** shows the average chloride (2008 to 2018) concentration in all Shallow Zone and Deep Zone wells.

Seawater Intrusion Monitoring Protocols are the same as for those used for groundwater quality (**Appendix 6a**). Chloride concentration contour intervals will be based on the ranges of recorded values, well control, and analytic considerations.

Seawater Intrusion Monitoring Data Gap: Currently there is no historic seawater intrusion in the Subbasin. The four new shallow monitoring well pairs will serve as sentinels and inform on the need for expanded monitoring at other locations. As data is collected and analyzed and if conditions change, additional wells can be installed with consideration of spatial and vertical control.



Luhdorff & Scalmanini Consulting Engineers

Representative Groundwater Quality Monitoring Network

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 6-5

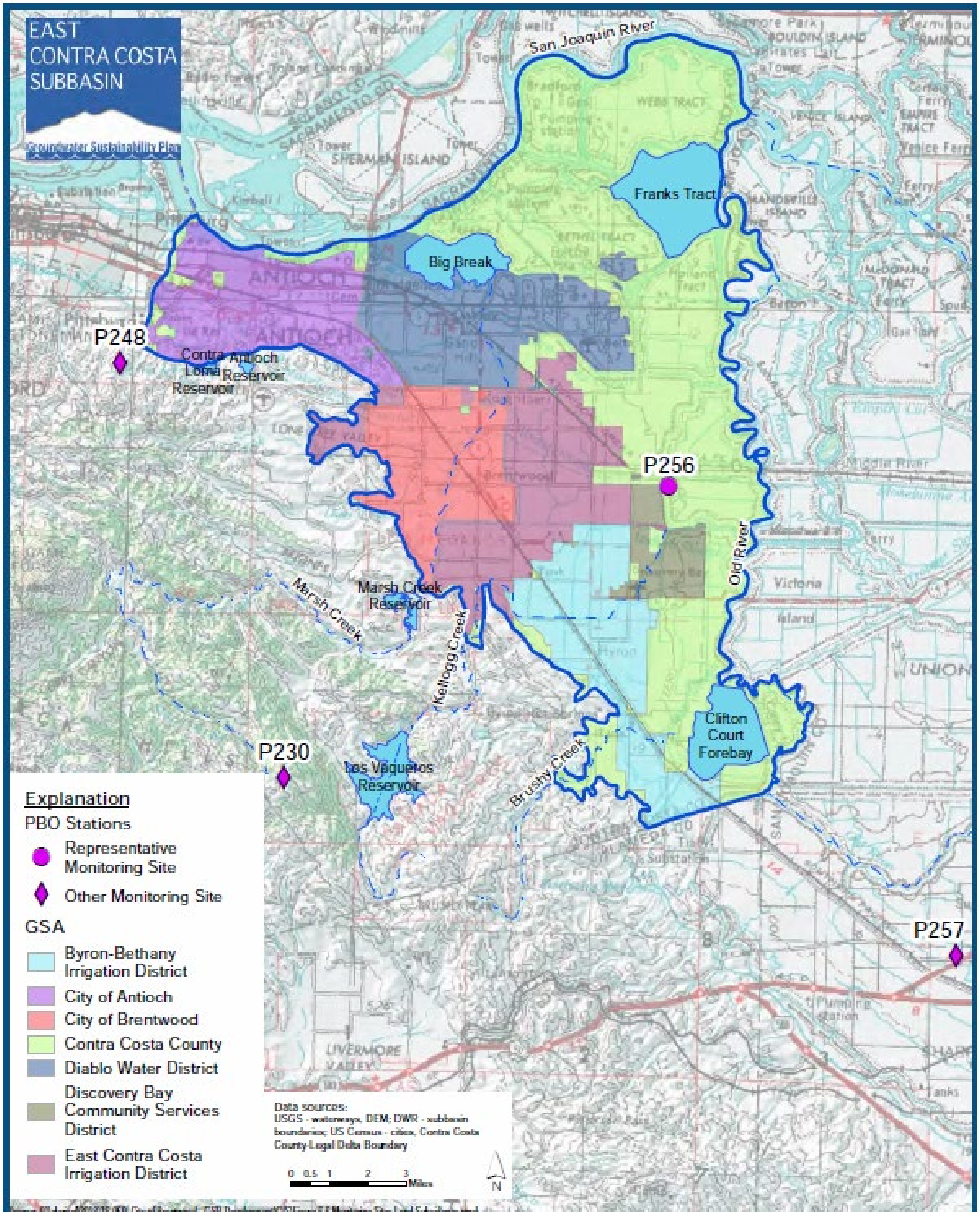
6.2.5. Land Subsidence Monitoring Network

The ECC Subbasin is not a locus for inelastic land subsidence due to groundwater extraction. This is a result of stable historic groundwater levels and lack of subsurface lithologies that would be susceptible to subsidence. However, the sustainability indicator for land subsidence will be monitored through an existing network as discussed below.

The existing land subsidence monitoring network applicable to the ECC Subbasin is comprised of four Plate Boundary Observatory (PBO) (see **Figure 6-6**) Stations. Details about the PBO network are presented in **Section 3.3.7**. PBO Station 256 is located within the ECC Subbasin and three others, P230, P248 and P257, are located in the same region but outside the Subbasin boundary. DWR has also published Interferometric Synthetic Aperture Radar (InSAR) results in partnership with the European Space Agency's Sentinel-1A satellite with the data processed by TRE ALTAMIRA[3]. These data present measurements of vertical ground surface displacement between two different dates. InSAR mapping of land surface elevation is particularly useful for complementing high spatial and temporal resolution data at CGPS station locations with observations of land subsidence over a large area for highlighting locations where change is occurring.

The representative monitoring network consists of Station 256 (P256). While land subsidence network spatial density recommendations are not provided in DWR technical guidance documents, the use of data from P256 is considered sufficient based on the lack of historical subsidence and lack of lithologies generally associated with subsidence caused by pumping. InSAR has been made available for the Subbasin and will provide coverage for the entire Subbasin and be used to compare results from the Station 256. In addition, the groundwater level monitoring will serve as a proxy to assess the sufficiency of the subsidence monitoring networks. Data from PBO Station 256 and InSAR will be reviewed annually. The land subsidence networks will be evaluated as part of the 5-year update and if there is evidence of subsidence at that time, additional monitoring will be considered.

[3] https://gis.water.ca.gov/arcgisimg/rest/services/SAR



Luhdorff & Scalmanini Consulting Engineers

Land Subsidence Monitoring Network

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 6-6

6.2.6. Interconnected Surface Water Monitoring Network

The Monitoring Networks and Identification of Data Gaps BPM (DWR, 2016) states that an interconnected surface water and groundwater network should include stream gages and groundwater level monitoring in areas where there is a known surface water groundwater connection. These data are then used to estimate depletions.

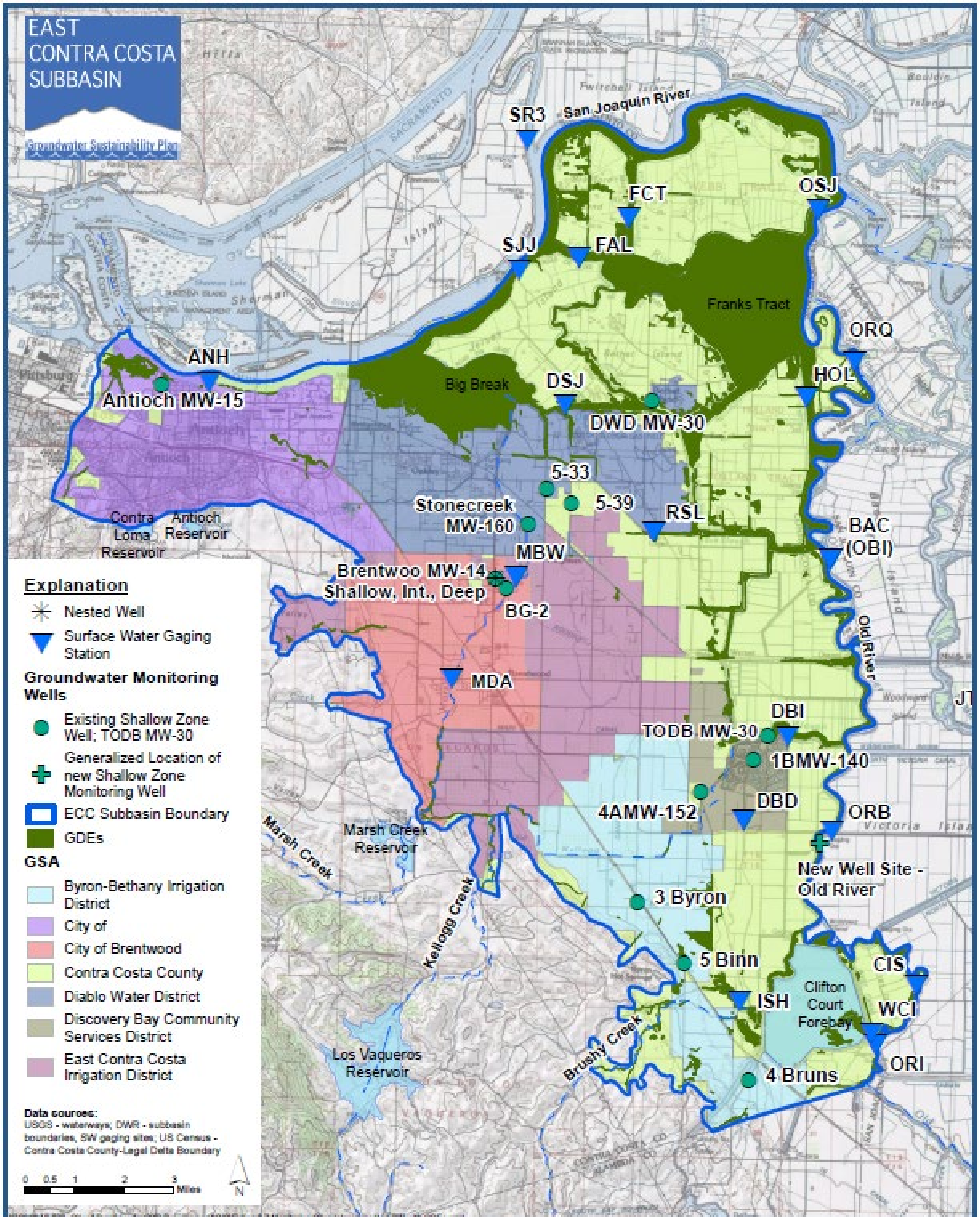
The interconnected surface water monitoring network for the ECC Subbasin consists of a subset of 15 Shallow Zone groundwater level monitoring network wells that are located adjacent to creeks, rivers and GDEs along with existing surface water flow monitoring stations (see **Figure 6-7** and **Table 6-9**). There are 19 surface water monitoring sites in the Subbasin or in the vicinity of the Subbasin boundary. These stations are independently or jointly operated by Contra Costa County Flood Control and Water Conservation District, DWR, and USGS. Most of the surface water monitoring stations at locations adjacent to the San Joaquin River, Old River, Middle River, Marsh Creek, and water conveying canals. Flow data collected at these stations (stage and/or flow rate) are publicly available. There is a range of historical data associated with these stations providing an ability to develop historical baselines to compare with future monitoring results.

A representative monitoring network is not necessary because the groundwater level monitoring network serves as a proxy for depletion of interconnected surface water. Surface water monitoring protocols are established by the monitoring entity (DWR and USGS in most cases). Spatial density for interconnected surface water monitoring networks is not specified in the Monitoring Networks and Identification of Data Gaps BMP (DWR, 2016), the incorporation of the active stations is considered sufficient for GSP implementation based on professional judgement. The special coverage for this initial GSP will be evaluated in the 5-year GSP update.

Currently there is an incomplete understanding of the interconnected surface water systems in the Subbasin. This is expected to be remedied through installation of shallow multiple completion monitoring wells (eight wells at four sites as part of this GSP) and future monitoring efforts related to this GSP.

6.2.6.1. Groundwater Dependent Ecosystem Monitoring

GSP Regulations do not require the monitoring of GDEs in a GSP, however, GDEs must be properly identified within the Plan area utilizing data available from DWR, as specified in GSP Regulation §353.2, or the best information available to the Agency. The subbasin will annually review remote sensing to monitor the health of GDEs. Landsat imagery is available at a resolution of 30 meters every 16 days, from which long-term temporal trends of vegetation metrics can be assessed on The Nature Conservatory's (TNC) GDE Pulse web app, allowing users to infer the relationships between groundwater levels, precipitation, and GDE vegetation metrics. As detailed on the GDE Pulse website, the methods in which TNC processed the satellite data results in a geospatial representation of the Normalized Derived Vegetation Index (NDVI) to estimate vegetation greenness and Normalized Derived Moisture Index (NDMI) to estimate vegetation moisture. TNC provides the average NDVI and NDMI for all Landsat pixels, masked to spatial data from the iGDE database, to present the average and trend geospatial layers representing positive and negative trends in the two-vegetation metrics.



Luhdorff & Scalmanini Consulting Engineers

Interconnected Surface Water Monitoring Network

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 6-7

Table 6-9. Basin-wide Interconnected Surface Water Monitoring Network

Station Name	CDEC Code	Monitoring Entity	Monitoring Frequency
San Joaquin River at Antioch	ANH	CA Dept of Water Resources	Hourly
Bacon Island at Old River	BAC	CA Dept of Water Resources	Hourly
Old River at Coney Island	CIS	CA Dept of Water Resources	15 minutes
Discovery Bay at Discovery Bay Blvd	DBD	CA Dept of Water Resources	Hourly
Discovery Bay at Indian Slough	DBI	CA Dept of Water Resources	Hourly
Dutch Slough At Jersey Island	DSJ	US Geological Survey	15 minutes
False River Near Oakley	FAL	US Geological Survey and CA Dept of Water Resources	15 minutes
Fishermans Cut	FCT	CA Dept of Water Resources	15 minutes
Holland Cut Near Bethel Island	HOL	US Geological Survey and CA Dept of Water Resources	Hourly
Italian Slough Headwater Nr Byron	ISH	CA Dept of Water Resources	15 minutes
Marsh Creek at Brentwood	MBW	Contra Costa County Flood Control and Water Conservation District	15 minutes
Marsh Creek at Dainty Blvd	MDA	Contra Costa County Flood Control and Water Conservation District	15 minutes
Old River at Bacon Island (USGS)	OBI[4]	US Geological Survey and CA Dept of Water Resources	Hourly
Old River at Byron	ORB	CA Dept of Water Resources	15 minutes
Old River at Clifton Court Intake	ORI	CA Dept of Water Resources	15 minutes
Old River at Quimbly Is Near Bethel Is	ORQ	US Geological Survey and CA Dept of Water Resources	15 minutes
Old River at Franks Tract Near Terminus	OSJ	US Geological Survey and CA Dept of Water Resources	hourly
Rock Slough Abv Contra Costa Canal	RSL	CA Dept of Water Resources	15 minutes
San Joaquin River at Jersey Point (USGS)	SJJ	US Geological Survey	15 minutes
Three Mile Slough at San Joaquin River	SR3	CA Dept of Water Resources	15 minutes
West Canal at Clifton Court Intake	WCI	CA Dept of Water Resources	15 minutes

[4] Same as Bacon Island at Old River (BAC).

6.3. Protocols for Data Collection and Monitoring (§ 352.2)

The GSP monitoring protocols are consistent with the Groundwater Monitoring Protocols, Standards, and Sites Best Management Practice (DWR, 2016). The recommended monitoring protocols were adapted based on experience of the ECC GSAs with the final protocols meeting or exceeding the recommendations in the BMP guidance document.

Monitoring protocols for groundwater pumping were not given in the BMP document but accounting for groundwater pumping is an important part of managing sustainability in the ECC Subbasin. Therefore, monitoring protocols for measuring groundwater pumping are included in this GSP.

The monitoring protocols that are described in **Appendix 6a** will provide the necessary data to track minimum thresholds and measurable objectives for each sustainability indicator. The monitoring protocols established here are to be reviewed in 5 years as a part of periodic review of the GSP. The following protocols shall be employed at all monitoring sites:

- Document basic information for each monitoring point: a unique identifier, a description of the site location, geographical coordinates, elevation, date established, access instructions, and type(s) of data to be collected.
  - *A modification log shall be to be kept in order to track all modifications to the monitoring site.*
- Locations shall be reported in geographical coordinates to a minimum accuracy of 30 feet or relative to the North American Datum of 1983 (NAD83).
- Reference point elevations shall be measured in feet to an accuracy of at least 0.5 feet relative to the North American Vertical Datum of 1988 (NAVD 88).

6.4. Data Gaps

The ECC Subbasin monitoring networks consists of groundwater monitoring wells, stream gages and subsidence monitoring stations. The networks will be integrated into the GSP to monitor hydrological conditions for six SGMA sustainability indicators.

The number of groundwater monitoring wells in the ECC Subbasin networks exceeds the minimum number of wells recommended in the DWR BMP technical guidance. As per the method developed by Hopkins (1984) and included in the BMP, a basin that pumps groundwater between 1,000 and 10,000 AFY per 100 square miles should have two monitoring wells. The ECC Subbasin has four monitoring wells and a maximum historical annual groundwater pumpage of approximately 14,000 AF (12,700 af metered and 1,100 af non-metered). When prorated to the Subbasin area of 168 square miles, pumpage is 8,300 af and the number of wells is 2.4 per 100 square miles thus satisfying the Hopkins (1984) criterion for a basin that pumps between 1,000 and 10,000 AFY per 100 square miles.

Groundwater pumping and usage vary between the seven GSAs in the ECC Subbasin. As a result, the monitoring network was designed to provide a higher density of monitoring sites in areas where groundwater pumping is high, while providing a sufficient spatial coverage throughout the Subbasin. The monitoring schedule for each sustainability indicator was developed to utilize existing monitoring programs while ensuring that relevant seasonal, short-term, and long-term trends are captured. The monitoring sites meet the standards described in GSP Regulations § 352.4.

The rationales for selection of groundwater monitoring wells were their construction (penetrate only one aquifer zone), location relative to the Subbasin boundary, groundwater pumping wells and surface water features, being affiliated with current monitoring programs, and availability of historical data. Subsidence and surface water monitoring stations were selected based on their locations and availability of data. Data gaps have been initially evaluated and filled with new monitoring wells to be installed prior to implementation of the GSP. To the extent that other data gaps become evident through evaluation of hydrologic conditions and have the potential to impair sustainable groundwater management, additional wells shall be proposed and assessed to add to the networks.

6.4.1. Well Inventory Data Gap

To date, there have been no comprehensive efforts or procedures instituted to inventory active production wells in the ECC Subbasin. With the implementation of this GSP, a well inventory program shall be created with completion targeted for the 5-year Plan update. The well inventory will be developed as a tool to better understand how management of the Subbasin affects groundwater users should adverse impacts occur.

The process of creating a well inventory will be coordinated with the Contra Costa County Environmental Health Division which is the permitting agency for new wells in the ECC Subbasin. A procedure for sharing information on all new wells constructed under the County’s permitting authority with the ECC Subbasin Data Management System shall be developed. The well inventory system will track various parameters including the following:

- Well location and GIS coordinates
- Date installed
- Permit number (County)
- Well Drillers Report number (DWR)
- Depth of well
- Well diameter
- Depths of perforations
- Use (domestic, industrial, commercial, agricultural, other)

A method to incorporate wells constructed prior to the new data exchange system is implemented will be evaluated with the objective that the DMS substantially accounts for active wells that serves sustainable management goal of the Subbasin as detailed in **Section 7**, **Sustainable Management Criteria**.

6.5. Ongoing Monitoring Network Evaluation

Monitoring network of the ECC GSP was established based on the ability to adequately monitor each sustainability indicator while utilizing all available monitoring sites. Each 5-year update of the GSP will include an analysis of the existing monitoring network and its ability to accurately characterize conditions and achieve sustainability. One data gap that has been currently identified is the monitoring of interconnected surface water, and it will be addressed before the next GSP update.

The monitoring network will be evaluated and potentially updated under any of the following conditions before a 5-year update:

- Exceedance of minimum threshold of a sustainability indicator.
- Highly variable spatial or temporal conditions that are inconsistent with historical baselines and the hydrogeological conceptual model.
- Adverse impacts to beneficial uses and users of groundwater.
- Determination of potential adverse effects on the ability of an adjacent basin to implement a GSP or impede achievement of sustainability goals in that basin.

6.6. Groundwater Data Management

The GSAs in the ECC Subbasin will measure the groundwater levels of wells according to the monitoring protocols set forth in the GSP **Appendix 6a**. Water level data will be submitted to a designated GSA or directly to a database manager for the GSP.

Groundwater quality samples will be collected by GSAs and sent for analysis by a certified laboratory per local practice. Quantitative testing results shall be submitted either to the designated GSA or directly to the GSP database manager. The database manager will annually transmit to the GSAs hydrographs for wells, analytical plots, brief overview of data and field reports.

Groundwater levels of the wells that are in the CASGEM network are typically collected in mid-March and mid-October of each year. All semi-annual data is sent to the database manager for review and uploading to the DWR website by March 31 (spring data) and October 31 (fall data). The database manager will upload the data according to procedures specified by DWR. In accordance with GSP Regulation §354.4, copies of monitoring data stored in the DMS shall be included in annual reports and submitted electronically on forms provided by DWR. The ECC GSAs have established guidelines to ensure that data are managed according to permissions granted by each well owner and/or as relating to applicable permit conditions.

6.7. Data Management System (§ 352.6)

In accordance with GSP Regulation § 352.6, the ECC Subbasin Data Management System (DMS) has been developed to incorporate existing and new data related to groundwater resources in the Subbasin. Site-specific information for monitoring points (identification, owner, location, construction details, measurement types, measurement method, measurement frequency, affiliated monitoring programs, permission, and other comments) and time series data shall be securely stored and backed-up in the DMS. The DMS is also capable of processing data and producing reports to meet the reporting requirements under GSP implementation. The current DMS platform is Microsoft Access and the database manager can control the access to data by DMS users.

6.8. Data Use and Disclosure

Some wells in the monitoring network are privately-owned. Monitoring and data reporting associated with those wells are conducted with the permission of well owners. Exact location information of private wells will be redacted from submittals, while water level and quality data will be published with the well owner's permission. Groundwater quality of public supply wells will be publicly available.

6.9. Data Submittals

Monitoring data will be submitted to DWR in electronic formats utilizing the forms provided by the DWR (GSP Reg. § 353.4).

6.10. Reporting

Annual reporting and periodic evaluation for the ECC GSP monitoring networks are detailed in **Section 9**.

6.11. References

California Department of Water Resources (DWR). December 2016. Guidance Document for the Sustainable Management of Groundwater: Monitoring Networks and Identification of Data Gaps, Best Management Practice.

SECTION 7 CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

7. SUSTAINABLE MANAGEMENT CRITERIA

Sustainable groundwater management is the management and use of groundwater in a manner that can be maintained for the next 50 years without causing undesirable results[1]. The avoidance of undesirable results is critical to the success of a Groundwater Sustainability Plan (GSP). Management of the basin through this GSP will be conducted using the best available science and it will be periodically updated through an adaptive process in response to various factors including climate change.

Consistent with the principles described above, the East Contra Costa (ECC) GSP has tailored sustainable management criteria (SMC) specific to the conditions found in the ECC Subbasin. The development and implementation of these SMCs, (e.g., sustainability goal, undesirable results, minimum thresholds, and measurable objectives[2]) ensures the continued sustainability of groundwater resources in the ECC Subbasin by committing the seven overlying GSAs to future management actions.

This section defines sustainable management criteria for the ECC Subbasin including the data and methods used in their development and how they relate to beneficial uses and users of groundwater. The SMC are based on current available data and analyses of the basin setting and groundwater conditions as detailed in (**Section 3)**.

GSP regulations require that sustainable management criteria be developed for each sustainability indicator (note that the seawater intrusion indicator is characterized in the ECC Subbasin as significant and unreasonable intrusion of Delta and Bay waters):

- Chronic lowering of groundwater Levels
- Reduction of storage (ECC Subbasin GSP uses proxy of groundwater levels)
- Seawater intrusion
- Degraded water quality
- Land subsidence
- Depletion of interconnected surface water (ECC Subbasin GSP uses proxy of groundwater levels)

The Department of Water Resources prepared a Best Management Practice document[3] to assist GSAs in developing SMC and that defines the terminology used in the section. **Figure 7-1** illustrates the relationship between sustainability indicators, minimum thresholds, and undesirable results. For reference during the review process only,

[1] California Water Code 10721 (v) and (r)
[2] 23 CCR Groundwater Sustainability Plans § 354.22 et seq.
[3] BMP 6 Sustainable Management Criteria Best Management Practice https://water.ca.gov/Programs/Groundwater-Management/SGMA-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents

Figure 7-1. Relationship between Sustainability Indicators, Minimum Thresholds, and Undesirable Results

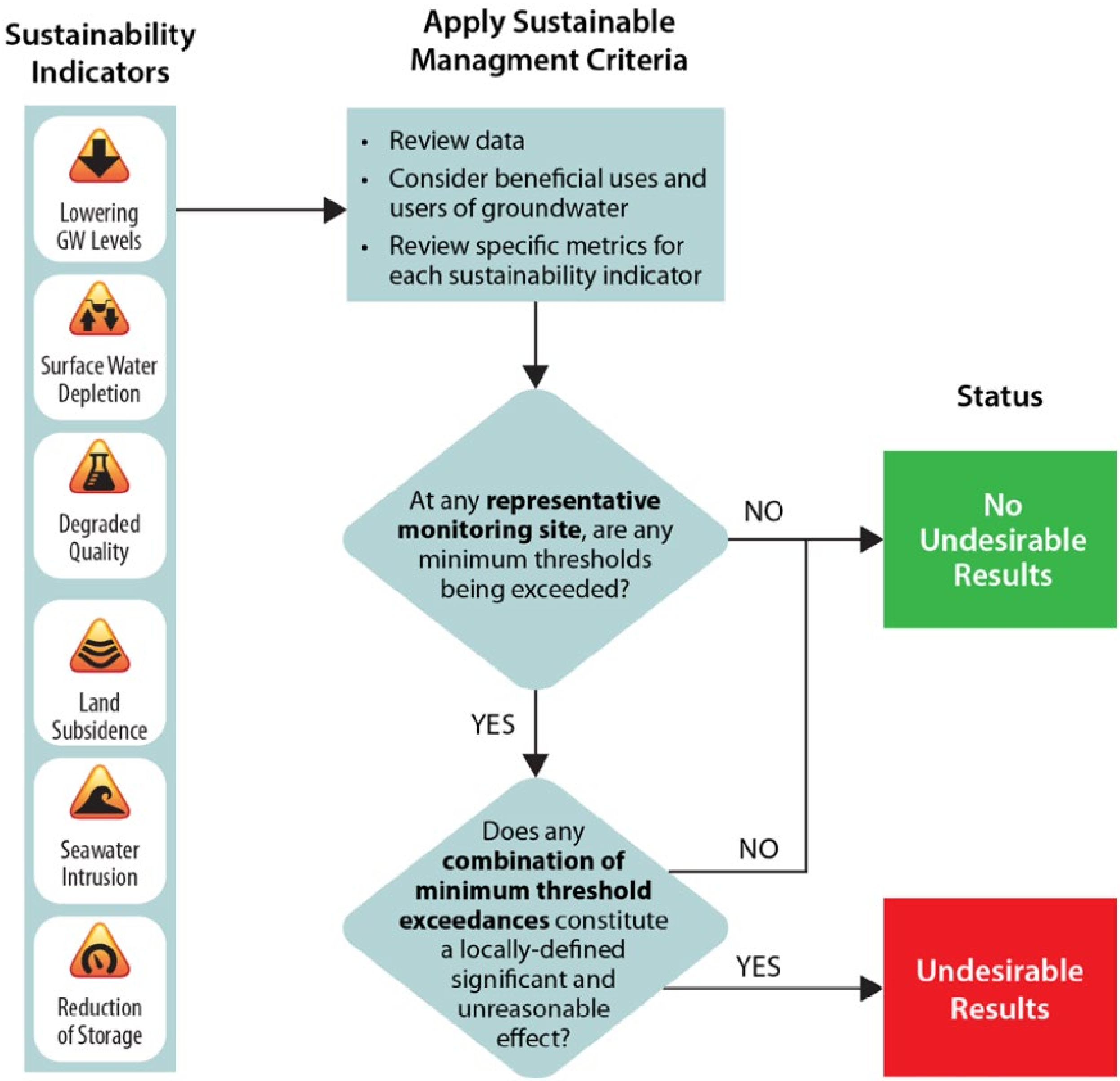
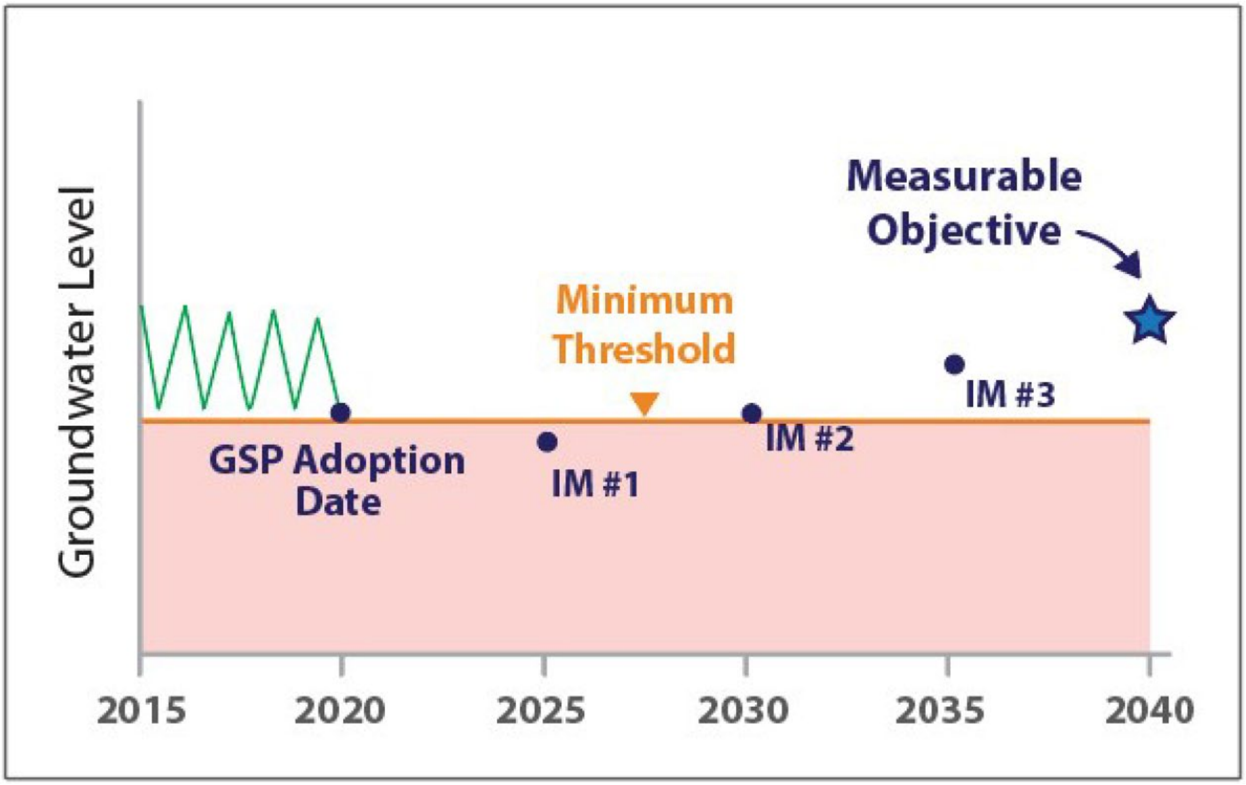


Figure 7-2. Sustainability Management Criteria Example-Groundwater Levels



The SMC developed for the ECC Subbasin were coordinated by the seven overlying GSAs, (City of Antioch and Brentwood, Byron Bethany Irrigation District, Contra Costa County, Diablo Water District, East Contra Costa Irrigation District, Town of Discovery Bay) and CCWD via an agreement to prepare a single GSP. SMC development was informed by hydrologic and hydrogeologic analyses leading to the ECC Hydrogeologic Conceptual Model presented in **Section 3**, **Basin Setting**. The process for establishing SMC included:

- GSA Working Group meetings.
- Public meetings on GSP development that introduced stakeholders to SMC.
- Additional public meetings on proposed methodologies to establish minimum thresholds and measurable objectives to receive additional public input.
- Public surveys to receive additional stakeholder input.
- Review of public input on preliminary SMC methodologies with GSA staff/technical experts.
- Preparation of a Draft GSP for public review and comment.
- Establishing and modifying minimum thresholds, measurable objectives, and definition of undesirable results based on feedback from public meetings, public/stakeholder review of the Draft GSP, and input from GSA staff/technical experts.

7.2. ECC Sustainability Goal

7.2.1. Goal Description

The ECC Subbasin is not experiencing undesirable results as defined under SGMA. The sustainability goal for the ECC Subbasin GSP is to manage the groundwater Subbasin to:

- Protect and maintain safe and reliable sources of groundwater for all beneficial uses and users.
- Ensure current and future groundwater demands account for changing groundwater conditions due to climate change.
- Establish and protect sustainable yield for the Subbasin by achieving measurable objectives set forth in this GSP in accordance with implementation and planning periods[4].
- Avoid undesirable results defined under SGMA.

The GSAs in the ECC Subbasin will manage the Subbasin under a single GSP. The GSAs and other water agencies have cooperatively engaged in water supply issues in the Subbasin including Integrated Regional Water Management plans, groundwater management plans, and California Statewide Groundwater Elevation Monitoring (CASGEM) monitoring. Through coordinating agreements, the GSAs will continue to manage the ECC Subbasin while retaining groundwater management authority within their respective jurisdictions.

The following principles are incorporated into the GSP to guide implementation of the sustainability goal:

- Continued public outreach to all interested parties and stakeholders with transparency in all planning, evaluations, and findings regarding groundwater management activities.
- Adaptively manage the ECC monitoring networks, by expansion and/or modification, based on periodic evaluations to ensure a comprehensive understanding of basin hydrogeology and mechanisms that affect groundwater sustainability.
- Prioritize environmental justice and groundwater dependent ecosystems as beneficial uses.
- Protect the groundwater supply of potentially underrepresented communities such as disadvantaged communities (DACs).
- View the use and protection of groundwater as an integral part of long-term water management strategies for the Subbasin.
- Protect and maintain sufficient groundwater storage to provide operational flexibility for all water year types and with consideration of climate change.
- Acknowledge that within the ECC Subbasin there are criteria and solutions that are regionally appropriate by each GSA jurisdiction.

[4] As defined under SGMA, the GSP implementation period is 20 years. The planning and implementation horizon is a 50-year time period over which the GSAs determine that plans and measures will be implemented to ensure that the basin or subbasin is operated within its sustainable yield.

- Continued cooperative water resources management by GSAs and other water agencies through updated MOUs or other agreements to ensure that all activities needed to maintain sustainability are identified, funded, and implemented.

7.2.2. Historical, Existing and Potential Future Conditions of Undesirable Results

Groundwater conditions in the ECC Subbasin exhibit stability and sustainability. Historic and current use of the groundwater basin show no signs of chronic lowering of groundwater levels, reduction of groundwater storage, land subsidence, sea water intrusion, degraded water quality or depletion of interconnected surface water. Nonetheless, future potential undesirable results for each sustainability indicator were identified as required under GSP regulations. This was accomplished through a Sustainable Management Criteria survey, public meetings, and input from the GSP Working Group.

Table 7-1 illustrates the historical, existing, and potential future conditions of undesirable results for the six sustainability indicators in the ECC Subbasin.

Table 7-1. Summary of Undesirable Results Applicable to the Plan Area

Sustainability Indicator	Historical Period	Existing Conditions	Future Conditions with GSP Implementation
Chronic Lowering of Groundwater Levels	No	No	No
Reduction of Groundwater Storage	No	No	No
Land Subsidence	No	No	No
Seawater Intrusion	No	No	No
Degraded Water Quality	No	No	No
Depletion of Interconnected Surface Water	No	No	No

7.2.3. Measures to be Implemented

Projects and management actions that have been completed or are planned to be implemented over the 20-year GSP implementation period (2022 through 2042) are discussed in (**Section 8)**. These measures are developed to ensure that the ECC Subbasin will continue to be managed sustainably during GSP implementation and throughout the 50-year planning and implementation horizon.

7.2.4. Explanation of How the Sustainability Goal will be Achieved

Undesirable results have not occurred historically and are not present in the ECC Subbasin. Furthermore, analyses of current monitoring data do not indicate undesirable results for the 20-year GSP implementation period. The GSAs will continue to work collaboratively and coordinate with other water supply entities, implement various projects and management actions to strengthen overall water supply reliability in the region that would have direct and indirect positive effects on groundwater sustainability.

The following projects and management actions, detailed in (**Section 8),** will be implemented to continue sustainability in the ECC Subbasin.

7.2.4.1. Projects

1. City of Antioch Brackish Water Desalination Project
2. Northeast Antioch Annexation Water and Sewer Facility Installation
3. City of Brentwood Non-Potable Storage Facility and Non-Potable Water Distribution
4. City of Brentwood Citywide Non-Potable Water Distribution System
5. Diablo Water District Treatment and Reuse of Alternative Water Supplies
6. ECCID-CCWD Dry-Year Water Sales

7.2.4.2. Management Actions

The proposed management actions in this GSP will be implemented by individual GSAs based on need and applicability. The management actions are consistent with authorities granted to GSAs through SGMA legislation and GSP regulations. Implementation of any action will be in coordination and consistent with the Contra Costa County well permitting process and regulations. Consistent with SGMA, these potential actions do not apply to de minimis extractors[5].

1. Well spacing control to mitigate potential impacts to existing wells
2. Oversight of well construction features such as completion intervals and seal depths to protect water quality and quantity using best management practices for the site conditions
3. Well metering, monitoring, and reporting to ensure accurate well and pumping data are provided to the GSAs
4. Pumping limits to protect existing supplies and avoid undesirable results
5. Pumping fees for implementing management actions

The projects and management actions will ensure that the ECC Subbasin is managed sustainably through the regulatory planning and implementation horizons.

7.3. ECC Sustainability Indicators

Each of the six sustainability indicators is defined by the following: undesirable results, minimum thresholds, and measurable objectives for the ECC Subbasin. The definitions of the sustainability indicators allow the GSAs, the State and the public to evaluate future conditions of the ECC Subbasin to ensure its managed sustainably and achieves the GSP sustainability goal.

The categories of groundwater use in the ECC Subbasin are:

---

[5] "De minimis extractor" means a person who extracts, for domestic purposes, two acre-feet or less per year. Section 10721, Water Code

- Agriculture
- Commercial
- Domestic Supply (Public Water Systems)
    - Small water system (2 to 199 connections)
    - Municipal supply (more than 200 connections)
- Industrial (may include process water)
- Environmental
    - Groundwater dependent ecosystems (see **Basin Setting**, **Section 3**, **Figures 3-26a and b**)
    - Other habitat protection including stream restoration projects

7.3.1. Chronic Lowering of Groundwater Levels

7.3.1.1. Undesirable Results

Chronic lowering of groundwater levels is absent from the ECC Subbasin. However, the potential of chronic lowering of groundwater levels in ECC Subbasin is an undesirable result as defined in California Water Code Section 10721(x)(1):

> *"Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods."*

7.3.1.2. Criteria to Define Undesirable Results

SGMA requires each GSP to consider the consequences of undesirable results even if they have not occurred historically or are projected to occur in the future. The ECC GSP defines significant and unreasonable chronic lowering of groundwater levels as:

- Unreasonable reduction or loss of water well capacity that cannot be mitigated, applies to:
    - Agricultural wells
    - Commercial
    - Domestic supply wells
        - Municipal supply wells
        - Small water system wells
        - Private domestic wells
    - Industrial wells
- Adverse economic impacts and burdens on local agricultural and commercial enterprises
- Adverse economic impacts to existing well owners resulting in the need to: lower a well pump ("chasing the water"), to replace a pump, and/or to deepen or replace a well

- Loss of water source due to drop in water levels (wells going "dry")
- Cause sustained water level impacts to neighboring wells (well pumping interference)
- Lack of prioritization of health and human safety over uses such as landscape irrigation
- Interference with other sustainability indicators

As indicated in the Water Code, water level declines in a drought, which may temporarily induce any of the above results, are not considered unsustainable if water levels recover in intervening non-drought periods.

Implementing the ECC GSP projects and/or management actions will prevent the chronic lowering of groundwater.

7.3.1.3. Potential Causes of Undesirable Results

There is no evidence that groundwater levels are chronically declining in the ECC Subbasin, and they are not expected to do so in the future. However, SGMA regulations require the GSP to identify future conditions (over 50 years) that may lead to chronically declining water levels, and they could include the following:

- Significantly worse hydrologic conditions than currently projected under climate change scenarios (see **Section 5**).
- Regulatory changes in streamflow requirements imposed by the SWRCB that reduce long standing surface-water rights and supplies.
- Expansion of pumping in place of existing surface water supply source. Expansion of pumping may induce localized drawdowns and groundwater level declines.
- Changes in the historical management of the Delta and salinity control point.

The above hypothetical causes are considered unlikely under projected land and water uses and the cooperative regional water supply coordination among GSAs and other agencies. In addition, factors such as climate change and sea level rise are included in the ECC Subbasin groundwater budget as described in (**Section 5)**.

7.3.1.4. Potential Effects of Undesirable Results

A potential effect for the chronic lowering of Shallow Zone groundwater levels is the potential impact to domestic well owners whose wells may go dry and decrease shallow water available to groundwater dependent ecosystems. These changes could impact property values, quality of life, and environment in the ECC Subbasin. Changes in groundwater levels in the Deep Zone where pumping for large systems serving municipalities occurs could impact groundwater supply reliability and increase costs for consumers throughout the Subbasin.

7.3.1.5. Minimum Thresholds

Section 354.28(c)(1) of the SGMA regulations states:

> *"The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results."*

Groundwater elevation data collected from existing and new groundwater monitoring wells, known as Representative Monitoring Site (RMSs), are used to measure the level of groundwater in the ECC Subbasin. Future groundwater level measurements will be evaluated against the defined minimum thresholds to ensure chronic lowering of groundwater levels does not occur. (**Figure 6-2 in Section 6)** shows the location of the RMSs in the ECC Subbasin and **Table 7-2**, below, lists the minimum thresholds at each RMS. **Appendix 7a** includes hydrographs of historical groundwater levels with minimum thresholds and measurable objectives for chronic lowering of groundwater levels.

The minimum thresholds for the chronic lowering of groundwater levels are informed by the Subbasin water budget quantified in (**Section 5)** using a groundwater flow model. Modeling scenarios were designed to quantify sustainable groundwater yield by successively reducing surface water deliveries and increasing pumping to the point that one or more sustainability indicators were adversely affected. These scenarios indicated that sustainable yield in the ECC Subbasin is likely constrained by changes in subsurface outflow to other subbasins and stream depletion. At the same time, groundwater levels and storage were not adversely affected. This is attributed to the direct connections to recharge sources tied to the Delta.

Based on the modeling results, minimum thresholds for chronic lowering of groundwater levels are quantified using the lowest historical water levels observed in a well plus 10 feet. If the MT in any well is exceeded over three consecutive years, indicating a trend, and do not recover in normal to wet years, undesirable results would be evaluated in terms of affects related to sustainable management activities. Since groundwater levels in the ECC Subbasin have been stable historically through the present and are projected to remain that way in the future, this is a conservative approach that will be adapted as additional groundwater level data and experience is accumulated. The modeling tool developed in (**Section 5)** provides additional support for the conservative nature of this approach.

Table 7-2. Minimum Threshold, Measurable Objectives, and Interim Milestones for Chronic Lowering of Groundwater Levels

Representative Monitoring Site (RMS)	Well Owner/ GSA	Well Depth (ft bgs)	Perforation Depths (ft bgs)	Minimum Threshold	Measurable Objective and Interim Milestones
				Groundwater Elevation (feet from mean sea level)	
Shallow Zone Wells					
Antioch MW-15‡	Antioch	15	5-15	-9	0.6
5 Binn	BBID	45	45 (TD)	-4	16
New Well	CCWD				
BG-2	COB	37.5	22.5-37.5	32	44
DWD MW-30‡	DWD	15	5-15	-9	1
Well #11 (4-61-A)	ECCID	100	50-100	12	40
TODB MW-30	TODB	30			
Deep Zone Wells					
Antioch MW-90‡	Antioch	90	75-85	-11	-1
Brentwood MW-14 Int.	COB	240	200-210, 220-230	-48	16
Bethel-Willow Rd	DWD	260	230-260	-15	-3
Stonecreek MW-300	DWD	300	230-240, 280-290	-37	-1.7
4AMW-357	TODB	357	307-347	-107	-21

Notes: Blue indicates New Monitoring Well, sustainability indicators will be set at the depth measured when the wells are installed.

‡ Well installed August 2021, MT and MO presented are interim until more data is available.

7.3.1.6. Information and Criteria Relied Upon to Establish the Minimum Threshold

Information used to establish the minimum threshold for the chronic lowering of groundwater levels includes:

1. Historical groundwater elevations from basin-wide monitoring wells in the ECC Subbasin.
2. Depths and locations of existing wells.
3. Current and historical groundwater elevation contour maps.
4. Modeling scenario for basin sustainable yield including climate change.
5. Other Information from GSAs and interested parties regarding significant and unreasonable conditions.

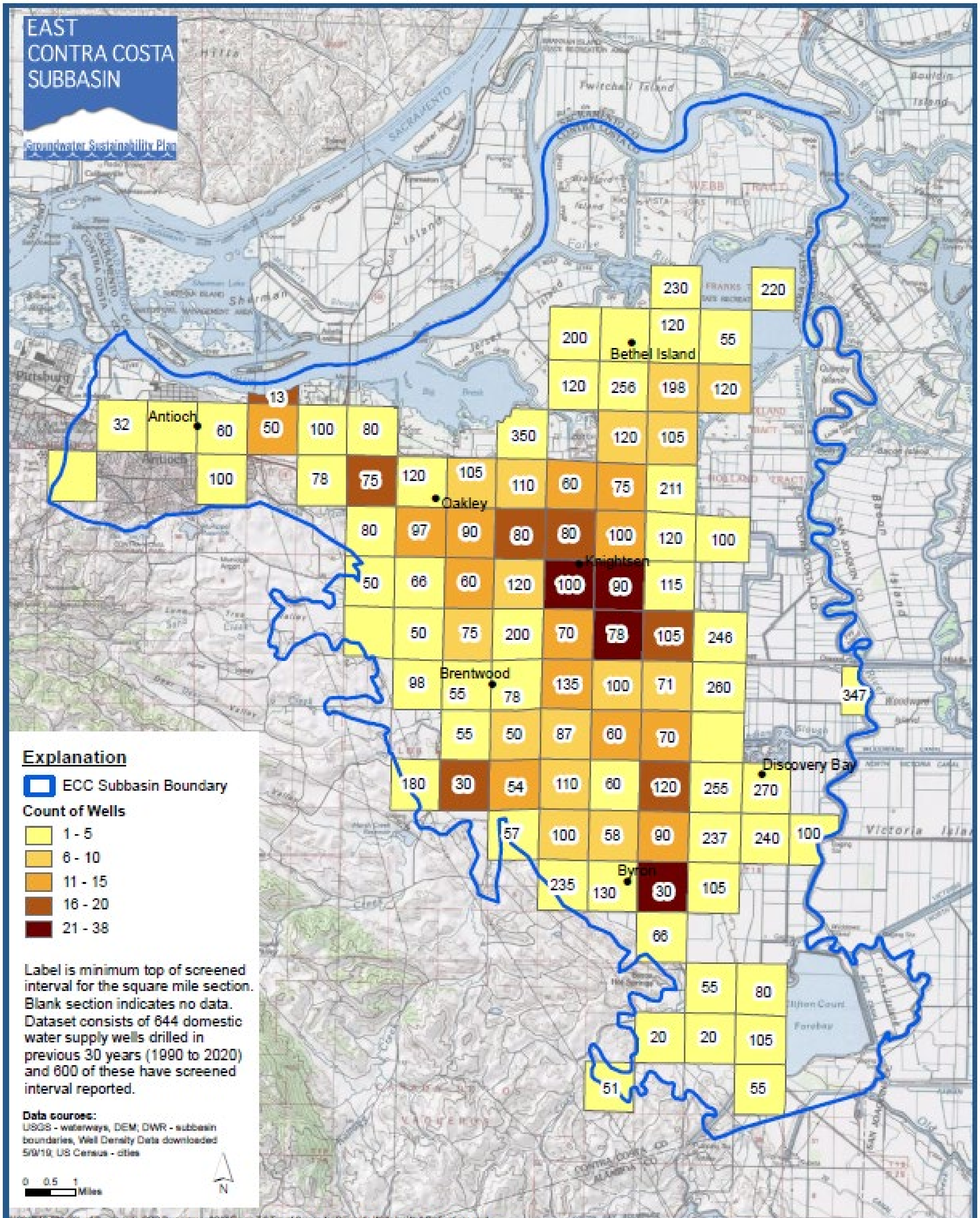
The minimum thresholds for chronic lowering of groundwater levels at each RMS is set at an elevation, when evaluated collectively, that could produce undesirable results in the ECC Subbasin. They are the following:

1. The minimum threshold for each RMS is set at a level for which the sustainable yield is exceeded based on groundwater flow model scenario (see **Section 5**).
2. Where chronic level declines do not exceed the sustainable yield, but otherwise cause undesirable results as described in this GSP.
3. For domestic wells, a minimum threshold which indicates that the 10th percentile of this category experiences a drop below the top perforations within the section where the RMS is located. This is considered protective of the water supply sustainability because it considers the most sensitive conditions of well operations.

Minimum thresholds were tentatively set for the four new monitoring well sites based on modeling results and professional judgement. Measurable objectives are also tentative and were set at the initial water levels measured in the wells. As additional data is available; these values may be revised.

The ECC Subbasin has not experienced chronic water level declines in the past. The initial MTs in this GSP may be considered as preliminary values which may change based on monitoring and annual reporting of groundwater conditions. Groundwater levels after the droughts of 2007-09 and 2013-16 recovered without even temporary undesirable results. This was due to multiple factors including water conservation and the diversification of supply sources (i.e., available surface water).

Information on domestic wells installed in the past 30 years and for which perforation intervals were listed was downloaded from DWR's Well Completion Report Map Application (DWR, 2019) dataset. **Figure 7-3** shows the number of wells (color coded) and the shallowest well perforations (numeric value in each square). There is a wide range of completion interval for this category of well with the shallowest perforations indicating that some wells pump, at least partially, from the Shallow Zone, while the deeper perforations target only the Deep Zone. Wells completed in the Shallow Zone are generally isolated from pumping in the Deep Zone, where most pumping occurs in the Subbasin, by confining zones that prevent propagation of impacts vertically. Wells that pump solely in the Shallow Zone will ultimately be protected through the MTs and MOs being developed through expansion of shallow monitoring throughout the Subbasin. The Deep Zone wells will be protected through the MTs and MOs assigned to the RMS in **Table 7-2**.



Luhdorff & Scalmanini Consulting Engineers

Top of Screen for Domestic Wells by Well Perforations

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 7-3

7.3.1.7. The Relationship of Minimum Thresholds for Other Sustainability Indicators

In accordance with the DWR Sustainable Management Criteria BMP (2017), the GSP must describe:

1. The relationship between each sustainability indicator's minimum threshold (how or why the MTs are the same or different).
2. The relationship between MTs for other sustainability indicators (e.g., how the water level minimum threshold would not trigger an undesirable result for land subsidence).

All sustainability indicators are intrinsically related and SGMA requires an assessment that a particular MT does not result in an undesirable result arising in another sustainability indicator. The minimum thresholds for chronic lowering of groundwater are established to avoid undesirable results for the remaining sustainability indicators, as described below.

- **Reduction in Groundwater Storage**. The groundwater level minimum thresholds are set with consideration that temporary exceedances during drought do not reflect an undesirable result if water levels recover in non-drought periods. The measurable objectives, which represent the anticipated long-term average groundwater levels, are not expected to result in significant or unreasonable change in groundwater storage based on historical conditions in the Subbasin.
- **Subsidence**. A significant and unreasonable condition for land subsidence is permanent (inelastic) subsidence that damages infrastructure as caused by compaction of clay-rich sediments in response to declining groundwater levels. No such subsidence has been recorded in the ECC Subbasin nor are geologic conditions susceptible to inelastic compaction present as represented in the hydrogeologic conceptual model of the Subbasin. Therefore, groundwater elevation minimum thresholds for subsidence in the ECC Subbasin are not initially being set. However, the GSP monitoring plan includes regular evaluation of groundwater levels, Plate Boundary Observation data, and potential infrastructure impacts within GSA jurisdictions will be conducted and reported.
- **Seawater Intrusion**. The groundwater level minimum threshold for shallow groundwater levels, will be protective of baywater intrusion in the Shallow Zone by avoiding downward vertical flow gradient that might otherwise induce saline water to migrate to water supply aquifers.
- **Degraded Water Quality**. A significant and unreasonable condition of degraded water quality is exceeding regulatory limits for constituents of concern in wells due to actions proposed in the GSP Water quality could be affected by chronic lowering of water levels through three processes.
    - Lowering groundwater levels could cause changes in groundwater flow gradients that result in commingling of poor-quality groundwater with supply sources.
    - Lowering groundwater levels could change groundwater gradients and cause poor quality groundwater from contaminant plumes to migrate to wells not previously impacted.
    - Potential projects consisting of surface water recharge through the vadose zone to the water table. Such projects have the potential to flush constituents of concern (e.g., TDS and nitrates) from the vadose zone to the water table. There may be a temporary increase in higher constituent concentrations prior to eventual dilution and reduction in these constituents.

At present, no such recharge projects are planned. However, the monitoring program developed for this GSP will be evaluated periodically to adapt to the GSP projects.

- **Depletion of interconnected surface waters**. It is recognized that shallow groundwater and surface water are interconnected in the delta region including portions of the ECC Subbasin. Changes in groundwater elevation could impact GDE areas as a result in decreased outflow of fresh groundwater due to chronic water level declines.

7.3.1.8. How the MT was Selected to Avoid Causing Undesirable Results in Adjacent Basins

The groundwater level minimum thresholds for the chronic lowering of groundwater levels established for the ECC Subbasin are expected to be protective of adjacent subbasins as there are no apparent direct connections between Deep Zone aquifers used for water supply in those basins. Further, the Delta provides a hydrologic buffer between the Solano, Eastern San Joaquin, and Tracy Subbasins such that Shallow Zone influences are not expected to propagate. The Pittsburg Plain Subbasin borders the City of Antioch between which there is either a groundwater divide or barrier to cross flow. New monitoring wells being installed in Antioch will provide more data on the relationship between the two subbasins. The modeling tool will be used to assess subsurface movement in and out of the subbasins to assess future changes and potential adverse conditions at the shared boundaries of those subbasins.

7.3.1.9. How the MT may Affect the Interests of Beneficial Uses and Users of Groundwater

Groundwater level minimum thresholds for the chronic lowering of groundwater levels may affect beneficial uses, users, and land uses in the Subbasin. RMS sites were selected to provide a basis for evaluating changes and impacts to the different uses and users of water wells throughout the Subbasin.

Rural residential land uses and users. The chronic lowering of groundwater level MT protects most domestic users of groundwater by considering the depths to which wells are completed and protection of reasonable operating margins for available pumping drawdown. A comparison of a hypothetical MT water surface was developed by interpolating MT values between RMS wells to potential domestic well locations based on DWR WCR data where construction in known. The precise locations and construction of wells that are currently active in the Subbasin is not known and some older WCRs may be associated with wells that are no longer active. If this hypothetical condition occurred with all wells experiencing the MT, less than 5% of the domestic wells in the Subbasin have the potential to go dry; i.e., the well would experience less than 10 feet of saturated screen. This comparison is highly conservative given the inclusion of wells that are 50 years old and that newer wells are likely not completed solely in the Shallow Zone. The proposed well inventory program discussed in Section 6 will aid the GSAs in refining the MT to maximize protection for this kind of user.

Agricultural land uses and users. Similar to rural residential uses and users, chronic lowering of groundwater level MTs are intended to protect agricultural users and their ability to meet existing and projected demands through typical well and pumping configurations (e.g., depths, perforation intervals, pumping lifts).

Urban land uses and users. The chronic lowering of groundwater level MTs are set so that existing and projected water demands can be met through typical well and pumping configurations (e.g., depths, perforation intervals, pumping lifts).

Environmental uses and users. Environmental uses include groundwater dependent ecosystems for which data gaps have been identified and new monitoring installations planned. Initially, a baseline shall be established to provide a basis for identifying effects of chronic lowering of groundwater and setting protective MTs.

7.3.1.10. How the MT Relates to the Federal, State, or Local Standards

There are no applicable federal, state, or local standards for MTs related to chronic lowering of groundwater levels in the plan setting.

7.3.1.11. How each MT will be Quantitatively Measured

The groundwater level minimum thresholds for the chronic lowering of groundwater levels will be directly and quantitatively measured at each RMS. Groundwater level monitoring will be conducted in accordance with the monitoring plan and protocols outlined in (**Section 6)** and will meet the requirements of the technical and reporting standards included in the SGMA regulations. The current representative monitoring network includes seven Shallow Zone wells and five Deep Zone wells.

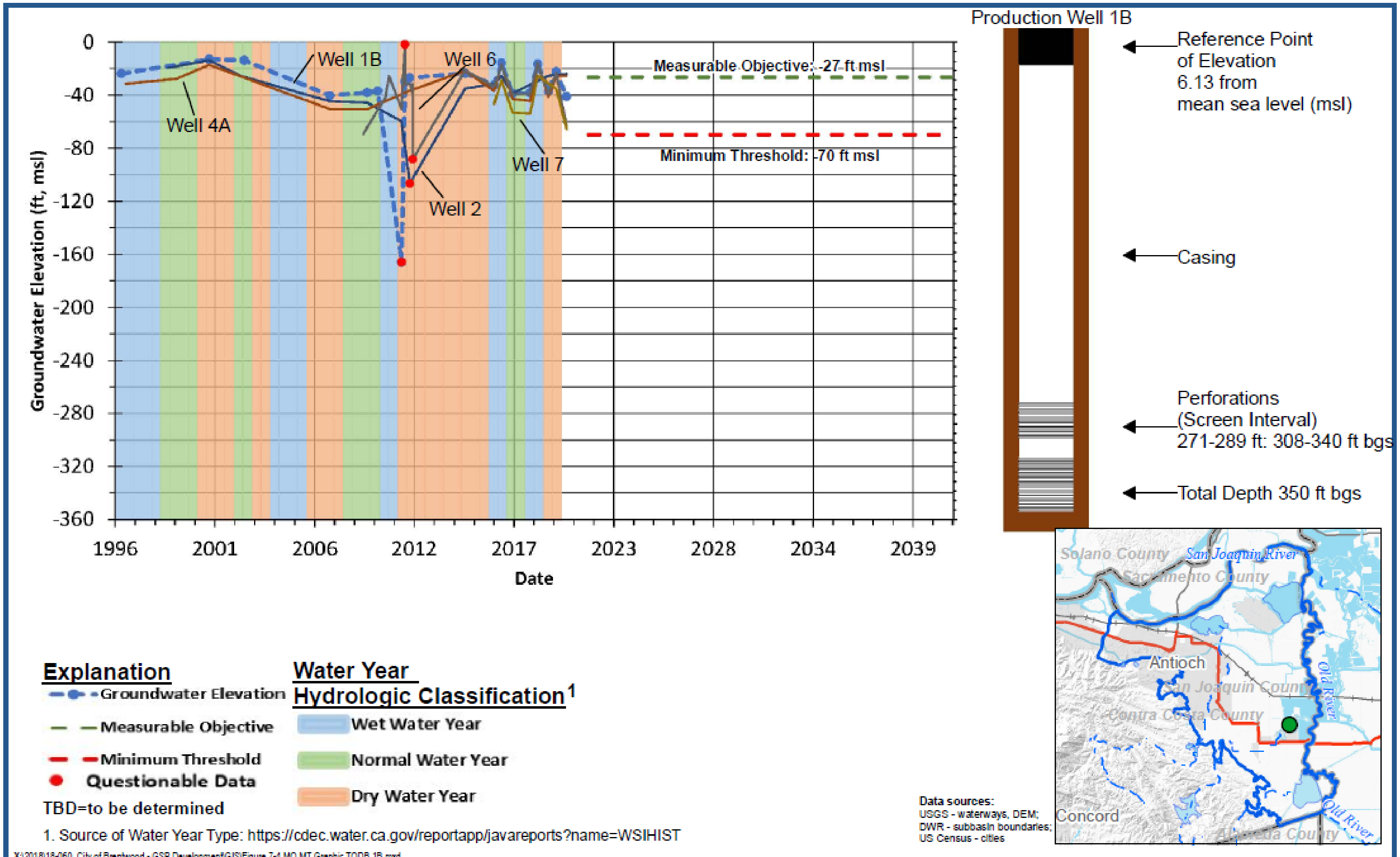
7.3.1.12. Measurable Objectives and Interim Milestones

Measurable objectives (MO) for the chronic lowering of groundwater levels are quantitative goals that reflect the Subbasin's desired groundwater conditions and goal to achieve sustainability within 20 years. It is set above the minimum threshold to allow a zone of operational flexibility that allows for drought, climate change, conjunctive use operations, and other groundwater management actions.

The measurable objective for chronic lowering of groundwater levels is the average spring elevation of groundwater at the RMS and its vicinity. Years in which drought caused temporary decline in water levels were excluded as outliers due to other causes (e.g., questionable field measurement). An example of setting MOs is illustrated for the RMS at the Town of Discovery Bay (**Figure 7-4**) in which measurements in Deep Zone production wells are shown with data from the RMS, which has a shorter period of record. In this situation, the MO at the RMS is informed by historical data from nearby wells of which the RMS is intended to be representative. The MOs for the Shallow and Deep Zone existing wells determined in this manner are listed in **(Table 7-2)** and are denoted on hydrographs in **Appendix 7a**.

Measurable objectives are preliminary for new Shallow and Deep Zone RMSs installed in summer 2021. MOs for these new Shallow and Deep Zone wells will be set at the water level measured at the time the well was drilled. However, as additional data is accumulated, the MOs may be adjusted.

Interim milestones are defined in five-year increments at each RMS to track progress toward meeting the sustainability goal. With the ECC Subbasin currently meeting the sustainability goal, the measurable milestones coincide with the measurable objective for this indicator (**Table 7-2**). Every five years the interim milestones will be reevaluated in the GSP review to confirm that management of the Subbasin satisfies the GSP sustainability goal.



Luhdorff & Scalmanini Consulting Engineers

Measurable Objectives and Minimum Thresholds-TODB Production Wells

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 7-4

7.3.2. Reduction in Groundwater Storage

7.3.2.1. Undesirable Results

As described in this GSP, the current and historical groundwater use in the ECC is free from undesirable results for groundwater storage. Additionally, modeling indicates that undesirable results are not anticipated to occur during the planning and implementation horizon. Stable groundwater levels from 1993 to 2019 indicate that historical pumping in the Subbasin has not depleted useable storage[6].

The sustainable yield of the Subbasin is the total volume of groundwater that can be withdrawn on an average annual basis without leading to a long-term reduction in useable groundwater storage or interfering with other sustainability indicators. **Section 5**, **Water Budget** quantifies sustainable yield of the Subbasin at 72,000 AF/year using the groundwater flow model developed for sustainable management. The modeling tool will be used, refined, and updated as needed, to quantify sustainable yield to avoid significant and unreasonable reductions in groundwater storage.

An undesirable result occurs when available groundwater storage is depleted to the degree that current uses and users are unable to meet groundwater demand.

7.3.2.2. Criteria to Define Undesirable Results

SGMA requires each GSP to consider the consequences of undesirable results even if they have not occurred historically or are projected to occur in the future. The undesirable result for the reduction in groundwater storage are the same as previously described for chronic lowering of groundwater levels, which act as a proxy for the groundwater storage sustainability indicator. In addition, significant and unreasonable changes in groundwater storage from implementing sustainable management policies, projects, or actions would occur if they caused any of the following:

- Reduction in groundwater storage that restricts the quantity of supply to satisfy existing beneficial use or harms an existing category of groundwater user.
- Any long-term reduction in available drawdown for pump operating margins that adversely affects available capacity or supply.
- Degraded water quality as a result of changed groundwater flow conditions.
- Interference with other sustainability indicators.

[6] Useable storage is that volume of groundwater that may be extracted within the constraints of a balanced water budget.

7.3.2.3. Potential Causes of Undesirable Results

The ECC Subbasin has experienced no long-term reduction in groundwater storage due to pumpage or other imbalance in the water budget. Although unlikely, hypothetical conditions that may lead to a reduction in groundwater storage include the following:

- Prolonged drought. An extensive drought greater than planned for may cause increased pumping of groundwater and a reduction of groundwater storage to a significant and unreasonable level.
- Regulatory changes in streamflow requirements imposed by the SWRCB that reduce long standing surface-water rights and supplies.
- Expansion of pumping and reduced surface water use.

The above hypothetical causes are considered unlikely under projected land and water use estimates even when the effects of climate change and sea level rise are considered (see **Section 5**).

7.3.2.4. Potential Effects of Undesirable Results

The reduction of groundwater storage in the Shallow Zone (e.g., lowering of shallow zone groundwater levels) could potentially impact domestic well owners whose wells may go dry, decrease shallow water available to GDEs, and induce baywater intrusion causing degraded groundwater quality. These changes could impact property values, quality of life, and environment in the ECC Subbasin. Changes in groundwater storage in the Deep Zone, which provides the main source of water supply in the Subbasin, could impact groundwater supply reliability, and increase costs for users and consumers.

7.3.2.5. Minimum Thresholds

SGMA Regulations (§354.36(b)(1)) allow GSAs to use groundwater elevation as a proxy for any sustainability indicator provided there is sufficient correlation between groundwater levels and the other metric (Sustainable Management Criteria BMP, 2017). This GSP uses chronic lowering of groundwater levels as a proxy for reduction in groundwater storage. As cited previously, useable storage, or sustainable yield, is estimated at 72,000 AFY. The ECC GSP groundwater flow model was used to determine the maximum sustainable yield and set groundwater elevation minimum thresholds (MT). As a proxy, the MTs for groundwater levels are protective of groundwater storage and beneficial uses and users in the Subbasin.

7.3.2.6. Measurable Objectives and Interim Milestones

The measurable objectives and interim milestones for the reduction in groundwater storage sustainability indicator are the same as for the chronic lowering of groundwater levels.

7.3.3. Seawater Intrusion

There is no evidence of seawater intrusion in the ECC Subbasin at present or in the past. However, potential mechanisms for saline baywater intrusion may be triggered as a result of sea-level rise, unsustainable levels of pumping, or changes in Bay-Delta water quality and flow requirements by the state Water Board. In recognition of these potential mechanisms, the seawater intrusion sustainability indicator is incorporated into the ECC Subbasin GSP.

7.3.3.1. Undesirable Results

Significant and unreasonable changes related to seawater intrusion as a result of implementing sustainable management policies, projects or actions could occur if they induce any of the following:

- Changes in baseline water quality that cause significant and unreasonable impacts on groundwater supply for beneficial users in the Subbasin.
- Changes in baseline water quality at any location which indicate new pathways or mechanisms of degradation of any freshwater source that adversely impacts existing beneficial uses and users.
- Changes in baseline water quality that adversely interfere with other sustainability indicators.

A data gap for monitoring the interface between baywater and shallow groundwater was identified in **Section 6** and will be filled by the installation of monitoring wells at multiple sites in the second half of 2021.

7.3.3.2. Criteria to Define Undesirable Results

SGMA requires each GSP to consider the consequences of undesirable results even if they have not occurred historically or are projected to occur in the future. Undesirable results for seawater intrusion would occur if inland migration of saline baywater adversely reduces groundwater availability through degraded water quality. The potential degradation of water quality will be monitored by groundwater chloride concentrations as previously discussed in **Section 3.3.4**. The criterion for potential undesirable results for this indicator is as follows:

> *An undesirable result may be present if a bayside monitoring well has a chloride concentration above 250 mg/L over three consecutive years and is causally related to groundwater sustainable management in the Subbasin.*

An increasing trend in chloride concentration may indicate that saline baywater is advancing inland and represents an undesirable result for the seawater intrusion Indicator. None of the wells listed in **Table 7-4** have chloride concentrations that exceed 250 mg/L.

A chloride isocontour shall be developed as more data is collected.

7.3.3.3. Potential Causes of Undesirable Results

Conditions that may lead to an undesirable result for seawater intrusion include the following:

- Sea level rise and saline baywater migrating into the Shallow Zone and vertically to the Deep Zone where the majority of pumping occurs.
- In combination with the above, changes in water quality and flow requirements by the state Water Board under the Bay-Delta Plan[7].

Periodic evaluations using the ECC Subbasin groundwater flow model will also be used to assess the potential causes and onset of undesirable results for this indicator (see model description in **Section 5**).

[7] https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/ Accessed June 29, 2021

7.3.3.4. Potential Effects of Undesirable Results

Baywater intrusion into the ECC Subbasin could cause the groundwater supply to become more saline and impact the use of groundwater for domestic, municipal, and agricultural purposes. Historically, there have been no limitations on the primary groundwater supply source (the Deep Aquifer Zone) due to elevated chloride concentration. The state's upper maximum contaminant level chloride concentration is 500 mg/L[8]. The potential effects of undesirable results for seawater intrusion are:

- Reduced available supply requiring users to replace wells or seek alternative sources of supply.
- Cause economic hardships on domestic wells users, many of which reside in DACs, to install water treatment or seek alternative sources.
- Added costs to systems serving municipalities to install treatment systems or seek alternate sources.
- Reduced groundwater quantity and quality for agricultural supply.
- Adverse effects to groundwater dependent ecosystems due to changes in freshwater quantity (e.g., outflow) and/or quality.
- Adverse effects on property values for landowners that rely on groundwater for domestic and agricultural supply.

7.3.3.5. Minimum Thresholds

Section §354.28(c)(3) of the Code of Regulations states:

> *"The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results."*

GSP regulations require that the minimum threshold for seawater intrusion be determined from a chloride isocontour line. In order to construct the isocontour, chloride concentrations at multiple monitoring locations are required. At present, Shallow Zone well chloride concentration data along the San Joaquin River is sparse and a chloride isocontour cannot be constructed. With the installation and sampling of new monitoring wells in 2021, a chloride isocontour will be developed as a basis for long-term monitoring for the seawater intrusion indicator. Consistent with other indicators in the ECC Subbasin, the initial isocontour is expected to be used as a minimum threshold until a more definitive value is determined. The expanded dataset from filling the Shallow Zone data gaps will be presented in the initial annual report in April 2022.

Based on the Subbasin HCM (see **Section 3**), the Shallow Zone would be impacted first if baywater salinity increases. Nevertheless, the Deep Zone RMSs will also be monitored for chloride and the interim seawater intrusion minimum threshold chloride concentration for any Shallow Zone or Deep Zone well is set at 250 mg/L which is the recommended level Secondary Maximum Contaminant Level (SMCL). This is based on the observation that the majority of wells in the Subbasin have chloride concentrations near this level and any significant increase may be indicative of a degradation mechanism such as seawater intrusion. As

[8] California secondary maximum contaminant level-upper limit for aesthetics (taste and color).

data from the new monitoring wells are collected, this interim approach will be modified and ultimately be replaced through isocontour maps for both aquifer zones.

7.3.3.6. Information and Criteria Relied Upon to Establish the Minimum Threshold

GSP Regulations (CCR 2016) require the following information when setting the seawater intrusion minimum threshold at a chloride isocontour:

- Section §354.28(c)(3)(A): Maps and cross-sections of the chloride concentration isocontour that define the minimum threshold and measurable objective for each principal aquifer.
- Section §354.28(c)(3)(B): A description of how seawater intrusion minimum threshold considers the effects of current and projected sea levels.

Due to the data gap in Shallow Zone wells and chloride concentration data, a chloride concentration map for Shallow Zone and Deep Zone wells developed in **Section 3, Figure 3-16d** in lieu of a chloride concentration isocontour. A chloride isocontour will be developed through the addition of the new monitoring wells to fill data gaps as discussed in **Section 6** and will be included with the submittal of the first annual report in April 2022. The groundwater flow model will be used to evaluate the potential impact of sea level rise on this indicator by assessing flow gradients along the margins of the Subbasin and the Bay-Delta water bodies. In addition, a groundwater transport model project is proposed in **Section 8** to further evaluate water quality degradation mechanisms in the ECC Subbasin.

7.3.3.7. The Relationship of Minimum Thresholds for Other Sustainability Indicators

The minimum thresholds for seawater intrusion are established to avoid undesirable results for the remaining sustainability indicators, as described below.

- **Chronic lowering of groundwater levels, Reduction in Groundwater Storage, Subsidence, Depletion of interconnected surface waters.** The minimum threshold for seawater intrusion is not associated with mechanisms or processes that would impact the minimum thresholds for these sustainability indicators.
- **Degraded Water Quality**. The minimum threshold for seawater intrusion is the same as for degraded water quality (250 mg/L chloride concentration) and will not cause an exceedance of groundwater quality minimum thresholds.

7.3.3.8. How the MT was Selected to Avoid Causing Undesirable Results in Adjacent Basins

Adoption of the seawater intrusion minimum threshold is expected to be protective of adjacent subbasins by monitoring mechanisms that may also arise in those regions. The hydrogeologic setting for the Shallow Zone in the ECC Subbasin is sufficiently separate from aquifers in the Solano, Eastern San Joaquin, and Tracy Subbasins such that if intrusion arises due to ECC sustainable management activities, it would not be expected to propagate to those areas.

The Pittsburg Plain Subbasin borders the City of Antioch and is separated by either a groundwater divide or barrier to cross flow. New monitoring wells being installed in Antioch will provide more data on the relationship between the two subbasins.

The groundwater flow model will be used to assess subsurface movement in and out of the ECC Subbasin and to assess future changes and potential adverse conditions at the shared boundaries with those subbasins.

7.3.3.9. How the MT may Affect the Interests of Beneficial Uses and Users of Groundwater

The minimum threshold for seawater intrusion is not expected to affect beneficial uses, users, or land uses in the Subbasin as it preserves existing water quality and seeks to protect future degradation.

7.3.3.10. How the MT Relates to the Federal, State, or Local Standards

There are no federal, state, or local standards for seawater intrusion that are applicable to the ECC Subbasin. However, the GSP accounts for the fact that there are state and federal standards for chloride concentration which is monitored as an indicator for seawater intrusion mechanisms.

7.3.3.11. How Each MT Will be Quantitatively Measured

Chloride concentrations are quantitatively measured in groundwater samples collected from the ECC GSP seawater intrusion monitoring network. **Figure 3-16d** presents the average chloride concentration for post-2008 measurements in Shallow and Deep Zone wells. It shows that most concentrations are below 250 mg/L. The symbols are color coded by aquifer to denote the aquifer zone. Noting that seawater has a total dissolved mineral content of 35,000 mg/L and a chloride concentration on the order of 19,000 mg/L, the groundwater monitoring data for the ECC Subbasin indicate that there is no inland saline intrusion of sea water into groundwater at any location).

The minimum threshold for the Subbasin is set at a chloride concentration of 250 mg/L because average native chloride concentrations in groundwater are typically less than this value (see **Figure 3-16a**). Any trend of increasing chloride concentration in the RMSs, or migration of a chloride isocontour inland (when the Shallow Zone data gap is filled), will be interpreted as a possible indication that saline baywater is moving inland. An assessment would then be made to determine 1) if bay water salinity has the potential at any location to elevate groundwater chloride concentrations, 2) whether a gradient for inland migration exists, and 3) whether any local groundwater management activity induced conditions to change. While any future intrusion process is expected to be slow (e.g., on the order of years), chloride concentration monitoring using 250 mg/L as a trigger for examining possible links to sustainable management in the Subbasin would be protective of groundwater resources.

7.3.3.12. Measurable Objectives and Interim Milestones

Measurable objectives for seawater intrusion are the desired conditions for the ECC Subbasin and are based on maintaining the current native chloride concentration in the Subbasin. The measurable objectives for each RMS are the average chloride concentrations from 2013 to 2017. **Table 7-4** presents the measurable objectives for each RMS. If an RMS does not have groundwater quality data during this period, the cells are left blank and will be populated when data is collected.

If chloride concentrations trend upward above the measurable objective, but below the minimum threshold, verification measures regarding links to groundwater management as described in the preceding section will be triggered.

Since the chloride concentration in the Subbasin is currently stable and above minimum thresholds for all RMSs, the interim milestones are set at the same values as the measurable objectives shown in **Table 7-4**. No changes in quality are expected as a result of implementing projects and management actions described in **Section 8**.

7.3.4. Degraded Water Quality

7.3.4.1. Undesirable Results

Significant and unreasonable changes in groundwater quality as a result of implementing sustainable management policies, projects, or other actions could occur if they cause any of the following:

- Increases in concentrations of key groundwater quality constituents above drinking water maximum contaminant limits (MCLs) that reduce groundwater availability for domestic, agricultural, municipal, or environmental beneficial uses.
- Changes in water quality that cause economic burdens placed on users to treat or replace sources of groundwater supply including but not limited to increased treatment costs to mitigate elevated mineral content such as hardness.
- Adverse impacts to agricultural crop production, yield, and/or quality.
- Migration of contaminants to domestic or agricultural sources of supply, including but not limited to unregulated discharges of hazardous substances, and from oil and gas wells.
- Movement or increases in currently unregulated chemical constituents that adversely impact beneficial uses and users (e.g., DACs and environmental users) of groundwater.

Overall, groundwater quality is satisfactory for the various beneficial uses in the ECC Subbasin. Some parts of the Subbasin experience naturally elevated TDS and chloride that are near or exceed the recommended SMCL indicating a higher baseline for these constituents. Elevated nitrate concentrations occur in shallow wells near Brentwood with concentrations exceeding the MCL attributable to past agricultural practices. Arsenic is generally less than the MCL and boron concentrations are naturally elevated in most wells. Water hardness varies and in some cases adds financial burdens on users needing to use water softeners. For municipalities, TDS and hardness may lead to customer dissatisfaction and limit the ability to blend groundwater with treated surface water under conjunctive use[9]. In order to meeting customer water hardness expectations municipalities may be required to install expensive water treatment systems.

7.3.4.2. Criteria to Define Undesirable Results

SGMA requires each GSP to consider the consequences of undesirable results even if they have not occurred historically or are projected to occur in the future. Any RMS that exceeds any state drinking water standard during GSP implementation because of groundwater management activities, would constitute an undesirable result for the degradation of groundwater quality.

[9] Conjunctive use is the coordinated and planned management of both surface and groundwater resources in order to maximize the efficient use of both resources.
https://water.ca.gov/Water-Basics/Glossary Accessed August 2021.

7.3.4.3. Potential Causes of Undesirable Results

Overall, groundwater quality is satisfactory for the various beneficial uses in the ECC Subbasin. However, potential causes of degraded groundwater quality may include the following:

- **Changes in groundwater gradients**- Changes to the location or rates of pumping could result in mobilization and vertical migration of certain constituents from the Shallow Zone to the Deep Zone including saline water and anthropogenic sources of contamination or natural constituents of concern.
- **Changes in groundwater pumping patterns-** Changes in location and rates of pumping may alter and increase contributions from zones containing higher dissolved minerals including hardness.
- **Groundwater recharge projects**–Use of recharge basins could cause localized groundwater mounding resulting in altered flow directions and potential movement of water quality constituents towards wells in concentrations that exceed water quality standards. Also, recharge of poor-quality water that exceeds the MCL or SMCL.

7.3.4.4. Potential Effects of Undesirable Results

The potential effects of undesirable results for degradation of water quality are the same as described above for seawater intrusion.

7.3.4.5. Minimum Thresholds

SGMA regulations guide the setting of the minimum threshold for degraded water quality as follows:

- The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined to be of concern for the basin.

The minimum thresholds for degraded groundwater quality in the ECC Subbasin were selected to avoid undesirable results induced as a result of implementing sustainable management policies, projects or actions. The minimum threshold at a given RMS in the ECC Subbasin is:

- The three-year running average exceedance of an MCL for a key monitoring constituent.

7.3.4.6. Information Used and Methodology

The information used to establish the degraded groundwater quality minimum threshold includes:

- Historical groundwater quality from basin-wide monitoring wells in the ECC Subbasin.
- Depths and locations of existing wells.
- Federal and state drinking water quality standards.
- Information from interested parties of significant and unreasonable conditions.

Federal and state drinking water quality standards will be used to define degraded groundwater quality minimum thresholds.

7.3.4.7. Degraded Groundwater Quality Minimum Thresholds

Minimum thresholds were set to represent conditions considered just above conditions that could cause undesirable results in the ECC Subbasin as discussed in (**Section 3**). **Table 7-3** lists the constituents of concern, the reason for concern, and the drinking water standard/minimum threshold.

Table 7-3. Constituents of Concern for Groundwater Quality Minimum Threshold

Constituent of Concern	Reason for Concern	Minimum Threshold
Total dissolved solids	Naturally Elevated; may be associated with higher hardness	1,000 mg/L[1]
Chloride	Baywater Intrusion/Naturally Elevated	500 mg/L[1]
Nitrate as nitrogen	Agriculture and Septic Systems	10 mg/L[2]
Arsenic	Naturally Elevated	10 ug/L[2]
Boron	Naturally Elevated	5,000 ug/L[3]
Mercury	Mercury Mine Upstream	2 ug/L[2]

1. California Secondary Maximum Contaminant Level (SMCL)
2. California Primary Maximum Contaminant Level (SMCL)
3. US EPA Health Advisory for non-cancer health effect.

The TDS minimum threshold of 1,000 mg/L is generally protective for domestic and agricultural uses. TDS is secondary standard established for aesthetic purposes such as taste, odor, and color and not based on public health concerns. Note: public water system threshold of 500 mg/L for TDS.

Groundwater contains numerous naturally occurring minerals that vary throughout the ECC Subbasin. While groundwater quality is generally favorable with respect to primary drinking water quality constituents, some areas have elevated total dissolved minerals, hardness, and some secondary constituents which may affect domestic and agricultural uses. The GSP is intended to avoid degradation of water quality as a result of implementing sustainable management policies, projects or actions. For example, projects that affect pumping patterns resulting in movement and mixing of groundwater sources that adversely affect certain users. The GSP does not mitigate groundwater quality in the Subbasin that is naturally occurring during the historical baseline."

7.3.4.8. The Relationship of Minimum Thresholds between Like and Different Sustainability Indicators

All sustainability indicators are intrinsically related and SGMA requires an assessment that a particular MT does not result in an undesirable result arising in another sustainability indicator. There is a minor influence on other sustainability indicators due to the potential degradation of groundwater quality. However, minimum thresholds were set to avoid undesirable results for other sustainability indicators as described below:

- **Chronic lowering of groundwater levels and groundwater storage**. Recharge projects implemented to mitigate lower water levels and storage must use sources that do not exceed any of the groundwater quality minimum thresholds.
- **Other sustainability indicators (seawater intrusion, subsidence, and depletion of interconnected surface water).** The groundwater quality minimum threshold is not associated with mechanisms or processes that would impact other minimum thresholds.

7.3.4.9. How the MT was Selected to Avoid Causing Undesirable Results in Adjacent Basins

The anticipated effect of the degraded groundwater quality minimum thresholds on each of the neighboring basins is the following:

Tracy Subbasin (medium priority), Eastern San Joaquin Subbasin (critically-over drafted), Solano Subbasin (medium priority). Minimum thresholds are set to protect groundwater quality. Any interaction, such as outflow to another basin, would not induce undesirable results in those areas. The interpreted groundwater flow direction in the ECC Subbasin is generally to the Delta and outflow to the ocean further reducing the likelihood of causing impacts to the surrounding basins.

Pittsburgh Plain Basin (low priority). There is no interpreted direct hydraulic connection with the Pittsburg Plain Basin. The City of Antioch borders the Pittsburg Plain Basin and does not pump groundwater, primarily due to poor native water quality. The ECC Subbasin degraded groundwater quality minimum threshold is protective of groundwater quality and would otherwise not induce undesirable results in that basin.

7.3.4.10. How the MT May Affect the Interests of Beneficial Uses and Users of Groundwater

Degraded groundwater quality minimum thresholds are not expected to have negative effects on beneficial uses, users, or land uses in the Subbasin as described:

- **Rural residential land uses and users**. The groundwater quality minimum thresholds protect domestic users of groundwater including individual well owners, small water systems, and DACs by applying drinking water standards.
- **Agricultural land uses and users**. The groundwater quality minimum thresholds protect agricultural users by applying drinking water standards which exceed generally acceptable irrigation quality.
- **Urban land uses and users**. The groundwater quality minimum thresholds protect municipal supplies by applying the same drinking water standards required under state permits.
- **Ecological land uses and users**. The groundwater quality minimum thresholds protect groundwater dependent ecosystems by employing standards that maintain current or existing conditions and preventing future degradation.

7.3.4.11. How the MT Relates to the Federal, State, or Local Standards

The MTs for water quality degradation are based on federal, state, and local regulations for groundwater source protection and drinking water quality standards.

7.3.4.12. How Each MT Will be Quantitatively Measured

The minimum threshold for degraded groundwater quality will be directly and quantitatively measured in accordance with the monitoring plan and protocols outlined in **Section 6** and will meet the requirements of the technical and reporting standards under SGMA regulations. The current representative monitoring network includes five Shallow Zone wells and six Deep Zone wells that are either designated monitoring wells or public supply wells.

7.3.4.13. Measurable Objectives and Interim Milestones

Measurable objectives for degraded groundwater quality are the desired conditions for the Subbasin and are based on maintaining the current water quality in the Subbasin. The measurable objectives for each RMS are the average concentrations (2013 to 2017) for each constituent of concern for each RMS (**Figure 6-5**). **Table 7-4** presents the measurable objectives for each RMS. If a RMS does not have groundwater quality data during this period, the cells are left blank, and it will be calculated after five years of data collection.

Since the groundwater quality in the Subbasin is currently sustainable and above minimum thresholds for all RMSs (**Figure 6-5**), the interim milestones are set at the same values as the measurable objectives shown in **Table 7-4**. No changes in quality are expected from projects and management actions implemented to achieve sustainability.

Table 7-4. Minimum Thresholds, Measurable Objectives, and Interim Milestones for Degradation of Groundwater Quality

Zone	Well Name	As (ug/L)	B (ug/L)	Cl (mg/L)	Hg (ug/L)	NO_3 as N (mg/L)	TDS (mg/L)
Minimum Threshold		**10**	**5,000**	**250**	**2**	**10**	**1,000**
Shallow Zone	BG-1	2.7	230	210	0.01	27	890
	Antioch MW-15						
	DWD MW-15						
	TODB MW 15						
	Unknown						
Deep Zone	Antioch MW-100						
	City of Brentwood Well 13	2.0	1,800	92	1.00	2.5	540
	City of Brentwood Well 14	3.2	1,150	180	1.00	4.1	970
	Glen Park Well	2.3	1,300[1]	100	1.00	1.2	690
	Bethel-Willow Rd						
	Town of Discovery Bay Well 4A	2.5	2,200	100	0.51	0.25	600

Notes: Blue shading indicates New Monitoring Well; Measurable objectives and interim milestones will be set at the concentrations from the initial results.

Interim Milestones are the same as Measurable Objectives (e.g., the average concentrations [2013 to 2017]).

[1]Average Concertation between 2006-2007

7.3.5. Land Subsidence

7.3.5.1. Undesirable Results

Land subsidence associated with groundwater pumping is a result of dewatering, or "mining" groundwater, from fine-grained geologic materials such as clay. The inelastic nature of this mechanism results in permanent deformation of the land surface and compaction of geologic formations. The potential undesirable results for this type of land subsidence are:

- Impacts to infrastructure such as damage to roads and structures, reduced capacity of water conveyances, and increased vulnerability to flooding.

There is no historic evidence of land subsidence related to groundwater pumping in the ECC Subbasin, in part or wholly due to the lack of formations which are susceptible to subsidence mechanisms[10]. This sustainability indicator will be assessed using existing independent monitoring at a UNAVCO Plate Boundary Observatory (PBO) station (see **Sections 3 and 6**). In addition, groundwater level and interferometric synthetic aperture radar (InSAR) measurements will be used to support analysis of the PBO data as discussed below.

7.3.5.2. Criteria to Define Undesirable Results

SGMA requires each GSP to consider the consequences of undesirable results even if they have not occurred historically or are projected to occur in the future. For this sustainability indicator, undesirable results occur when inelastic land subsidence due to groundwater extraction results in significant and unreasonable impacts to roads and structures, water conveyances, and flood control facilities.

7.3.5.3. Potential Causes of Undesirable Results

A potential cause of undesirable results for the land subsidence sustainability indicator is the following:

- **Increased pumping in susceptible areas** – Compressible clays of sufficient volume which are susceptible to dewatering and compaction due to groundwater pumping have not been identified under the present hydrogeologic conceptualization of the Subbasin. Expansion of pumping into new areas where geologic formations susceptible to compaction mechanisms are present, may result in subsidence that has not been observed historically in the Subbasin.

7.3.5.4. Potential Effects of Undesirable Results

The undesirable result for land subsidence includes impacts to infrastructure. The potential effects of undesirable results for this indicator would be the following:

- Damage to water conveyance facilities and flood control facilities.
- Reduced capacity of surface water delivery systems that in turn leads to increased groundwater demand.
- Adverse effects to property values.
- Economic burdens to mitigate damage.

7.3.5.5. Minimum Thresholds

Land subsidence induced by groundwater pumping has not been observed in the ECC Subbasin including through recent state-wide drought periods (2007-2009 and 2012-2016). Despite the lack of historical land subsidence, minimum thresholds and measurable objectives are established to guide sustainable management response should land subsidence occur.

[10] While land subsidence associated with groundwater pumping has not occurred historically, another type of subsidence due to exposure of peat soils in reclaimed lands in the Delta has occurred to a significant degree.

Section 354.28(c)(5) of the SGMA regulations state that "The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results."

A minimum threshold is based on data from the UNAVCO P256 Plate Boundary Observatory station described in (**Section 3)** and presented in (**Figure 3-22)**. Two other sources of information, groundwater elevations and InSAR measurements, will be used for verification of associations with groundwater pumping and management in the Subbasin.

A minimum threshold of 1 inch land surface elevation outside the historical elastic range over a three-year period as exhibited by monitoring data at the UNAVCO site P256. Deviations from this minimum threshold over three or more consecutive years may indicate the onset of an inelastic component of subsidence. The historic elastic range is approximately 0.8 inches observed between 2005 to 2016 (see **Figure 3-22**). Exceedance of this minimum threshold would not necessarily result in undesirable results; however, since land subsidence associated with groundwater pumping may occur over many years even after pumping stresses are reduced, it is desired to identify mechanisms and implement sustainability measures to ensure that significant and unreasonable impacts do not arise over time.

7.3.5.6. Information and Criteria Relied Upon to Establish the Minimum Threshold

Information used to establish minimum threshold for land subsidence includes:

1. Historical subsidence measurements from P256 UNAVCO station.
2. Current and historical groundwater elevation in wells.
3. Modeling scenario results of future groundwater level conditions
4. InSAR measurement surveys.

The minimum threshold for subsidence is set to detect the onset of conditions that could potentially lead to undesirable results in the ECC Subbasin as follows.

In addition to the PBO station monitoring data, groundwater elevation data and InSAR measurements[11] will be reviewed to determine whether any inelastic component of land subsidence, should it occur, is related to groundwater pumping. This includes review of minimum thresholds for chronic groundwater decline. If the MT for land subsidence is exceeded for three consecutive years and an associated with groundwater pumping is verified, new adaptive management measurements will be developed and detailed in the subsequent plan update report.

[11] InSAR surveys have only been recently conducted in the ECC Subbasin area. **Figure 3-22** shows survey results for the period June 2015 to June 2019

7.3.5.7. The Relationship of Minimum Thresholds between Like and Different Sustainability Indicators

All sustainability indicators are intrinsically related and SGMA requires an assessment that a particular MT does not result in an undesirable result arising in another sustainability indicator. In the ECC Subbasin, the conservative nature of the land subsidence minimum threshold would have little or no impact to the other minimum thresholds.

- **Chronic lowering of groundwater levels**. The land subsidence minimum threshold will not result in significant and unreasonable lowering of groundwater elevations. However, declining groundwater elevations may have causal association with land subsidence.
- **Reduction in Groundwater Storage**. The land subsidence minimum threshold will not result in significant and unreasonable change in useable groundwater storage.
- **Seawater Intrusion**. The land subsidence minimum threshold will not cause an increase in baywater intrusion in the Subbasin.
- **Degraded Water Quality**. The land subsidence minimum threshold will not result in significant and unreasonable changes in groundwater quality.
- **Depletion of interconnected surface waters**. The land subsidence minimum threshold will not result in significant and unreasonable changes in groundwater elevations and will not impact depletion of interconnected surface waters.

7.3.5.8. How the MT was Selected to Avoid Causing Undesirable Results in Adjacent Basins

There are four adjacent basins to the ECC Subbasin:

- Pittsburg Plain Basin
- Solano Subbasin
- Eastern San Joaquin Subbasin
- Tracy Subbasin

The land subsidence minimum threshold induced by groundwater pumping was set to prevent significant and unreasonable land subsidence that damages infrastructure in the ECC Subbasin. No impacts to the adjacent basins are expected because 1) subsidence due to groundwater withdrawal has not occurred historically in the ECC Subbasin and 2) groundwater demand is projected to be stable or decrease in the future. In addition, the MT for land subsidence is sufficiently conservative to avoid adverse impacts from propagating outside the Subbasin.

7.3.5.9. How the MT May Affect the Interests of Beneficial Uses and Users of Groundwater

The subsidence minimum thresholds are set to prevent inelastic subsidence that could impact infrastructure. Currently there is no inelastic subsidence occurring in the ECC Subbasin that impacts any beneficial user and the MT is sufficiently conservative to avoid impacts by subsidence and permit adaptive mitigation measures to be implemented if it occurs.

7.3.5.10. How the MT Relates to the Federal, State, or Local Standards

There are no federal, state, or local standards for land subsidence.

7.3.5.11. How Each MT Will be Quantitatively Measured

Minimum thresholds are based on UNAVCO data for site P256 and measurements of groundwater levels as described in **Section 6**.

7.3.5.12. Measurable Objectives and Interim Milestones

The measurable objectives and interim milestones are based on the elastic range of historically observed land deformation at the UNAVCO P256 station. The measurable objective and interim milestones for P256 is set at the average seasonal elastic movement (0.6 inch vertical) as shown in (**Figure 3-22**). Deviations from this measurable objective over three or more years may indicate the onset of an inelastic component of subsidence as discussed above.

7.3.6. Depletions of Interconnected Surface Waters

As described in **Section 3.3.8,** the majority of the ECC Subbasin may have interconnected surface water and groundwater through the Shallow Zone. In the Subbasin setting, the major surface water conveyances are the San Joaquin River and Old River. These conveyances are influenced by two major water supply projects, the California State Water Project and the federal Central Valley Project. Through the Bay-Delta Plan, the state Water Board sets regulations for water quality and flow to protect both environmental and water supply concerns in the region. Thus, shallow groundwater and surface water interconnections are not controlled locally or by the ECC Subbasin GSAs.

The hydraulic connections between groundwater and surface water have not been definitively characterized. New shallow monitoring wells are being installed as part of this GSP at locations on the San Joaquin River and Old River, and immediately upstream of the San Joaquin and Sacramento confluence in Antioch. This expanded Shallow Zone monitoring network, plus two existing shallow wells on western creeks, will be used to characterize the nature of surface water-groundwater connections and to assess the surface water depletion sustainability indicator in relation to local groundwater management as instituted in the ECC Subbasin GSP. Groundwater level monitoring adjacent to streams will be used with existing stream gages to show the spatial and temporal relationships between groundwater and surface water heads.

The groundwater flow model described in **Section 5** will be used as a comparative tool to provide initial estimates of the limits of groundwater pumping in the Subbasin which could cause undesirable results for stream depletion. This provides an interim basis for setting minimum thresholds and measurable objectives which can then be refined using data from the expanded Shallow Zone and surface water monitoring networks.

7.3.6.1. Undesirable Results

There is no evidence of past or present significant and unreasonable depletions of surface water as a result of groundwater use in the ECC Subbasin. Major rivers and streams that have a hydraulic connection to the groundwater system are the San Joaquin River and Old River. Managed conveyances (i.e., conveyances for irrigation water, drainage, and flood control) are generally not considered in the analysis of depletions. Creeks, including Marsh Creek, are considered important aspects of the environmental setting and the Shallow Zone monitoring network is designed to assess the presence of depletion mechanisms for these features (see **Section 6**).

7.3.6.2. Criteria to Define Undesirable Results

SGMA requires each GSP to consider the consequences of undesirable results even if they have not occurred historically or are projected to occur in the future. Significant and unreasonable depletions of interconnected surface waters in the Subbasin are defined as:

- Depletions that result in reductions in flow or stage of major rivers and streams that are hydrologically connected to groundwater in the Subbasin and which cause significant and unreasonable impacts on beneficial uses and users of surface water and the environment.

The relationship between shallow groundwater levels and potential impacts on species and habit will be evaluated as data are collected from the expanded Shallow Zone monitoring network discussed in **Section 6**.

7.3.6.3. Potential Causes of Undesirable Results

Potential causes of depletion of interconnected surface water include the following:

- New large-scale pumping or diversions from shallow wells.
- New localized pumping from Deep Zone wells in locations that are vertically connected to the Shallow Zone and surface water.
- Interception or reduction of natural patterns of groundwater discharge to surface water.

7.3.6.4. Potential Effects of Undesirable Results

Depletions of interconnected surface water could result in:

- Reduction in flows that negatively impact aquatic species and groundwater dependent ecosystems.
- Reduced flows within rivers and streams that adversely impact diversions for agricultural or urban users.
- Increased costs to mitigate impacts.

7.3.6.5. Minimum Thresholds

Section 354.28(c)(6) of the SGMA regulations states:

> *"The minimum threshold or depletions of interconnected surface water shall be the 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."*

The rate and volume of flow in and out of surface water have been initially quantified through water budget modeling scenarios in **Section 5**. For the Base Period 1997 to 2018, the average annual groundwater inflow attributed to all surface water features was 18,560 AFY and ranged from 10,135 to 31,887 AFY. High values occurred during dry years and the low values during wet years.

For sustainable yield scenarios, groundwater pumping at higher than historical levels were simulated to assess potential impacts to the interconnected surface water indicator. The historical average annual pumping in the ECC Subbasin during the Base Period was approximately 46,455 AFY. Annual pumping ranged between a high of approximately 58,250 and a low of 32,500 AF in dry and wet years, respectively. In the sustainable yield scenarios, surface water deliveries were reduced by 40, 45, 50, and 75 percent. This resulted in greater groundwater pumping to meet various demands. Relative to the Base Period average, these four scenarios resulted in 30, 42, 55, and 135 percent more groundwater pumping. With regard to sustainability indicators, the contribution to the water budget from surface water features (i.e., depletion) in the 75-percent surface water reduction scenario was nearly 10,000 AFY more than the Base Period average (approximately 26,850 versus 17,770 AFY). Net subsurface flow between adjoining groundwater basins also changed significantly for the highest surface water reduction scenario. Instead of average outflow of -8,500 AFY in the Base Period, this scenario resulted in about 8,300 AFY inflow.

From the modeling, it was seen that up to 50 percent reductions in surface water deliveries, there were no significant changes in water budget components that might induce undesirable results. At the more conservative 75-percent reduction scenario, undesirable results may be triggered for the interconnected surface water sustainability indicator. While no conclusion was drawn as to whether this scenario actually would lead to significant and unreasonable results, the results indicate that changes in basin management that result in sustained pumping in all water years at more than twice the historical average (i.e., 135 percent) would be required to induce a major changes in surface water depletion.

Based on the groundwater flow model results, a conservative interim minimum threshold for depletion of interconnected surface water is set at a value corresponding to 45 percent reduction in surface water deliveries. In this scenario, sustained basin-wide pumping would be 42 percent greater than the historic Base Period average, or 66,000 AFY. While this leads to a moderate increase in average contribution from surface water bodies in the subbasin water budget (about 18,100 AFY versus 17,800 AFY), it serves as conservative threshold at which closer examination of undesirable results could be undertaken if more groundwater use is projected in the future.

Greater precision and accuracy for the minimum threshold for this sustainability indicator may be achieved by using Shallow Zone groundwater levels as a proxy. This proxy would be complemented by the stream stage monitoring network described in **Section 6**. GSP regulations allow GSAs to use groundwater levels as a proxy metric for any sustainability indicator if the GSP demonstrates there is significant correlation between groundwater levels and the depletions of interconnected surface water. The relationship between the ECC Subbasin GSP groundwater flow model results and measured groundwater level data will serve as a basis for determining the effectiveness of a groundwater level proxy. Since no apparent surface water depletions are evident in the Subbasin, future projects and management actions shall be evaluated through comparative modeling scenarios and with monitoring data to assess potential mechanisms for the onset of undesirable rates of surface water depletion.

7.3.6.6. Information and Criteria Relied Upon to Establish the Minimum Threshold

Water budget modeling scenarios presented in **Section 5** are used to inform potential hydraulic mechanisms that could indicate significant and unreasonable results for this indicator. As data are developed, groundwater level minimum thresholds may be used as a proxy with data from the expanded Shallow Zone groundwater monitoring network and informed by the ECC groundwater flow model.

7.3.6.7. How the MT May Affect the Interests of Beneficial Uses and Users of Groundwater

The interconnected surface water minimum thresholds are set to avoid effects on beneficial users and land uses in the Subbasin:

- Domestic and agricultural well owners: Currently there are no reported shallow groundwater level declines in the Subbasin and none are expected by employing a minimum threshold for this indicator.
- Urban land uses and users: No changes are expected since no changes to shallow groundwater are expected.
- Environmental land uses and users. The minimum threshold is set to protect GDEs near streams where there is a connection to shallow groundwater.

7.3.6.8. The Relationship of Minimum Thresholds for Other Sustainability Indicators

The minimum thresholds for the depletions of interconnected surface waters are established to avoid undesirable results for other sustainability indicators, as described below.

- **Chronic Lowering of Groundwater Levels and Reduction in Groundwater Storage.** Modeling scenarios indicate that the minimum threshold for interconnected surface water depletions would not trigger chronic declines in water levels or storage.
- **Land Subsidence.** Since the minimum threshold for interconnected surface water depletions would not trigger chronic declines in water levels, land subsidence would not be induced.
- **Seawater Intrusion and Degraded Water Quality.** The minimum threshold for the depletions of interconnected surface waters may be linked to these indicators as they may be affected by induced movement of surface water into the groundwater system at higher pumping volumes. However, the MT is sufficiently conservative that if pumping increased to the threshold, significant impacts are not expected to occur. Rather, the MT is set as a trigger to further assess the presence of mechanisms that might lead to undesirable results.

7.3.6.9. How the MT was Selected to Avoid Causing Undesirable Results in Adjacent Basins

Adjacent basins are linked through their proximity and possible similar connections to the Bay-Delta ecosystem. The minimum threshold for the interconnected surface water sustainability indicator is conservatively based on comparative model scenarios that consider the entire Subbasin water budget including flows to and from other basins. The modeling results indicate that for a scenario of 135 percent increased pumping compared to the Base Period, significant changes in inter-basin flow to balance the ECC water budget could occur. It was concluded that setting an interim MT at 42 percent more pumping relative to the Base Period average, the potential impacts would be less than significant and allow the GSAs to conduct further modeling and monitoring to determine how and where impacts might occur if the pumping rates were projected to continue rising beyond that level. Using the ECC groundwater flow model to continually update the water budget will enable the ECC GSAs to identify needs for management changes to avoid adverse impacts to adjoining basins.

7.3.6.10. How the MT Relates to the Federal, State, or Local Standards

There are no federal, state, or local standards for depletion of interconnected surface water. However, depletion of interconnected surface water has the potential to conflict with the state Water Board Bay-Delta Plan and, as such, the GSAs will consider any future updates to the plan and how such updates may affect sustainable groundwater management in the ECC Subbasin, particularly with respect to the Shallow Zone.

7.3.6.11. How Each MT Will be Quantitatively Measured

Groundwater flow modeling suggests a link to increased pumping and stream depletion over baseline levels. The flow model relies on quantitative groundwater level data as measured in the basin-wide and representative monitoring networks. The use of the model to assess this sustainability indicator may be complemented or replaced by proxy groundwater level measurements.

7.3.6.12. Measurable Objectives

The measurable objectives and interim milestones for depletions of interconnected surface water sustainability indicator are set at the average annual groundwater pumping during the Base Period 1997 to 2018, or 46,455 AFY. In dry years, pumping increased to 58,250 AFY in the Base Period, still well below the 42-percent pumping increase used to define the MT.

7.4. References

California Department of Water Resources (DWR). November 2017. Draft Guidance Document for the Sustainable Management of Groundwater: Sustainable Management of Groundwater, Best Management Practice.

California Department of Water Resources (DWR). Well Completion Report Map Application. 2019. https://www.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37. Accessed May 2019.

SECTION 8 CONTENTS

LIST OF TABLES

LIST OF FIGURES

8. PROJECTS AND MANAGEMENT ACTIONS (§ 354.44)

As established in **Section 7**, groundwater conditions in the ECC Subbasin exhibit stability and sustainability. The technical analysis of groundwater conditions shows through historic and current use of the Subbasin no signs of chronic lowering of groundwater levels, reduction of groundwater storage, land subsidence, sea water intrusion, degraded water quality or depletion of interconnected surface water. The Subbasin Sustainability Goal broadly includes maintaining safe and reliable access to groundwater, assessing and managing groundwater in the future under climate change, protecting the sustainable yield, and continuing to avoid undesirable results of groundwater extraction as defined by Subbasin stakeholders.

Projects and management actions (PMAs) were developed to achieve the ECC Subbasin sustainability goal by 2042 and avoid undesirable results over the GSP planning and implementation horizon. Given the current and projected stability and sustainability of groundwater in the ECC Subbasin, PMAs are developed with the goal of maintaining sustainable groundwater conditions. PMAs include a suite of targeted PMAs that the GSAs may develop and implement, if needed under future conditions. The GSP also includes some PMAs that are expected to be implemented (or are already being implemented) by individual GSAs in the Subbasin to maintain sustainability.

ECC Subbasin GSAs have identified a range of PMAs. Projects generally refer to structural programs, including, for example, direct and in-lieu recharge utilization of recycled water, and other capital improvement projects. In contrast, management actions are typically non-structural programs or policies that do not require a substantial capital outlay and are intended to incentivize reductions in groundwater pumping when needed.

ECC Subbasin PMAs are described in accordance with 23 California Code of Regulations (CCR) §354.44. Because the ECC Subbasin is currently and projected to be sustainable over the implementation and planning horizon (i.e., no onset of undesirable results), PMAs are not expected to be essential for sustainability. However, future conditions are uncertain and PMAs are viewed as enhancing management capabilities and will be implemented on an as-needed basis. It is anticipated that PMAs would be targeted at specific regions that may emerge in the future as potential areas of concern.

Projects included in the GSP include infrastructure to provide in-lieu recharge, improve water quality, and increase use of recycled wastewater. Projects are either ongoing, under construction, or in the planning stage and are expected to help maintain sustainable conditions in the Subbasin and mitigate potential future problems. The estimated groundwater recharge benefit and capital cost of each project is shown. Project cost information is limited for many projects because a detailed feasibility assessment has not been completed. Other projects have cost estimates that were developed several years ago and may not reflect current conditions. To the extent possible, project costs are adjusted and reported on a consistent basis. GSAs and other agencies in the Subbasin will further develop projects during the GSP implementation period and refine estimated costs.

Management actions are options available to the GSAs if groundwater conditions begin to trend below Measurable Objectives (MO) or approach Minimum Thresholds (MT). Some GSAs may implement management actions proactively as a local policy. However, this appears unlikely based on current and projected groundwater modeling for the Subbasin (**Section 7**). Management actions in the GSP include oversight of well construction features, metering, and demand management. Management actions have more concise descriptions because they generally do not require outside approval or infrastructure and are part of authorities granted to GSAs under SGMA legislation. Benefits and costs will mostly depend on necessity and the extent of the area or areas which would require the action.

In accordance with CCR §354.44(b)(9), GSAs will identify sources of funding to cover project development, capital, and operating costs, including but not limited to, groundwater extraction fees, increasing water rates, grants, low interest loans, and other assessments. The exact funding mechanism will vary by project and the legal authority of each GSA (or project proponent). A general description of how each GSA expects to cover costs is presented after the description of each project.

Individual GSAs or other water agencies in the Subbasin will manage the permitting and other specific implementation oversight for its own projects. The ECC GSAs have an obligation to ensure groundwater sustainability in the Subbasin, however, they are not the primary regulator of land use, water quality, or environmental project compliance. The individual GSAs will be responsible for implementing projects and management actions in accordance with applicable statutes and regulations, and in coordination with other local, state, and federal authorities that may have permitting and regulatory authority over PMAs.

GSAs will notify the public and other agencies of the planned or ongoing implementation of PMAs through the communication channels identified for each project (23 CCR §354.44(b)(1)(B)). Noticing will occur as projects are being considered for implementation, and as future projects are implemented. Noticing will inform the public and other agencies that the GSA is considering or has implemented the PMA and will provide a description of the actions that will be taken.

PMAs are categorized and presented in this chapter according to the current status of implementation and development. This is consistent with the adaptive approach to PMA implementation and with development of PMAs based on the best available data and science (per 23 CCR §354.44(c)). This chapter also acknowledges ongoing investments made by GSAs and other agencies in the Subbasin (including prior to the passage of SGMA), such as projects that were identified and moved forward under regional water management planning efforts.

The PMA categories described in this chapter include:

- Completed Projects and Management Actions are PMAs that the GSA or other project proponents have implemented that will support sustainable groundwater management in the Subbasin. In accordance with 23 CCR §354.44(a) these are PMAs that would allow GSAs to achieve the sustainability goal for the ECC Subbasin and avoid minimum thresholds defined in this GSP under future, changing conditions.
- Under Construction Projects and Management Actions are PMAs that are being implemented and will support sustainable groundwater management in the Subbasin. In accordance with 23 CCR

§354.44(a) these are PMAs that would allow GSAs to achieve the sustainability goal for the Subbasin and avoid minimum thresholds defined in this GSP under future, changing conditions.

- Planned Projects and Management Actions are PMAs that are expected to be implemented and support sustainable groundwater management in the Subbasin. These may have been studied by the project proponent, or in earlier regional water planning documents, but most project design, costs, and planning work has yet to be completed.

- Conceptual Projects and Management Actions are PMAs that are being discussed as potential options to be implanted only as needed in any areas of the Subbasin facing deleterious groundwater conditions. This is not expected in the Subbasin as a whole, but these PMAs may be considered in specific areas facing unforeseen unsustainable conditions due to, for example, prolonged drought or supply disruption.

Table 8-1 summarizes the PMAs, type, and expected benefits to measurable objectives in the Subbasin. Most proposed PMAs are expected to benefit groundwater levels and groundwater storage, whether through direct or in-lieu groundwater recharge, management of water supplies, or demand reduction. Projects that increase the overall water supply are also expected to reduce depletions of interconnected surface water. Some management actions would potentially benefit all measurable objectives if those were ultimately triggered for implementation.

Table 8-1. Summary of ECC Projects & Management Action

Project/ Management Action Name	Project/ Management Action Category	Measurable Objectives Expected to Directly Benefit					
		GW Levels	GW Storage	SW Depletion	Land Subsidence	Seawater Intrusion	Water Quality
Northeast Antioch Annexation Water and Sewer Facility Installation	Completed	X	X				X
Non-Potable Storage Facility and Pump Station	Completed	X	X	X			
Dry-Year Water Transfer ECCID/CCWD	Completed	X	X	X			
Citywide Non-Potable Water Distribution System	Under Construction	X	X	X			
City of Antioch Brackish Water Desalination Project	Under Construction	X	X	X			X

Project/ Management Action Name	Project/ Management Action Category	Measurable Objectives Expected to Directly Benefit					
		GW Levels	GW Storage	SW Depletion	Land Subsidence	Seawater Intrusion	Water Quality
Treatment and Reuse of Alternative Water Supplies	Planned	X	X	X			X
Transport Model Development	Planned						X
Well Spacing Control	Conceptual	X	X		X		
Oversight of Well Construction Features	Conceptual						X
Well Metering, Monitoring, and Reporting	Conceptual	X	X	X	X		
Demand Management Program	Conceptual	X	X	X	X	X	X
Water Conservation Programs	Varied	X	X	X	X	X	X

This rest of this chapter is structured as follows. **Section 8.1** provides a summary of projects. The three subsequent subsections describe the projects in each of the three categories. **Section 8.2** describes management actions.

8.1 Projects

Seven (7) projects are included in the GSP. These projects provide a benefit to water supply or water quality, and are currently completed, under construction, or planned for implementation over the next 20 years (GSP implementation period). As described above and in **Section 7**, groundwater conditions are projected to be sustainable over the GSP implementation period, even in the absence of any projects. The GSAs will continue to monitor groundwater conditions, and report on them in annual GSP reports and 5-year GSP updates. Some projects may be triggered if undesirable results are projected to occur and subsequent GSP updates would provide an implementation schedule and additional project details.

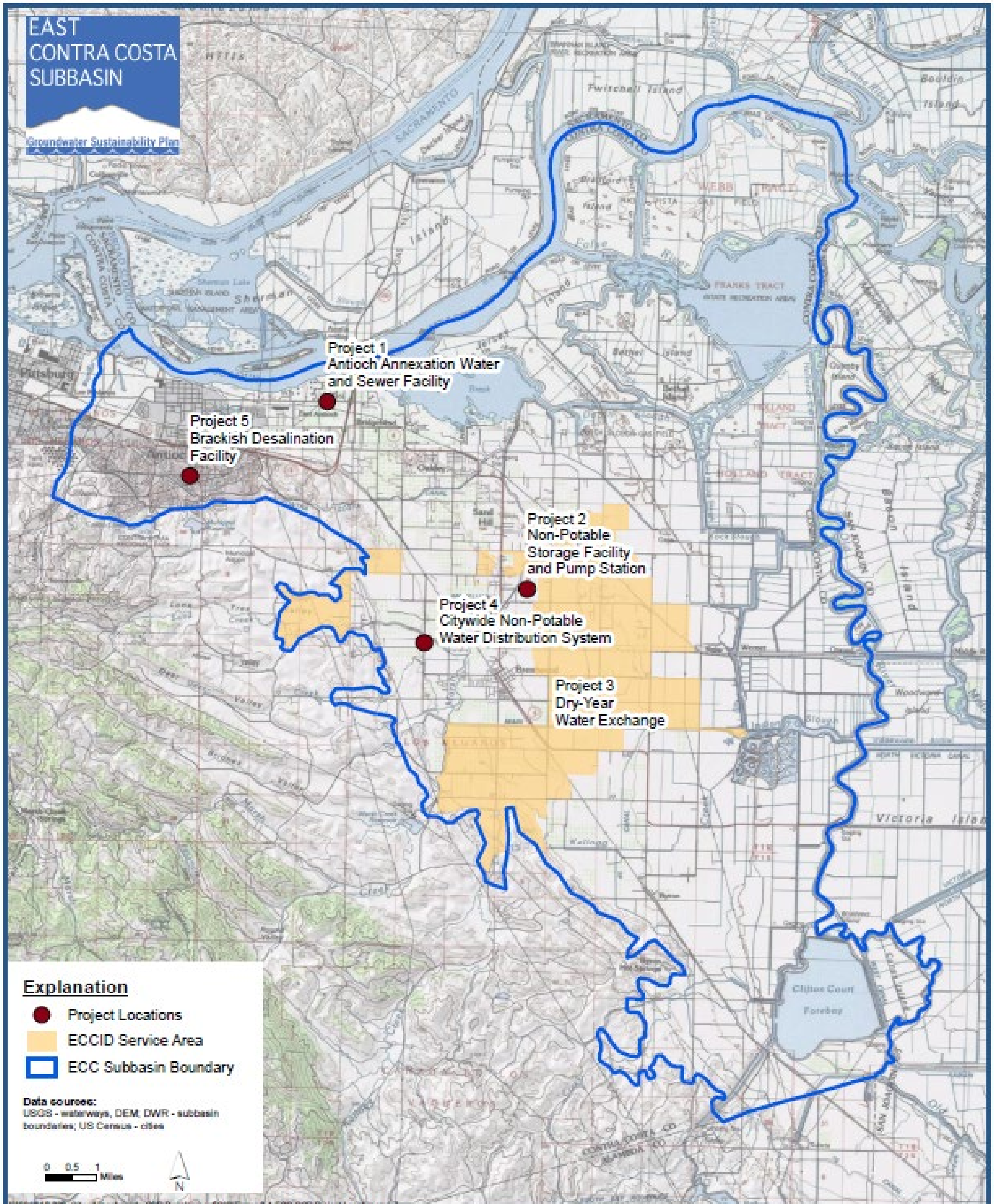
The ECC GSP Working Group used the Integrated Regional Water Management (IRWM) Plan (ECWMA 2019) to generate a preliminary list of projects that have been previously developed and evaluated by local entities in the ECC Subbasin. The GSAs then selected projects from this list that are expected support sustainable groundwater management and help maintain sustainable conditions in the Subbasin. Some projects described in this section are extensions of those detailed in the most recent IRWM Plan. Interested parties were informed and could provide feedback on the projects at a public workshop held on June 23, 2021; additional comments will be received during public review of this GSP.

8.1.1 Project Implementation

Projects will be administered by the project proponent (e.g., GSA). The project proponent has sole discretion to designate and implement a project in a timeframe in accordance with its funding, capability, and prioritization. No projects identified to date are considered essential for achieving the Subbasin sustainability goal because the ECC Subbasin is currently and projected to be sustainable over the implementation and planning horizon.

8.1.2 List of Projects

Seven possible projects to increase water supply availability and reliability in the ECC Subbasin were identified and are included in the GSP. These projects help contribute to the current and continued sustainability of the Subbasin. Projects include water recycling and water quality and are detailed in the project summaries below and in **Figure 8-1** and **Table 8-1**. **Figure 8-1** illustrates projects that are completed or under construction. **Table 8-2** lists projects which are completed, under construction, or planned.



Luhdorff & Scalmanini Consulting Engineers

ECC GSP Project Locations

East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figre 8-1

Table 8-2. Summary of ECC GSP Projects

Name	Type	Proponent	MO to Benefit	Status	Completion Year[1]	Capital Cost ($)	Expected Yield[2]
Northeast Antioch Annexation Water and Sewer Facility Installation	In-Lieu Recharge / Water Quality	City of Antioch	Groundwater Levels, Groundwater Storage, Water Quality	Completed	2020	4,400,000	8 AFY (.0007 MGD)
Non-Potable Storage Facility and Pump Station	In-Lieu Recharge / Recycled Water	City of Brentwood	Groundwater Levels, Groundwater Storage, Interconnected Surface Water	Completed	2020	12,804,500	1,661 AFY (1.5 MGD)
Dry-Year Water Transfer ECCID/CCWD	In-Lieu Recharge	East Contra Costs ID	Groundwater Levels, Groundwater Storage, Interconnected Surface Water	Completed	2000	N/A	4,000 AFY (3.5 MGD)
Citywide Non-Potable Water Distribution System	In-Lieu Recharge / Recycled Water	City of Brentwood	Groundwater Levels, Groundwater Storage, Interconnected Surface Water	Under construction	2021	9,054,036	1,661 AFY (1.5 MGD)
City of Antioch Brackish Water Desalination Project	In-Lieu Recharge	City of Antioch	Groundwater Levels, Groundwater Storage, Interconnected Surface Water	Under construction	2023	110,000,000	6,720 AFY (6 MGD)
Treatment and Reuse of Alternative Water Supplies	In-Lieu Recharge / Recycled Water	Diablo Water District	Groundwater Levels, Groundwater Storage, Interconnected Surface Water	Planned	TBD	20,000,000 to 100,000,000	2,800 AFY (2.5 MGD)
Transport Model Development[3]	Water Quality	Diablo Water District	Water Quality	Planned	TBD	250,000 to 500,000	N/A

1. SGMA's required planning implementation horizon is 50 years.
2. Represents total offset to water supply; direct benefits to groundwater will vary.
3. The Transport Model Development project is in progress.

8.1.3 Completed Projects

Projects in this category are completed and operating. They have either been completed recently and will have benefits not accounted for in the water budget described in **Section 5**, or they are ongoing with the capacity to expand. These projects provide in-lieu groundwater recharge benefits. The estimated cumulative benefit of these projects is 5,669 AFY.

8.1.3.1 Project 1: Northeast Antioch Annexation Water and Sewer Facility Installation

Project Summary	
Submitting GSA	City of Antioch
Project Type	In-Lieu Recharge / Water Quality
Estimated Groundwater Offset and/or Recharge	8 AFY, Water Quality Benefits

This project involved construction of new water and sewer facilities where there were none. Residents in this area had been relying on aging individual wells and septic tanks without access to municipal treated water or sewer services. This project provides facilities to a lower-income community, thus more equitably providing water access and protecting groundwater from potential septic tank and leach field contamination.

Measurable Objective Expected to Benefit:

This project, through reducing well use, helps avoid potential lowering of groundwater levels and reduction in groundwater storage. It also avoids potential water quality degradation from existing septic tanks and leach fields.

Project Status and Timetable for Initiation and Completion:

This project was completed in May of 2020.

Required Permitting and Regulatory Process:

All work was performed in City right-of-way or in areas that easements have been acquired. Permitting was required through BNSF Railroad for installation of a pipeline across its right-of-way.

Expected Benefits and Evaluation:

Groundwater recharge is an important part of the GSP and will be critical to maintaining long-term Subbasin sustainability. This project is anticipated to reduce 8 AFY in groundwater pumping by providing residents and businesses access to the City of Antioch water supply. Furthermore, the project is expected to benefit water quality through reduction of potential contamination. Benefits to groundwater levels and water quality will be evaluated through monitoring, as described in **Section 6**.

How Project Will Be Accomplished/Evaluation of Water Source:

New pipelines provide City water to residents that were not in the system. The source of water will be the City of Antioch, which is expected to provide a reliable water supply for the annexed area.

Legal Authority:

GSAs, in this case the City of Antioch GSA, have the authority to plan and implement projects. The City of Antioch is a local agency established to serve water for agricultural and municipal demands.

Estimated Costs and Plans to Meet Costs:

The capital cost for this project is $4,400,000. Costs for this project have been met through City of Antioch and County funds.

Annual operating costs of the project are $21,500. Operating costs from the project are paid for by ratepayers.

Circumstances for Implementation:

A construction agreement for this work was approved by the Antioch City Council on December 11, 2018. The Notice of Completion was approved by the Antioch City Council on June 9, 2020. No further process is needed to determine the conditions which would require this project because it is already constructed.

Notice to Public and Other Agencies

Public noticing for this project is being done in accordance with noticing requirements and in public meetings held the City of Antioch GSA and others.

8.1.3.2 Project 2: Non-Potable Storage Facility and Pump Station

Project Summary	
Submitting GSA	City of Brentwood
Project Type	In-Lieu Recharge / Recycled Water
Estimated Groundwater Offset and/or Recharge	Up to 1,661 AFY

The Wastewater Treatment Plant (WWTP) discharges about 2 million gallons of recycled water per day into Marsh Creek. Utilization and blending of this valuable resource are major strategic components for compliance with the requirements of the National Pollution Discharge Elimination System (NPDES) Permit. This reduces the reliance and associated treatment costs on potable water and complies with both State and City mandates on increasing recycled water usage.

The City of Brentwood is implementing steps to utilize more recycled water citywide; however, the peak daily recycled water supply (morning and evenings) does not align with the peak recycled water demand (night). The City of Brentwood needs an adequate storage facility to maximize utilization of this valuable resource. This project offsets the use of 1,661 AFY of potable water sourced in part from the Subbasin, reduces discharge to Marsh Creek, and reduces surface water diversions used for irrigation.

Measurable Objective Expected to Benefit:

This project, through increasing the city water supply, helps avoid potential lowering of groundwater levels, reduction in groundwater storage, and depletion of interconnected surface water.

Project Status and Timetable for Initiation and Completion:

This project was completed in 2020.

Required Permitting and Regulatory Process:

Requirements from the Central Valley Regional Water Quality Control Board, as part of the WWTP NPDES Permit, include that the City of Brentwood must expand recycled water usage and decrease discharge of treated water into Marsh Creek. Storage facility construction was completed following all required permitting and regulatory requirements.

Expected Benefits and Evaluation:

Recycled water is an important part of the City's water resources. Recycled water allows the City of Brentwood to conserve potable water, thereby ensuring a reliable water supply for current and future demand. This project is expected to offset 1,661 AFY in water demand.

The amount of in-lieu recharge depends on the availability of other sources, but some offset of groundwater pumping is expected. The Non-Potable Storage Facility project will improve access to recycled water supplies. Alternate water supplies will be an important component of the priorities and requirements to facilitate sustainable groundwater management and will be critical to establishing long-term groundwater sustainability. Benefits will be evaluated through volumetric measurement of recycled water added back into the system.

How Project Will Be Accomplished/Evaluation of Water Source:

The City's Wastewater Treatment Plant's tertiary treatment and disinfection provides recycled water for landscaping. The City of Brentwood is a producer and distributor of Title 22 tertiary recycled water for unrestricted reuse. Upon completion of the pipeline installation, recycled water will be pumped throughout the City of Brentwood for irrigation uses in lieu of potable water. Since the source of water is recycled wastewater, this is expected to be reliable even during drought periods.

Legal Authority:

GSAs, in this case the City of Brentwood GSA, have the authority to plan and implement projects. Unrestricted, non-potable recycled water is defined as wastewater that has been treated to tertiary standards (via filtration and disinfection) that meet Title 22 of the California Code of Regulations (California Department of Public Health, 2018). The production and distribution of recycled water is covered in the City's Master Reclamation Permit. Recycled water treated to this level can be used for all outdoor irrigation demands in a community, including parks, schools, street medians, residential front and backyard landscaping, public open space, as well as industrial uses such as cooling water.

Estimated Costs and Plans to Meet Costs:

The capital cost for this project was $12,804,500. The project was funded by a State Water Resources Control Board Revolving Fund "SRF" loan, so project approvals were obtained from the Regional Water Quality Control Board (RWQCB) and other affected local agencies. The SRF funding consisted of 35% from State and Federal grants and 65% from a loan that will be repaid using Wastewater Development Impact Fees and Wastewater Enterprise Funds.

Annual operating costs associated with this specific project are minor because this is an improvement on existing WWTP operations, which are already paid for by ratepayers.

Circumstances for Implementation:

This project was completed in 2020. The City of Brentwood has developed preliminary planning documents to identify uses for recycled wastewater at both existing and future sites. The recycled wastewater will be used for the irrigation of parks and other landscape amenities. The City of Brentwood already has constructed a portion of the recycled water distribution system and will continue to expand the system as the City of Brentwood grows. Recycled water demands are estimated to be 2,111 AF (688 MGY) at buildout. No further process is needed to determine the conditions which would require this project because it is already complete.

Notice to Public and Other Agencies

Public noticing for this project is being done in accordance with noticing requirements and in public meetings held by the City of Brentwood GSA and others.

8.1.3.3 Project 3: Dry-year Water Transfer ECCID/CCWD

Project Summary	
Submitting GSA	East Contra Costa Irrigation District
Project Type	Dry-Year Water Exchange
Estimated Groundwater Offset and/or Recharge	Up to 4,000 AFY

Under this project, CCWD diverts surface water of the same quantity ECCID has pumped from groundwater sources to meet local municipal and industrial demands within the ECC Subbasin. In wet years ECCID does not pump groundwater beyond what is required for use by ECCID direct use customers. This project is ongoing and implemented on an as needed basis and could be expanded if necessary to meet water supply needs while avoiding undesirable results. This exchange benefits local domestic supply as the aquifer recovers quickly through natural recharge and aids in meeting the measurable objective of maintaining average groundwater storage through all water year types. Although surface water meets about 85 percent of the ECC Subbasin water supply, groundwater can play a key role in prolonged droughts and benefit and preserve the agricultural resources of the region. ECCID will pump additional groundwater in dry years when surface waters are in a shortage as a result of drought.

Measurable Objective Expected to Benefit:

This project can help to avoid lowering groundwater levels and reduction in groundwater storage through replenishment of groundwater pumped during dry water years using surface water in wet water years. It also can help avoid depletion of interconnected surface water through taking stress of surface water supplies during dry years.

Project Status and Timetable for Initiation and Completion:

This project was first implemented in 2000 and is ongoing. The project will be implemented in dry years under an existing agreement.

Required Permitting and Regulatory Process:

The dry year transfer has been permitted and approved under the following agreements:

- Contract Among the Department of Water Resources of the State of California, East Contra Costa Irrigation District, and Contra Costa Water District, 1991 (amended 2000).
- Water Sales Agreement Between the East Contra Costa Irrigation District and the Contra Costa Water District, 2000.
- DWR approved the dry year exchange in a letter dated May 22, 2003.

Expected Benefits and Evaluation:

This project helps ensure groundwater is made available and distributed fairly to as many users as possible in the Subbasin when needed. Although surface water meets about 85 percent of the ECC Subbasin water supply, groundwater can play a key role in prolonged droughts and benefit and preserve the agricultural resources of the region. Benefits will be evaluated through volumetric measurement of delivered water.

How Project Will Be Accomplished/Evaluation of Water Source:

ECCID will pump additional groundwater in dry years when surface waters are in a shortage as a result of drought. Currently a long-term agreement is in place to initiate the transfer in dry years. Implementation includes a monitoring plan that was approved by DWR. The source of water will be the ECCID which is expected to be reliable. At this time there are no exchanges scheduled. However, additional wells may be considered to improve the efficiency of the groundwater transfer as well as to allow transfers outside of the irrigation season.

Legal Authority:

The dry year groundwater exchange is included in the Water Sales Agreement between ECCID and CCWD, dated February 22, 2000.

Estimated Costs and Plans to Meet Costs:

The initial implementation costs for this project have already been met by ECCID. Ongoing and future costs of the project are expected to be minimal and would be paid for by rate payers as needed.

Circumstances for Implementation:

For purposes of this transfer, a shortage situation must be determined when the U.S. Bureau of Reclamation notifies the CCWD that the allocation of Central Valley Water Project (CVP) water to CCWD will be less than CCWD's requested schedule of water supply service, submitted pursuant to CCWD's CVP contract. DWR will be informed when the transfer begins and ends. Total volumes of water will be reported monthly and annually to DWR per the existing agreements and approved monitoring plan. No further process is needed to determine the conditions which would require this project because it has already been implemented.

Notice to Public and Other Agencies

Public noticing for this project is being done in accordance with noticing requirements and in public meetings held by the ECCID GSA and others.

8.1.4 Projects Under Construction

Projects in this category are currently under construction and will be operating by 2042. Both projects provide in-lieu groundwater recharge benefits. The projected cumulative supply of these projects is 8,381 AFY.

8.1.4.1 Project 4: Citywide Non-Potable Water Distribution System

Project Summary	
Submitting GSA	City of Brentwood
Project Type	In-Lieu Recharge / Recycled Water
Estimated Groundwater Offset and/or Recharge	Up to 1,661 AFY

This project consists of the expansion of the reclaimed (non-potable) water distribution system throughout the City to provide reclaimed water for irrigation of golf courses, parks, parkways, medians, and other applicable uses. There are parks and public landscaping that are currently irrigated using potable water. By converting to non-potable water usage, the City can save on potable water supply. This project will deliver an additional 1,661 AFY produced by its treatment plant and offset the use of potable water sourced in part from the Subbasin.

Measurable Objective Expected to Benefit:

This project, through increasing the city water supply, helps avoid potential lowering of groundwater levels, reduction in groundwater storage, and depletion of interconnected surface water.

Project Status and Timetable for Initiation and Completion:

This project is currently under construction. This project began February 16, 2021 and is on schedule to be completed by November 2021.

Required Permitting and Regulatory Process:

This project requires the installation of non-potable water main lines throughout various portions of Brentwood. The project is being funded by a State Water Resources Control Board Revolving Fund "SRF" loan, so project approvals were obtained from the Regional Water Quality Control Board (RWQCB) and other affected local agencies.

Expected Benefits and Evaluation:

Recycled water is an important part of the City's water resources. Recycled water allows the City to conserve potable water, thereby ensuring a reliable water supply for current and future demand. The Non-Potable Water Distribution System project will expand the non-potable water distribution system and improve access to recycled water supplies. This project will create an additional 1,661 AFY in total water supply and offset groundwater pumping and dependence on surface water. Developing alternative water supplies is an important component of the requirements to achieve sustainable groundwater management and will be critical to maintaining long-term groundwater sustainability. Benefits will be evaluated through volumetric measurement of recycled water added back into the system.

How Project Will Be Accomplished/Evaluation of Water Source:

The City's Wastewater Treatment Plant's tertiary treatment and disinfection provides recycled water for landscaping. The City is a producer and distributor of Title 22 tertiary recycled water for unrestricted reuse. Upon completion of the pipeline installation, recycled water will be pumped throughout the City of Brentwood for irrigation uses in lieu of potable water. Since the source of water is recycled wastewater, this is expected to be reliable even during drought periods.

Legal Authority:

GSAs, in this case the City of Brentwood GSA, have the authority to plan and implement projects. Unrestricted, non-potable recycled water is defined as wastewater that has been treated to tertiary standards (via filtration and disinfection) that meet Title 22 of the California Code of Regulations (California Department of Public Health, 2018). The production and distribution of recycled water is covered in the City's Master Reclamation Permit. Recycled water treated to this level can be used for all outdoor irrigation demands in a community, including parks, school grounds, street medians, residential landscaping, public open space, as well as industrial uses such as cooling water.

Estimated Costs and Plans to Meet Costs:

The estimated capital cost for this project is $9,054,036. The State approved an agreement with the City for utilization of the SRF to fund the City's Recycled Water Project, which included the Citywide Non-Potable Water Distribution System project. The loan agreement also provides for a portion to be funded with grants from both Proposition 1 and Proposition 13. The final loan amount will be dependent upon final project costs, with the loan portion of the agreement to be repaid from Wastewater Enterprise and Wastewater Development Impact Fee funds over 30 years.

Annual operating costs associated with this expansion project are minor because this is an improvement on existing City of Brentwood non-potable water system infrastructure, with operations already paid for by ratepayers.

Circumstances for Implementation:

The Brentwood City Council approved this project in August 2020. This project began on February 16, 2021. The City of Brentwood has developed preliminary planning documents to identify uses for recycled wastewater at both existing and future sites. The recycled wastewater will be used for the irrigation of parks and landscape amenities. The City of Brentwood already has constructed a portion of the recycled water distribution system and will continue to expand the system as the City grows. Recycled water demands are estimated to be 2,111 AF (688 MGY) at buildout. There is no process for determining the conditions which would require this project because it is already underway.

Notice to Public and Other Agencies

Public noticing for this project is being done in accordance with noticing requirements and in public meetings held the City of Brentwood GSA and others.

8.1.4.2 Project 5: City of Antioch Brackish Water Desalination Project

Project Summary	
Submitting GSA	City of Antioch
Project Type	In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge	Up to 6,720 AFY

This project improves water supply reliability by providing the production of up to 6 MGD of drinkable water utilizing high salinity water from the San Joaquin River that was previously untreatable via conventional treatment methods.

Measurable Objective Expected to Benefit:

This project, through increasing water supply, helps avoid potential lowering of groundwater levels, reduction in groundwater storage, and depletion of interconnected surface water.

Project Status and Timetable for Initiation and Completion:

Construction for this project began following a construction agreement for this work approved by the Antioch City Council on December 15, 2020. The project is currently under construction and expected to be completed in 2023.

Required Permitting and Regulatory Process:

This project includes the construction of a new intake from the San Joaquin River, modification to an existing water treatment plant, installation of approximately 4.5 miles of pipeline, and the introduction of brine in the discharge stream at the location of the wastewater treatment facility. The work will require permits from National Marine Fisheries Services (NMFS), California Department of Fish and Wildlife (DFW), Regional Water Quality Control Board (RWQCB), U.S. Army Corps of Engineers (USACE), State Department of Transportation (Caltrans), and Union Pacific Railroad (UPRR). All permits for this project have been obtained.

Expected Benefits and Evaluation:

Water supply reliability is a critical component of the GSP and will be important in maintaining the sustainability of the Subbasin. This project will introduce up to 6 MGD of new drinking water into the region, equivalent to providing water for 27,000 people per day[1]. This water will be produced from high salinity source water from the San Joaquin River that is currently unusable, utilizing conventional treatment methods. The benefits will be evaluated based on volumetric measurement of the amount of treated water put into the system.

How Project Will Be Accomplished/Evaluation of Water Source:

The City of Antioch will continue to use its pre-1914 water rights to pump water from the San Joaquin River. The river pump station is currently permitted to pump up to 16 MGD from the river. As a pre-1914 right, this supply will be highly reliable.

---

[1] In 2016 the Legislative Analyst's Office estimates that the average residential water use was 85 gallons per person per day. The average number of people per household is 2.5 (average number of people per household in the United States from 1960 to 2019).

Legal Authority:

GSAs, in this case the City of Antioch GSA, have the authority to plan and implement projects. The City of Antioch will continue to use its pre-1914 water rights to pump water from the San Joaquin River. Construction of the new facilities will occur on existing City right-of-way or with new easements which have been acquired.

Estimated Costs and Plans to Meet Costs:

The estimated capital costs for this project total $110,000,000. **Table 8-3** summarizes the funding sources for the project.

Estimated annual operating costs of the project are between $2,100,000 and $4,000,000, depending on annual rainfall. Operating costs from the project will be paid for by ratepayers.

Table 8-3. City of Antioch Brackish Water Desalination Project Funding Sources

Source	Amount ($)
California Department of Water Resources Desalination Grant	10,000,000
State Water Resources Control Board Drinking Water Revolving Loan Fund Award	56,000,000
California Department of Water Resources Settlement Agreement Funds	27,000,000
City of Antioch Water Enterprise Funds	17,000,000

Circumstances for Implementation:

A construction agreement for this work was approved by the Antioch City Council on December 15, 2020. The project is already underway and does not require any new conditions or approvals.

Notice to Public and Other Agencies

Public noticing and public meetings for this project have complied with all noticing requirements followed by the City of Antioch GSA and other participating agencies.

8.1.5 Planned Projects

Projects in this category are planned and are expected to be completed and operating by 2042. One project provides in-lieu groundwater recharge benefits, and the other provides water quality benefits. The projected cumulative supply of these projects is 2,800 AFY.

8.1.5.1 Project 6: Treatment and Reuse of Alternative Water Supplies

Project Summary	
Submitting GSA	Diablo Water District
Project Type	In-Lieu Recharge / Recycled Water
Estimated Groundwater Offset and/or Recharge	Up to 2,800 AFY

This project will offset current and future groundwater pumping. Through the introduction of recycled water for future park and public landscaping areas, future groundwater pumping in these areas is reduced. Additionally, through aquifer storage and recovery via indirect potable reuse, a drought-resilient water supply will be created to help limit groundwater drawdown during periods of drought.

Measurable Objective Expected to Benefit:

This project, by increasing water supply, will help to avoid potential lowering of groundwater levels, reduction in groundwater storage, and depletion of interconnected surface water.

Project Status and Timetable for Initiation and Completion:

The feasibility study phase is complete, and the project will move into the planning phase in late 2021. The timeline for initiation and completion is still under development, pending the final plan. It is anticipated to take between 5 and 10 years from the beginning of project construction to completion.

Required Permitting and Regulatory Process:

This project will require a CEQA review and permit from the SWRCB. Additional requirements may include County Well Permits, and City/County encroachment permits.

Expected Benefits and Evaluation:

This project will create up to 2,800 AFY reduction in future estimated aquifer extraction through availability of recycled water. This likely will increase as flows to the sanitary district increase due to regional growth. The yield will be evaluated through volumetric monitoring of recycled water delivered for parks and landscape use. Developing alternative water supplies is an important component of maintaining long-term groundwater sustainability.

How Project Will Be Accomplished/Evaluation of Water Source:

Currently, the GSA is in initial discussions with the sanitary district regarding funding, organization structure, responsibilities, etc. Each agency has created an ad hoc committee to assess ideas and bring to their full Boards for evaluation. Since the source of water would be recycled wastewater, this is expected to be reliable even during drought periods.

Legal Authority:

GSAs, in this case the Diablo Water District GSA, have the authority to plan and implement projects. Unrestricted, non-potable recycled water is defined as wastewater that has been treated to tertiary standards (via filtration and disinfection) that meet Title 22 of the California Code of Regulations (California Department of Public Health, 2018). This project may also involve the creation of a Joint Powers Agreement between DWD and Ironhouse Sanitary District (ISD).

Estimated Costs and Plans to Meet Costs:

The estimated capital costs for this project are expected to fall between $20 and $100 Million. A more precise estimate and the proposed method to cover this cost will be determined during the planning phase of the project, which will begin in late 2021.

Circumstances for Implementation:

This is a future action approved by both the sanitary board and the Diablo Water District Board. The project will be implemented following completion of the East Cypress Corridor. The decision to move forward will depend on confirmation of water supply availability from the project and desire to move forward from the stakeholders. Water supply availability and stakeholder desire will be determined during the planning phase. Unsustainable changes in aquifer conditions, while not expected, would accelerate the implementation of this project. Aquifer conditions will be monitored as described in **Section 6**.

Notice to Public and Other Agencies

Public noticing for this project is being done in accordance with noticing requirements and in public meetings held by the Diablo Water District GSA and others.

8.1.5.2 Project 7: Transport Model Development

Project Summary	
Submitting GSA	Diablo Water District
Project Type	Water Quality
Estimated Groundwater Offset and/or Recharge	N/A, Water Quality Benefits

This project will address the water quality measurable objective by expanding the existing surface water/groundwater flow model to include a solute transport component. The development of a solute transport component will complement the existing ECCSim modeling work completed for the GSP by allowing the simulation of the transport of chemicals within the East Contra Costa Subbasin. This will improve the understanding of the movement of water and constituents under various flow regimes including climate change, sea level rise, and changes in groundwater use. The current ECCSim platform does not directly support inclusion of a transport component, so this project would involve converting the IWFM model platform inputs to a MODFLOW platform, with various improvements necessary to facilitate solute transport. Particle tracking would be incorporated into the new MODFLOW model for the ECC Subbasin after sufficient refinement of lateral and vertical discretization, calibration, development of climate change and sea level rise scenarios, and various additional future groundwater pumping regimes. The new flow and transport model would allow ECC to determine how chemicals could potentially be mobilized as a result of additional groundwater development, in order to avoid degradation of groundwater quality. This project would require converting the current ECCSim model to the MODFLOW platform and would include a detailed report, including maps, figures, charts, and tables describing the development of the model. This also would include developing the solute transport component and documenting the results of the modeling effort.

Measurable Objective Expected to Benefit:

This project will help to avoid degraded water quality concerns.

Project Status:

This project is currently in the planning phase. The timeline for implementation is still under development. It is anticipated to take about a year to complete.

Required Permitting and Regulatory Process:

No permits will be required for this project.

Expected Benefits and Evaluation:

The new model will increase the understanding about movement of poor-quality water within the Subbasin under various hydrologic conditions including climate change and sea level rise. This also will enhance the water quality monitoring described in **Section 6**.

How Project Will Be Accomplished/Evaluation of Water Source:

The project is currently in initial discussions with GSAs regarding funding, organizational structure, and responsibilities.

Legal Authority:

GSAs have the authority to plan and implement projects.

Estimated Costs and Plans to Meet Costs:

The estimated costs for this project are $250,000 to $500,000. The plans to cover these costs are currently under development.

Circumstances for Implementation:

This project would be implemented by the ECC Working Group. Implementation would begin when agreement about funding and potential grant money is secured. Water supply availability, political desire, and aquifer conditions are all motivating the desire to develop a transport model.

Notice to Public and Other Agencies

Public noticing for this project is being done in accordance with noticing requirements and in public meetings held the Diablo Water District GSA and others.

8.2 Management Actions

Management actions are activities that GSAs may implement locally to achieve or maintain groundwater sustainability. These management actions are all “planned” and therefore are currently in the conceptual phase. GSAs will consider these management actions to address possible future threats to groundwater sustainability on an as-needed basis in potential areas of concern. They generally do not require outside approval or infrastructure and are part of the authorities granted to GSAs under SGMA legislation.

As established in **Section 7***,* groundwater conditions in the ECC Subbasin exhibit stability and sustainability. Basin-wide management actions are not currently proposed for GSP implementation, but future actions may be instituted by GSAs to address local concerns if they arise during the implementation and planning horizon. Some GSAs may implement management actions proactively as a local policy. If undesirable results occur or are projected to occur during the GSP implementation period, subsequent GSP updates will identify additional management actions and provide an implementation schedule as needed.

8.2.1 Potential Management Actions

The GSAs may elect to implement one or more potential management actions for maintaining sustainability in the Subbasin (or portion thereof). **Table 8-4** lists the potential management actions included in this GSP. Generally, these management actions are not applicable to de minimis well users[2]. De minimis well users are discussed further in **Section 8.2.1.1**. Management actions include well spacing control, oversight of well construction, reporting, and a potential demand management program. These potential management actions fall within the powers and authorities of GSAs under SGMA.

[2] “De minimis extractor” means a person who extracts, for domestic purposes, two acre-feet or less per year. Section 10721, Water Code

Table 8-4. Summary of Potential Management Actions

Name	Type	MO to Benefit	Status
Well Spacing Control	Demand Management	Groundwater Levels, Groundwater Storage, Land Subsidence	Concept
Oversight of Well Construction Features	Water Quality	Water Quality	Concept
Well Metering, Monitoring, and Reporting	Improved Data / Demand Management	Groundwater Levels, Groundwater Storage, Interconnected Surface Water, Land Subsidence	Concept
Demand Management Program	Demand Management	All	Concept
State Programs for Domestic Well Users	Well Data	Groundwater Levels, Groundwater Quality	Concept

Not listed under **Table 8-4** are potential advocacy and engagement with other lead agencies that oversee activities that can have an impact on groundwater sustainability. Of particular concern expressed by the public and some GSAs is the risk posed by hazardous substances and oil and gas drilling. The presence of contamination and oil and gas activity in the ECC Subbasin are cited in **Section 3.3.6**. Although GSAs do not have authorities under SGMA to regulate such activities, they may seek to advise applicable agencies of potential risks to sustainability posed by projects and permitting actions. The basis for such engagement may include the subbasin hydrogeologic conceptualization which can provide a more current and robust risk assessment with respect to threats to groundwater.

The next two subsections discuss non-applicability to de minimis users, and coordination with Contra Costa County which would be needed with these actions. The subsections following those summarize the potential management actions.

8.2.1.1 Non-Applicability to De Minimis Users

Management actions related to wells are generally not applicable to de minimis users. Primary exceptions may be made when certain well standards are needed to ensure source protection for the de minimis user and other users. A GSA may therefore impose standards for seal and intake depths where such standards are needed to avoid water quality degradation and are consistent with the sustainability goal and the sustainable management criteria detailed in **Section 7**.

Where applicable, GSAs may seek to develop options to quantify groundwater pumping by de minimis users, including self-certification. This measure is strictly to provide better accuracy for projecting impacts and sustainability and is not intended to infringe on privacy or place any financial or other burden on this category of user. Information will be included in the GSP Data Management System described in **Section 6**.

8.2.1.2 Coordination with Contra Costa County

Implementation of any management action pertaining to new wells, excluding de minimis users, shall be coordinated with Contra Costa County. A management action that pertains to existing wells, such as a requirement to install a meter, would not involve County coordination but would be undertaken by a GSA in accordance with authorities and powers granted under SGMA.

With regard to new wells, the County Environmental Health Division is the permitting authority for well siting (plot plan) and construction inspection. The latter includes a final surface inspection of the completed well. Coordination between the County permitting division and GSAs is recognized as a requirement for implementing future GSP management actions related to wells. If needed to ensure sustainability, existing well owners may be required to conform to well management actions such as metering or pumping limitations. These existing well owners may be identified through county records as part of the well inventory data gap discussed in **Section 6**.

Since each GSA may implement a variety of requirements for new wells as a function of individual sustainable management responsibilities, the permitting process cannot anticipate every possible requirement that may be imposed by the GSAs. Nor is it expected that the County will inspect and regulate conformance to any GSA requirement for all permit applications. Rather, this GSP envisions that an administrative process be developed under which the County would notify well applicants of their responsibility to contact the appropriate GSA for local requirements involving siting, construction, and use of new wells. It would be the GSA's responsibility to provide information on local requirements and a point of contact to ensure that well owners have a clear understanding of the purpose and execution of a requirement. The GSA, at its discretion, may perform inspections as it deems necessary to certify compliance with a particular requirement.

Presently, the County permit process includes discretionary requirements only for additional water analyses and pump testing. The coordination with GSA requirements would require, as applicable, that a permit application identify any local GSA requirements and provide the certification at completion that such requirements were met. Measures such as ongoing reporting of pumped volumes would be the responsibility of the well owner. Any follow-up inspections or enforcement of a measure would be the responsibility of the GSA.

This GSP recognizes that its management actions must be consistent with and subject to County authorities and responsibilities as the well permitting agency in the Plan area. It is expected that the process will be developed over two to three years commencing with implementation of the GSP in January 2022.

8.2.1.3 Management Action 1: Well Spacing Control

As determined by a GSA, well spacing control may be imposed to prevent a new well from causing a significant reduction in the production of any existing well in the vicinity. Sufficient well spacing, defined as the distance between the proposed new well and existing wells, would be required to mitigate the impacts of pumping interference (water level drawdown) induced by operation of the prospective new well to a less-than-significant degree. Determination of a significant impact shall be made by the GSA on a case-by-case basis considering, but not limited to, the number of wells potentially affected, the estimated effect on existing well production and cost, and the types and uses of the affected wells (e.g., domestic, agricultural, and industrial). The GSAs will seek to prioritize protection of disadvantaged communities, rural domestic wells, agricultural uses, and environmental resources consistent with the Sustainable Management Criteria set forth in this GSP (see **Section 7**).

Measurable Objective Expected to Benefit

This management action would help to avoid lowering of groundwater levels, reduction in groundwater storage, and land subsidence by preventing significant drawdown.

Management Action Status:

This management action is currently conceptual and may be employed as needed by one or more GSAs.

Required Permitting and Regulatory Process:

No additional permitting would be required. Contra Costa County will notify new well permit applicants to identify and comply with the requirements of the applicable local GSA.

Expected Benefits and Evaluation:

The expected benefit is a reduction in groundwater level drawdown. Quantification of interference impacts may be made through direct measurements (well testing), calculations using applicable well hydraulic methods employed in groundwater science, or groundwater flow modeling. These methods shall use aquifer parameters consistent with the basin Hydrogeologic Conceptual Model described in **Section 3** and incorporate flow rate and pumping duration as proposed by the well applicant.

How Management Action Will Be Accomplished:

If a determination that interference would result in a significant deleterious impact on the capacity of an existing well or wells, the well permit applicant may propose an alternate location that reduces the impact to a less than significant degree. The impact assessment and degree of significance may depend on numerous factors and shall be determined on a case-by-case basis by the GSA.

Legal Authority:

GSAs have the authority to plan and implement management actions. Each GSA in the Subbasin has the authority to implement and enforce this management action if needed based on aquifer conditions.

Estimated Costs and Plans to Meet Costs:

Since this management action is in the conceptual phase, specific costs are not yet determined. The costs would be associated with the number of new well permit applications in the Subbasin if the action is implemented.

Circumstances for Implementation:

Groundwater conditions are projected to remain at sustainable levels into the future under GSP implementation as described in **Section 7**. This management action may be implemented and would be monitored and quantified with respect to groundwater levels, as needed, if sustainable groundwater levels cannot be maintained in any areas of the Subbasin during GSP implementation. This will be determined by the methods described in **Section 6**.

Notice to Public and Other Agencies

Public noticing for this management action would be done in accordance with noticing requirements and in public meetings held by the GSA or GSAs which elect to implement this management action. Additionally, Contra Costa County will notify new well permit applicants to identify and comply with the requirements of their GSA.

8.2.1.4 Management Action 2: Oversight of Well Construction Features

A GSA may impose requirements for well construction to ensure that a new well does not induce adverse impacts to water quality and availability. Such requirements may include specifying depths for well seals and intake screens to avoid commingling of zones with differing water quality where such commingling may lead to degradation of the water supply. A GSA may also institute construction standards that exceed local and state requirements where it has been determined that such standards are needed to protect water quality for conditions in the GSA plan area.

Measurable Objective Expected to Benefit

This management action would help to avoid degraded water quality concerns through more locally targeted well construction requirements.

Management Action Status:

This management action is currently conceptual and may be employed as needed by one or more GSAs.

Required Permitting and Regulatory Process:

No additional permitting would be required. Contra Costa County will notify new well permit applicants to identify and comply with the requirements of the applicable local GSA.

Expected Benefits and Evaluation:

The expected benefit is the protection of water quality. Water quality will be monitored using the methods described in **Section 6**.

How Management Action Will Be Accomplished:

The GSA or GSAs which elect to implement this management action would work with the County well permitting office to ensure new well permit holders are aware of construction requirements. The GSAs will also establish and/or develop with the County a process for inspecting well construction activities and ensuring requirements are met.

Legal Authority:

GSAs have the authority to plan and implement management actions. Each GSA in the Subbasin has the authority to implement and enforce this management action if needed based on aquifer conditions.

Estimated Costs and Plans to Meet Costs:

Since this management action is in the conceptual phase, specific costs are not yet determined. The costs would be associated with the number of new well permits sought in the Subbasin if the action is implemented.

Circumstances for Implementation:

Groundwater conditions are projected to remain at sustainable levels into the future under GSP implementation, as described in **Section 7**. This management action may be implemented and would be monitored and quantified with respect to water quality, as needed, if sustainable conditions are not maintained in any areas of the Subbasin during initial GSP implementation. This will be determined by the methods described in **Section 6**.

Notice to Public and Other Agencies

Public noticing for this management action would be done in accordance with noticing requirements and in public meetings held by the GSA or GSAs which elect to implement this management action, if needed. Additionally, Contra Costa County will notify existing and new well permit applicants to identify and comply with the requirements of their GSA.

8.2.1.5 Management Action 3: Well Metering, Monitoring, and Reporting

A fundamental requirement for sustainable groundwater management is quantification of a water budget and continual updating of predictive tools, such as groundwater flow models, used to assess water supply availability under future water demands, land-use changes, climate change, and sea level rise. To meet this need, a GSA may impose metering, monitoring, and reporting requirements for new and existing wells.

Measurable Objective Expected to Benefit

By providing better data on water budgets, this management action would help to avoid the potential lowering of groundwater levels, reduction in groundwater storage, depletion of interconnected surface water, and land subsidence.

Management Action Status:

This management action is currently conceptual and may be employed as needed by one or more GSAs.

Required Permitting and Regulatory Process:

No additional permitting would be required. Contra Costa County will notify new well permit applicants to identify and comply with the requirements of the applicable local GSA. Implementation of this management action for existing wells (i.e., after a well is constructed under a County permit) shall be done by the GSA in accordance with its authorities and powers under SGMA.

Expected Benefits and Evaluation:

The expected benefit is more accurate estimation of groundwater extraction in the Subbasin. This will enhance the planned monitoring programs described in **Section 6**.

How Management Action Will Be Accomplished:

The GSA or GSAs which elect to enforce this management action would work with the County well permitting office to ensure new and existing well permit holders are aware of monitoring and reporting requirements. The GSAs would also establish a process for inspecting and ensuring that monitoring and reporting requirements are met, and/or work with the County to establish a process.

Legal Authority:

GSAs have the authority to plan and implement management actions. Each GSA in the Subbasin has the authority to implement and enforce this management action if needed based on aquifer conditions.

Estimated Costs and Plans to Meet Costs:

Since this management action is in the conceptual phase, specific costs are not yet determined. The costs would be associated with the number of wells located in the area or areas requiring this management action.

Circumstances for Implementation:

Groundwater conditions are projected to remain at sustainable levels into the future under GSP implementation, as described in **Section 7**. This management action may be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if sustainable conditions are not maintained in any areas of the Subbasin during initial GSP implementation. This will be determined by the methods described in **Section 6**. Some GSAs may implement metering and reporting of existing and new wells proactively as a local policy.

Notice to Public and Other Agencies

Public noticing for this management action would be done in accordance with noticing requirements and in public meetings held by the GSA or GSAs which elect to implement this management action, if needed. Additionally, Contra Costa County will notify new well permit applicants to identify and comply with the requirements of their GSA.

8.2.1.6 Management Action 4: Demand Management Program

The planned PMAs described in this Section will be pursued by the ECC Subbasin GSAs to maintain sustainable groundwater conditions. The GSAs have also included a potential demand management program to avoid undesirable results as a "backstop" to other PMAs. Events that may trigger this management action include, but are not limited to severe, prolonged drought conditions resulting in groundwater levels approaching MT or MO in specific parts of the Subbasin; other PMAs are not achieving the expected level of benefits; or new information about projected future conditions show that sustainability objectives will not be met.

Demand management broadly refers to any water management activity that reduces the consumptive use of water. To be effective for purposes of sustainable groundwater management, demand management must result in a reduction in net groundwater pumping (pumping net of recharge). Activities that, for example, reduce canal seepage or reduce deep percolation from irrigation will not be effective.

They may decrease quantity of water diverted or applied but they also reduce recharge to usable groundwater, so do not improve the net pumping from the aquifer.

For purposes here, a demand management action is one that incentivizes, enables, or possibly requires water users to reduce their consumptive use, but does not dictate exactly how users have to do it. Agricultural users can respond to demand management by changing to lower water-using crops, water-stressing crops (providing less water than the crop would normally consume for full yield), reducing evaporation losses, and reducing irrigated acreage. Urban users can respond to demand management through lower water-using landscapes, reducing evaporative losses, or reducing landscape requiring irrigation.

The ECC member water agencies have a range of options for implementing demand management, if required. These would only be included as part of GSP implementation as needed in any areas where sustainable groundwater conditions are not maintained. Through reducing overall water demand, this action would potentially provide a benefit to all measurable objectives.

General types of demand management programs include:

- **Allocation**. An allocation may be directly coupled with pumping limits. Under an allocation, the different sources of groundwater are quantified and allocated to individual parcels, wells, or entities (such as, for example, farming operations). By defining the quantities of groundwater available to individuals, this can incentivize reductions in use and development of new recharge opportunities. An allocation is a rigid method for implementing demand management. It effectively limits water use on a well, parcel, or operation basis. This could require idling land or switching crop or landscape on lands that have insufficient allocation to meet irrigation demand, which imposes costs on water users (e.g., growers). There are ways to increase the flexibility of allocations to reduce the costs of demand management. For example, the allocation could be defined as an average over a period of time rather than a fixed amount every year, or users could be allowed to carry over unused allocation into the next year.
- **Allocation + Water Market**. An allocation that is less than historical water use can be coupled with a water market. A groundwater market is another way to increase the flexibility of an allocation to reduce costs of demand management. A market is an institution that allows willing buyers and sellers to exchange groundwater allocation ("credits"). More broadly, a market creates a means to exchange allocation with another groundwater user, whether for a single season or using a multi-year trade. Willing sellers trade a part of their allocation to willing buyers in exchange for a payment that the seller expects will exceed the return he/she would have earned from using the water for irrigation. This additional flexibility reduces the cost to the GSA's users of achieving demand reduction under an allocation. Development of a water market institution is a complex process that encompasses more than defining the groundwater allocation. This investigation would be initiated by the GSAs in the future, if needed.
- **Land Repurposing**. Land repurposing programs are more targeted than an allocation or market program but maintain flexibility for participants by its voluntary nature. Such a program would provide a financial incentive to willing participants for their currently irrigated lands to be repurposed into other, non-irrigated uses. Programs can focus on short-term drought conditions,

or they can provide multi-year reductions in demand if that is needed under some conditions. For longer-term programs, lands can be repurposed to achieve other multi-benefit objectives - for example, to create habitat corridors or to support local endangered species.

- **Other financial incentives**. Demand management can also be achieved through a range of other financial incentives. This could include positive financial incentives to reduce consumptive groundwater use. It could also include groundwater extraction fees that disincentivize groundwater use.

Measurable Objective Expected to Benefit

Depending on how the demand management program is structured, it has the potential to benefit all measurable objectives in the ECC Subbasin.

Management Action Status:

This management action is currently conceptual and would only be employed as needed by one or more GSAs.

Required Permitting and Regulatory Process:

No additional permitting would be required.

Expected Benefits and Evaluation:

The expected benefit is preventing lowering of groundwater levels and reduction in groundwater storage, where and when this may be needed. Water quality and other benefits may also be present depending on the specific program deployed. These will be monitored as described in **Section 6**.

How Management Action Will Be Accomplished:

The GSA or GSAs that elect to implement a demand management program would first initiate a study for the program design. This would include assessing program goals, incentives, and potential program structure. It would also involve substantial stakeholder outreach and engagement. Program design would include an assessment of the economic impacts of alternative demand management strategies to identify ways to minimize costs to individuals, businesses, and the regional economy in affected areas.

Legal Authority:

GSAs have the authority to plan and implement management actions. Each GSA in the Subbasin has the authority to implement and enforce this management action if needed based on aquifer conditions.

Estimated Costs and Plans to Meet Costs:

Since this management action is in the conceptual phase, specific costs are not yet determined. Costs would be assessed as part of the demand management program design.

Circumstances for Implementation:

Groundwater conditions are projected to remain at sustainable levels into the future under GSP implementation, as described in **Section 7**. This management action would be implemented and would be monitored and quantified with respect to groundwater conditions, as needed, if and only if sustainable conditions are not maintained in any areas of the Subbasin during GSP implementation. This will be determined by the methods described in **Section 6**.

Notice to Public and Other Agencies

Public noticing for this management action would be done in accordance with noticing requirements and in public meetings held by the GSA or GSAs which elect to implement this management action, if needed. Additionally, and as appropriate depending on the structure of the program, Contra Costa County will notify new well permit applicants to identify and comply with the requirements of their GSA.

8.2.1.7 Management Action 5: State Programs for Domestic Well Users

A GSA may engage existing and developing state programs to monitor and strengthen resiliency of domestic well users including DACs and vulnerable populations that use groundwater. They are located at the following links:

- https://mydrywell.water.ca.gov/report/shortage_resources
- https://mydrywell.water.ca.gov/report/
- https://water.ca.gov/Programs/Groundwater-Management/Drinking-Water-Principles

Measurable Objective Expected to Benefit

This management action would help to identify significant and unreasonable impacts from lowering of groundwater levels, reduction in groundwater storage, and degradation of groundwater quality.

Management Action Status:

This management action is currently conceptual and will be employed by one or more GSAs to enhance outreach and information exchange with key groundwater users in the basin.

Required Permitting and Regulatory Process:

No additional permitting would be required.

Expected Benefits and Evaluation:

The expected benefit is reporting of groundwater level drawdown and degradation of groundwater quality. These programs may be expanded in the future and would be incorporated into Annual Reports.

How Management Action Will Be Accomplished:

GSAs will notify their constituency that these programs are available.

Legal Authority:

GSAs have the authority to plan and implement management actions. Each GSA in the Subbasin has the authority to provide the information in this management action if needed desired.

Estimated Costs and Plans to Meet Costs:

No costs are expected at this time.

Circumstances for Implementation:

If constituents are concerned about sustainability and protection of drinking water, GSAs would seek to facilitate participation in these state programs

Notice to Public and Other Agencies

Public noticing for this management action would be done in accordance with noticing requirements and in public meetings held by the GSA or GSAs which elect to implement this management action.

8.2.2 Other Water Conservation Actions

The ECC member water agencies have a full range of existing water conservation policies and programs promoting efficient water use. Like the other management actions listed, these would be included as part of GSP implementation as needed in any areas where sustainable groundwater conditions are not maintained. The various conservation efforts proposed by different GSAs and other agencies could provide benefits to all measurable objectives, as needed. Some of these actions are ongoing or have been implemented previously, while others are in the conceptual or planning phase. Additional permitting should not be required for any of these actions, and the County will notify new well permit applicants to identify and comply with the requirements of their GSA. Benefits to groundwater levels would be monitored using the methods described in **Section 6.** Specific costs have not been established for actions in the conceptual phase. For those that are planned or already implemented, costs beyond what the agencies already incur should be minimal.

Groundwater conditions are projected to remain at sustainable levels into the future under GSP implementation, as described in **Section 7**. However, if sustainable levels are not maintained in any areas of the Subbasin during initial GSP implementation, management actions may be implemented and their effects would be monitored and quantified with respect to groundwater conditions, as needed. This will be determined by the methods described in **Section 6**. Public noticing for these actions would be done in accordance with noticing requirements and in public meetings held by the GSA or GSAs which elect to implement the actions as part of the GSP, if needed. Additionally, Contra Costa County will notify new well permit applicants to identify and comply with the requirements of their GSA.

Table 8-5 summarizes key water conservation efforts listed by GSA in corresponding Urban Water Management Plans and Agricultural Water Management Plans. Plans include those listed for the City of Antioch, City of Brentwood, Diablo Water District, Town of Discovery Bay Community Services District, BBID, and CCWD. While CCWD is not a GSA, the District has several water conservation plans.

Table 8-5. Summary of Water Conservation Programs Listed in Urban Water Management Plans and Agricultural Water Management Plans

Programs	City of Antioch[1]	City of Brent-wood[1]	Diablo Water District[2]	Discovery Bay[3]	BBID[4]	CCWD[5]
Water Waste Prevention Ordinances	X	X	X	X	X	X
Metering	X	X	X	X	X	X
Conservation Pricing	X	X	X	X	X	X
Public Education and Outreach	X	X	X	X	X	X
Programs to Assess Management Distribution System Real Loss	X	X	X	X	X	X
Water Conservation Program and Coordination Staffing Support	X	X	X	X	X	X
Increasing Water Order Flexibility					X	
Providing for Availability of Water Management Services					X	X
Rebates for Lawn Replacements						X

1. Brown and Caldwell (2021)
2. CDM Smith (2021)
3. LSCE (2021)
4. CH2M (2017)
5. CCWD (2021)

8.3 References

Brown and Caldwell. 2021. Final 2020 Urban Water Management Plan. Prepared for City of Antioch. May 2021.

Brown and Caldwell. 2021. Draft 2020 Urban Water Management Plan. Prepared for City of Brentwood. May 2021.

Contra Costa Water District. 2021. Draft 2020 Urban Water Management Plan. April 2021.

CDM Smith (CDM). 2021. Draft 2020 Diablo Water District Urban Water Management Plan. May 2020.

CH2M.2017.Byron Bethany Irrigation District Agricultural Water Management Plan. Prepared for Byron Bethany Irrigation District. October 2017.

East County Water Management Association. 2019. East Contra Costa County Integrated Regional Water Management Plan, Update 2019. March 2019

Legislative Analyst's Office (LAO). 2017. Residential Water Use TRENDS AND Implications for Conservation Policy. https://lao.ca.gov/Publications/Report/3611#top.Accessed June 2021.

Luhdorff and Scalmanini, Consulting Engineers. 2021. Draft 2020 Urban Water Management Plan Town of Discovery Bay Community Services District. March 2021.

SECTION 9 CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

9 PLAN IMPLEMENTATION

This section outlines the schedule and costs to implement the Groundwater Sustainability Plan (GSP) over the first five years and discusses implementation effects in accordance with GSP regulations, CCR §354.6(e) and §354.8(f)(3), in addition to the annual and 5-year evaluation reporting in accordance with GSP regulations CCR §356.2 and §356.4. The implementation plan is based on the hydrogeologic conceptual model of the East Contra Costa Subbasin (Subbasin) (**Section 3**), current and projected water demands (**Section 4**), and the projected water budget (**Section 5**). Estimated costs are developed to meet GSP regulations and to implement PMAs under **Section 8**. Costs include annual and 5-year reports as required under GSP regulations (CCR §356.2 and §356.4).

To achieve the Subbasin sustainability goal by 2042 and avoid undesirable results through 2072 as required by SGMA and the GSP regulations, a range of Projects and Management Actions (PMAs) will be developed and implemented by the GSAs. **Section 8** describes each PMA, gross benefit, project capital and operating costs, and how it will be implemented. This section describes:

- Costs for GSAs to administer GSP activities (not including the project-specific costs described in **Section 8**), as required by CCR § 354.6(e).
- Financing approaches.
- Timeline for implementing all GSA PMAs between 2022 and 2042.
- Monitoring and reporting, including the contents of annual reports and 5-year periodic evaluations that the GSAs must provide to DWR (CCR §356.2 and §356.4).

9.1 Estimate of GSP Implementation Costs

The seven GSAs and Contra Costa Water District (CCWD) are exploring whether amendments to the existing MOU, new MOU or other cooperative agreement will be used to administer and implement the ECC GSP.It is anticipated that an annual operating budget will be established that is considered for approval by each GSA. The initial development of the GSP was funded by the GSAs and CCWD with help from grant funding under Proposition 1. No fees have been charged to landowners and water users in the Subbasin. It is anticipated that funding and financing sources—including potential fees—will be developed to cover the costs of GSP implementation, development of PMAs, annual reports, and 5-year periodic evaluations of the GSP. Groundwater management fees, as authorized through SGMA, may be adopted by GSAs based on their needs and applicable to their jurisdictions only.

Implementation of the GSP includes project and management actions discussed in **Section 8** and the following:

- **GSA Administration:** Public Outreach, Legal Services, and other tasks.
- **GSP Implementation:** Implementation Agreement, Grant Writing, Internal Coordination and Meetings.
- **GSP Updates:** Addressing Comments from DWR on the GSP, Annual Reports, Periodic (5-year) Evaluations, GSP Studies.
- **Monitoring and Data Management:** Monitoring of Wells, Metering and Monitoring Water Use, DMS.
- **Contingency**

The following subsections describe these cost components in greater detail and the estimated costs for these activities are summarized in Section 9.2. In this section, costs are not included for project development or implementation. It is anticipated that each GSA will generate revenue to cover its PMA costs using its available legal authorities.

9.1.1 GSA Administration

Administration may be performed through outside services, agency staff, or a combination. Administrative costs generally include record keeping, bookkeeping, continued outreach to stakeholders, legal services, government relations, and general management. GSA administration also includes project and contract management for external services for GSP implementation and technical studies for PMAs. It is anticipated that some administrative tasks will have a lead GSA.

9.1.1.1 Public Outreach

Each GSA will conduct public outreach and engagement to provide timely information to stakeholders regarding GSP progress and Subbasin conditions. A GSP Working Group will meet regularly to inform participating agencies and the public regarding implementation activities and reporting. Any changes in administration and management will be conducted through a public process in which stakeholders will be engaged for input into the decision-making process.

The GSP Working Group will routinely meet at a regular frequency to be determined through the implementation agreement to implement the GSP. The Working Group will provide information to the public about GSP implementation and the status of groundwater sustainability in the Subbasin. The GSP website[1] will be maintained as a communication tool for posting updated groundwater level time series graphs, reports, meeting information, technical updates and data analyses. Other outreach starting in 2022 includes an electronic newsletter, board notifications, and inter- and intra-Subbasin coordination.

Most GSAs have included public outreach costs under general GSA Administration, however, others include public outreach as part of GSP Implementation costs. Therefore, GSP implementation costs vary across GSAs for public outreach activities (**Section 9.1.2**).

9.1.1.2 Legal Services

The ECC Working Group currently receives in-kind legal services from Contra Costa County on an as-needed basis. If legal services are needed on issues requiring specific expertise in groundwater, SGMA compliance, or other specialized matters, the ECC Working group may engage outside counsel. Costs for such services are not currently anticipated and are not included in the current budget estimates. Any legal costs would be authorized separately by the GSP Working Group on an as-needed basis. GSA legal services costs included in the GSP are for general legal review and retainers.

[1] https://www.eccc-irwm.org/about-sgma

9.1.2 GSP Implementation

The GSAs will be responsible for GSP implementation. The GSAs implementing the ECC Subbasin GSP anticipate this will involve substantial coordination across GSAs for technical tasks. For example, many planned PMAs require coordination between one or more GSAs. The overall Subbasin sustainability depends on continued coordination, planning, and evaluation of groundwater conditions.

The lead GSA, or GSAs, for each implementation task will keep the other GSAs informed through periodic updates to stakeholders, the public, the GSP Working Group, and any other ad-hoc committees.

9.1.2.1 Implementation Agreement

The GSAs and CCWD will enter into a joint implementation agreement after the GSP is approved by DWR. Cost sharing to fund GSP implementation, as described in this section, will be part of the joint agreement.

9.1.2.2 Grant Writing

DWR and other agencies may release solicitation packages for grants to assist medium priority subbasins in funding PMA development and GSP implementation. The GSP Working Group will review future grant solicitations from DWR and other state and federal agencies and be responsible for grant writing and submission. The Working Group may engage outside services to assist in grant writing. It is anticipated that the GSAs may also engage outside services to implement grant activities (e.g., development of planned PMAs).

9.1.2.3 Internal Coordination and Meetings

The GSP Working Group will meet at a regular frequency to be determined through the Implementation agreement to implement the GSP. GSAs will regularly hold board meetings, committee meetings, and other public meetings throughout the year to discuss updates and ongoing initiatives.

9.1.3 GSP Updates

In addition to finalizing the GSP, GSP regulations require submittal of annual reports and 5-year GSP assessment reports to DWR. The elements of these reports shall comply with DWR technical guidance and requirements and be made available to the public.

9.1.3.1 Response to DWR Comments on the ECC GSP

As applicable, responses or revisions to the GSP based on DWR review comments will be made and authorized through the GSP Working Group.

9.1.3.2 Annual Reports

Annual reports will be submitted to DWR starting on April 1, 2022. The contents of the report are detailed in **Section 9.5** below. Annual reports will be available to ECC Subbasin stakeholders on the ECC GSP website. The reports may be prepared by a technical consultant, agency staff designated by the GSP Working Group, or a combination of the two. The estimated cost of the annual report is presented in **Table 9-1** based on typical rates for technical consulting services. GSAs expect that annual reports will also require inter- and intra-GSA coordination as well as stakeholder outreach.

Table 9-1. ECC GSP Estimated Joint Implementation Costs

Cost Category	2022	2023	2024	2025	2026
Community Outreach & Education	$10,000 to $25,000	$10,000 to $25,000	$10,000 to $25,000	$10,000 to $25,000	$10,000 to $25,000
Monitoring and Data Management	$45,000	$45,000	$45,000	$45,000	$45,000
GSP Updates[1]	$33,000 to $50,000	$33,000 to $50,000	$48,000 to $65,000	$48,000 to $65,000	$140,000 to $500,000
Grant Writing	$25,000	$25,000	$25,000	$25,000	$25,000
Contingency	$11,300 to $14,500	$11,300 to $14,500	$12,800 to $16,000	$12,800 to $16,000	$22,000 to $59,500
Total	$124,300 to $159,500	$124,300 to $159,500	$140,800 to $176,000	$140,800 to $176,000	$242,000 to $654,500

1. Annual reports and 5-Year Update.

9.1.3.3 Periodic (5-year) Assessments

Periodic (5-year) GSP assessment reports will be submitted to DWR starting in 2027. The GSAs will evaluate the GSP at least every five years to assess whether GSP implementation is achieving the sustainability goal for the Subbasin. The contents for this report are detailed in **Section 9.5** below. The estimated cost of the 5-year evaluations is presented in **Table 9-1** based on typical rates for technical consulting services. 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. It may also include substantial updates to the GSP, if monitoring of groundwater conditions show that the GSP is not achieving the sustainability goal. GSAs expect that periodic evaluations will also require significant inter- and intra-GSA coordination and stakeholder outreach.

9.1.3.4 GSP Studies

GSP implementation will require various planning, technical, and economic/financial studies. These are additional costs that are not covered by the cost of specific PMAs (see **Section 8**). For example, this may include planning studies for proposed PMAs and studies to assess and allocate PMA and GSP implementation costs. GSAs will also need to continue to monitor PMAs to assess their benefit, update implementation, and coordinate with stakeholders and other GSAs. This may include modifying PMAs to ensure the Subbasin meets its sustainability objectives. These reports and analyses may be prepared by a technical consultant, agency staff designated by the GSP Working Group, or a combination of the two.

9.1.3.4.1 Planning Studies

GSAs may develop planning studies to integrate the GSP with other regional water management efforts, monitor Subbasin conditions, and update the GSP to ensure that the Subbasin continues to meet all sustainability objectives. GSAs will continue to evaluate Subbasin conditions and may adjust short- and long-term Subbasin planning efforts accordingly. Other planning studies may include evaluating projects and developing other programs to support sustainable management.

9.1.3.4.2 Technical Evaluations

Annual and 5-year reports will require additional technical analysis. GSAs will continue to monitor data pertaining to sustainability indicators in the Subbasin to document progress toward sustainability objectives. Additional monitoring wells may be installed in an adaptive process, and GSAs will evaluate and report groundwater conditions, water use, and change in groundwater storage as required by DWR. GSAs will continue to evaluate data gaps and implement programs to improve data quality and applicability.

9.1.3.4.3 Economic/Financial Analyses

GSAs may develop economic and fiscal studies to support implementation of PMAs and the overall GSP. This may include feasibility assessments for proposed projects, or to support development of grant applications. Other financial analyses may include rate studies and supporting technical analysis required to implement fees or assessments to cover costs. GSAs would engage legal and technical experts to help develop the required studies.

9.1.4 Monitoring and Data Management

Monitoring of the six sustainability indicators as described in **Sections 6** and **7** shall be performed as part of the GSP implementation. **Section 6** identifies the monitoring networks for the ECC GSP and **Section 7** describes the management criteria for SGMA sustainability indicators. The ECC GSP monitoring networks incorporate existing monitoring conducted by the GSAs and other agencies. The GSAs will continue their individual monitoring programs as outlined in **Section 6** to satisfy the requirements under the GSP. The ECC GSP does not fund these individual monitoring efforts and these costs are not included in the overall cost to implement the GSP.

9.1.4.1 Monitoring of Wells

Monitoring and well maintenance costs reported in Section 9.2 include four new well installations that are required to fill data gaps discussed in Section 6. Additionally, appendix 9a gives a detailed table of monitoring costs of the new wells.

9.1.4.2 Metering and Monitoring Water Use

Some GSAs may introduce a program to meter and monitor groundwater pumping. Costs reported by the GSAs would be associated with direct costs to the individual GSA. The capital and operating costs associated with the flow meters and monitoring equipment will be determined at the time of adoption by the GSA. Costs may be borne by the well owner or another entity other than the GSA or could be funded under future grant opportunities from state or federal sources.

9.1.4.3 Data Management System

Data from the various monitoring sources is included in the DMS discussed in **Section 6**. The DMS will be updated with monitoring network data and will be used to prepare reports made publicly available on the ECC GSP website. The DMS will be used for analysis and will be presented in various forms to enhance interpretation and to demonstrate basin conditions with respect to sustainability indicators. As required by DWR, certain data will be uploaded to the SGMA portal twice per year.

9.1.4.4 Well Inventory Program

As discussed in **Section 6**, a well inventory program shall be created to be completed by the first 5-year GSP evaluation and report. The well inventory will be developed as a tool to better understand how GSP implementation is affecting groundwater sustainability in the Subbasin.

The process of creating a well inventory will be coordinated with the Contra Costa County which is the permitting agency for new wells in the ECC Subbasin. A procedure for sharing information on all new wells constructed under the County's permitting authority with the ECC Subbasin Data Management System shall be developed. The well inventory system will track various parameters including:

- Well location (physical address) and GIS coordinates
- Date installed
- Permit number (County)
- Well Drillers Report number (DWR)
- Depth of well
- Well diameter
- Depths of perforations
- Use (domestic, industrial, commercial, agricultural, other)

A method to incorporate wells constructed prior to implementation of the new data exchange system will be evaluated with the objective that the DMS substantially accounts for active wells in the Subbasin to serve the sustainable management goals as detailed in **Section 7.**

9.1.5 Contingency

An additional GSA contingency cost is included for planning purposes. This may include actions needed to respond to critically dry years or if Subbasin conditions start trending towards minimum threshold levels in any area. The GSA budgets include a 10-percent annual contingency to account for unanticipated expenses (see **Table 9-1**). This is in addition to other contingency costs identified and reported by some GSAs.

9.2 GSA Implementation Costs

This section summarizes GSP implementation activities and estimated budgets for the first five years of GSP implementation. This does not include PMAs that are discussed in **Section 8**. The estimated 5-year budget for total GSA implementation costs is between $2.4 and $3.0 million. The estimated annual cost is between $450,000 and $480,000 for most years and could be in excess of $1 million during years when 5-year evaluations and reports are prepared. There also are expected to be additional costs in 2024 and 2025 to address DWR review comments. GSA implementation costs will be paid for through contributions from the member GSAs and CCWD under a cost-sharing arrangement to be developed following GSP adoption. Annual costs for individual GSAs will vary and generally be higher in years when 5-year evaluations and reports are prepared.

There are two components of GSA Implementation costs in the ECC Subbasin: joint implementation costs, which will be shared by the member GSAs, and individual costs for each of the GSAs. Joint implementation costs are summarized in **Table 9-1**. Details are available in **Appendix 9a**. These costs generally are for services provided to complete necessary tasks associated with implementation, including outreach, monitoring, data management, reporting and grant writing. Cost sharing between the GSAs will be determined prior to execution of the joint implementation agreement. There are some uncertainties regarding the joint costs, particularly for the costs to prepare the 5-year evaluation and reports. Therefore, ranges are reported for many of the joint cost categories and totals in **Table 9-1**.

Table 9-2 summarizes the estimated total of individual GSA implementation costs across all GSAs (and CCWD) by year. This is followed by subsections summarizing costs by agency. All costs are preliminary estimates based on the information available as of GSP development. GSAs will evaluate funding needs, opportunities, and update budget projections periodically.

Table 9-2. ECC GSP Estimated Total of Individual GSA Implementation Costs

Cost Category	2022	2023	2024	2025	2026
GSA Administration	$118,550	$111,772	$112,003	$112,245	$122,829
GSP Implementation	$71,539	$71,836	$72,145	$72,467	$88,450
GSP Updates	$19,516	$19,598	$19,683	$19,771	$43,363
Monitoring and Implementation	$62,015	$62,015	$62,015	$62,015	$62,015
Contingency	$48,362	$47,722	$47,785	$47,850	$57,866
Total	**$319,982**	**$312,943**	**$313,631**	**$314,348**	**$374,523**

Other costs borne by each of the GSAs are presented in the following subsections. These costs reflect local needs and engagement that are unique to each agency’s area and may change based on future assessment of conditions in the subbasin.

9.2.1 Byron-Bethany Irrigation District GSA

The Byron-Bethany Irrigation District GSA (BBID) estimates that annual implementation costs will be approximately $47,860 per year over the next five years (**Table 9-3**). GSA Administration includes public outreach and legal services. GSP Implementation includes public outreach, internal coordination, committee meetings, and board meetings. GSP Updates includes GSP document review. Monitoring and Implementation covers well monitoring, metering water use, and DMS costs. Contingency includes GSP management and legal services. The budget also includes a 10-percent annual contingency to account for unanticipated expenses. These costs do not include project-specific costs, described in **Section 8**, nor costs to build and operate additional PMAs that may be required if the GSA determines that its sustainability objectives are not being met.

BBID will recover GSP implementation costs through grants and local revenues that are yet to be determined. The GSA is currently evaluating options. **Section 9.3** provides a general description of how BBID and other GSAs may recover GSP implementation costs.

Table 9-3. BBID GSA Implementation Costs

Cost Category	2022	2023	2024	2025	2026
GSA Administration	$22,000	$22,000	$22,000	$22,000	$22,000
GSP Implementation	$11,920	$11,920	$11,920	$11,920	$11,920
GSP Updates	$1,000	$1,000	$1,000	$1,000	$1,000
Monitoring and Implementation	$2,950	$2,950	$2,950	$2,950	$2,950
Contingency	$9,987	$9,987	$9,987	$9,987	$9,987
Total	**$47,857**	**$47,857**	**$47,857**	**$47,857**	**$47,857**

9.2.2 City of Antioch GSA

The City of Antioch GSA estimates that annual implementation costs will be approximately $17,600 per year over the next five years (**Table 9-4**). GSA Administration includes public outreach and legal services. GSP Implementation includes public outreach, internal coordination, committee meetings, and board meetings. Monitoring and Implementation covers well monitoring, metering water use, and DMS costs. The budget also includes a 10-percent annual contingency to account for unanticipated expenses. These costs do not include PMA-specific costs, described in **Section 8**, nor costs to build and operate additional projects or management actions that may be required if the GSA determines that its sustainability objectives are not being met.

The City of Antioch GSA will recover GSP implementation costs through grants and local revenues that are yet to be determined. The GSA is currently evaluating options. **Section 9.3** provides a general description of how City of Antioch GSA and other GSAs may recover GSP implementation costs.

Table 9-4. City of Antioch GSA Implementation Costs

Cost Category	2022	2023	2024	2025	2026
GSA Administration	$4,500	$4,500	$4,500	$4,500	$4,500
GSP Implementation	$8,000	$8,000	$8,000	$8,000	$8,000
Monitoring and Implementation	$3,500	$3,500	$3,500	$3,500	$3,500
Contingency	$1,600	$1,600	$1,600	$1,600	$1,600
Total	**$17,600**	**$17,600**	**$17,600**	**$17,600**	**$17,600**

9.2.3 City of Brentwood GSA

The City of Brentwood GSA estimates that annual implementation costs will be approximately $13,500 per year over the next five years (**Table 9-5**). GSA Administration includes public outreach and legal services. GSP Implementation includes public outreach. Monitoring and Implementation covers well monitoring. The budget also includes a 10-percent annual contingency to account for unanticipated expenses. These costs do not include project-specific costs, described in **Section 8**, nor costs to build and operate additional projects or management actions that may be required if the GSA determines that its sustainability objectives are not being met.

The City of Brentwood GSA will recover GSP implementation costs through grants and local revenues that are yet to be determined. The GSA is currently evaluating options. **Section 9.3** provides a general description of how the City of Brentwood GSA and other GSAs may recover GSP implementation costs.

Table 9-5. City of Brentwood GSA Implementation Costs

Cost Category	2022	2023	2024	2025	2026
GSA Administration	$6,130	$6,130	$6,130	$6,130	$6,130
GSP Implementation	$3,065	$3,065	$3,065	$3,065	$3,065
Monitoring and Implementation	$3,065	$3,065	$3,065	$3,065	$3,065
Contingency	$1,226	$1,226	$1,226	$1,226	$1,226
Total	**$13,486**	**$13,486**	**$13,486**	**$13,486**	**$13,486**

9.2.4 Contra Costa Water District

CCWD, although not a GSA, will be active in GSP implementation and will therefore incur associated costs. CCWD estimates that annual implementation costs will be approximately $7,000 per year over the next five years (**Table 9-6**). GSA Administration includes public outreach. GSP Implementation includes internal coordination, committee meetings, and board meetings. GSP Updates include GSP document review. The budget also includes a 10-percent annual contingency to account for unanticipated expenses. These costs do not include project-specific costs, described in **Section 8**, nor costs to build and operate additional projects or management actions that may be required if the CCWD determines that its sustainability objectives are not being met.

CCWD will recover GSP implementation costs through grants and local revenues that are yet to be determined. CCWD is currently evaluating options. **Section 9.3** provides a general description of how CCWD and the GSAs may recover GSP implementation costs.

Table 9-6. CCWD Implementation Costs

Cost Category	2022	2023	2024	2025	2026
GSA Administration	$1,257	$1,295	$1,333	$1,373	$1,415
GSP Implementation	$3,769	$3,882	$3,998	$4,118	$4,242
GSP Updates	$966	$995	$1,025	$1,055	$1,087
Contingency	$599	$617	$636	$655	$674
Total	**$6,591**	**$6,789**	**$6,992**	**$7,201**	**$7,418**

9.2.5 County of Contra Costa GSA

The County of Contra Costa GSA estimates that annual implementation costs will be approximately $33,000 per year over the next five years (**Table 9-7**). Annual costs are projected to be higher when a 5-year evaluation and report is prepared. GSA Administration includes public outreach and legal services. GSP Implementation includes public outreach, internal coordination, committee meetings, and board meetings. The budget also includes a 10-percent annual contingency to account for unanticipated expenses. These costs do not include PMA-specific costs, described in **Section 8**, nor costs to build and operate additional projects or management actions that may be required if the GSA determines that its sustainability objectives are not being met.

The County of Contra Costa GSA will recover GSP implementation costs through grants and local revenues that are yet to be determined. The GSA is currently evaluating options. **Section 9.3** provides a general description of how the County of Contra Costa GSA and other GSAs may recover GSP implementation costs.

Table 9-7. County of Contra Costa GSA Implementation Costs

Cost Category	2022	2023	2024	2025	2026
GSA Administration	$13,988	$6,988	$6,988	$6,988	$15,317
GSP Implementation	$18,610	$18,610	$18,610	$18,610	$25,256
Contingency	$3,260	$2,560	$2,560	$2,560	$4,057
Total	**$35,858**	**$28,158**	**$28,158**	**$28,158**	**$44,630**

9.2.6 Diablo Water District GSA

DWD estimates that annual implementation costs will be approximately $140,400 per year over the next five years (**Table 9-8**) and $164,650 in 2026 when the 5-year evaluation and report will be prepared. GSA Administration includes public outreach, legal services, and staff time. GSP Implementation includes public outreach, internal coordination, committee meetings, and board meetings. GSP Updates include GSP document review, which will be higher in years when a 5-year assessment is prepared. Monitoring and Implementation covers well monitoring, metering water use, and DMS costs. Contingency includes GSP management and legal services, plus a 10-percent annual contingency to account for unanticipated expenses. These costs do not include project-specific costs, described in **Section 8**, nor costs to build and operate additional projects or management actions that may be required if the GSA determines that its sustainability objectives are not being met.

DWD will recover GSP implementation costs through grants and local revenues that are yet to be determined. The GSA is currently evaluating options under its current legal authorities. **Section 9.3** provides a general description of how DWD and other GSAs may recover GSP implementation costs.

Table 9-8. DWD GSA Implementation Costs

Cost Category	2022	2023	2024	2025	2026
GSA Administration	$60,000	$60,000	$60,000	$60,000	$60,000
GSP Implementation	$10,500	$10,500	$10,500	$10,500	$10,500
GSP Updates	$7,500	$7,500	$7,500	$7,500	$25,000
Monitoring and Implementation	$36,000	$36,000	$36,000	$36,000	$36,000
Contingency	$26,400	$26,400	$26,400	$26,400	$33,150
Total	**$140,400**	**$140,400**	**$140,400**	**$140,400**	**$164,650**

9.2.7 Discovery Bay Community Services District GSA

The Discovery Bay Community Services District GSA estimates that annual implementation costs will be approximately $10,000 per year over the next five years (**Table 9-9**). GSA Administration includes public outreach and legal services. GSP Implementation includes public outreach, internal coordination, committee meetings, and board meetings. GSP Updates includes GSP document review. The budget also includes a 10-percent annual contingency to account for unanticipated expenses. These costs do not include project-specific costs, described in **Section 8**, nor costs to build and operate additional projects or management actions that may be required if the GSA determines that its sustainability objectives are not being met.

Discovery Bay Community Services District GSA will recover GSP implementation costs through grants and local revenues that are yet to be determined. The GSA is currently evaluating options. **Section 9.3** provides a general description of how Discovery Bay Community Services District GSA and other GSAs may recover GSP implementation costs.

Table 9-9. Discovery Bay Community Services District GSA Implementation Costs

Cost Category	2022	2023	2024	2025	2026
GSA Administration	$3,675	$3,859	$4,052	$4,254	$4,467
GSP Implementation	$3,675	$3,859	$4,052	$4,254	$4,467
GSP Updates	$1,050	$1,103	$1,158	$1,216	$1,276
Contingency	$840	$882	$926	$972	$1,021
Total	**$9,240**	**$9,703**	**$10,188**	**$10,696**	**$11,231**

9.2.8 East Contra Costa Irrigation District GSA

The East Contra Costa Irrigation District GSA (ECCID) estimates that annual implementation costs will be approximately $49,000 per year over the next five years (**Table 9-10**), and $67,650 in FY 2026 when the 5-year evaluation and report will be prepared. GSA Administration includes public outreach and legal services. GSP Implementation includes public outreach, internal coordination, committee meetings, and board meetings. GSP Updates includes GSP document review. The budget also includes a 10-percent annual contingency to account for unanticipated expenses. These costs are all expected to be higher in 2026 when the 5-year evaluation and report will be prepared. Monitoring and Implementation covers well monitoring, metering water use, and DMS costs. These costs do not include PMA-specific costs, described in **Section 8**, nor costs to build and operate additional projects or management actions that may be required if the GSA determines that its sustainability objectives are not being met.

ECC ID will recover GSP implementation costs through grants and local revenues that are yet to be determined. The GSA is currently evaluating options. **Section 9.3** provides a general description of how the ECC ID and other GSAs may recover GSP implementation costs.

Table 9-10. ECCID GSA Implementation Costs

Cost Category	2022	2023	2024	2025	2026
GSA Administration	$7,000	$7,000	$7,000	$7,000	$9,000
GSP Implementation	$12,000	$12,000	$12,000	$12,000	$21,000
GSP Updates	$9,000	$9,000	$9,000	$9,000	$15,000
Monitoring and Implementation	$16,500	$16,500	$16,500	$16,500	$16,500
Contingency	$4,450	$4,450	$4,450	$4,450	$6,150
Total	**$48,950**	**$48,950**	**$48,950**	**$48,950**	**$67,650**

9.3 GSP Funding and Financing

Administering the GSP and monitoring and reporting progress is projected to cost approximately $360,000 per year on average across all Subbasin GSAs and CCWD. Costs are projected to be higher during years in which a 5-year periodic evaluation and report is prepared, and slightly lower during other years when an annual report is prepared. This does not include the capital and annual operating cost of PMAs (see **Section 8**).

Covering the costs of PMAs and general GSP implementation requires evaluating both financing and funding sources. Financing relates to identifying sources of capital (typically bonds and bank loans) to pay for project capital expenses. Funding relates to sources of money required to cover capital repayment (pay back the debt financed projects) as well as project O&M, GSA administration, and other annual expenses.

The agencies in the ECC Subbasin have the powers and authority to impose fees and assessments and may pursue other financing sources for capital projects and funding sources for repayment of debt, operations, and other ongoing expenses. The GSAs also have explicit fee authorities under SGMA legislation (Water Code §10730 and §10730.2). **Table 9-11** summarizes potential financing and funding sources that may be used by GSAs for GSP implementation. Individual GSAs will create their own funding and financing plans to address their portion for the cost share, considering the options available to them.

Table 9-11. Potential Funding and Financing Sources for GSP Implementation

Capital Financing	Considerations
State (DWR) Grants (Prop. 68 and future bonds)	Solicitations are typically targeted to general types of projects and specific benefits that are in the State's interest
US Bureau of Reclamation WaterSmart Grants	Project-specific funding that can support planning studies (e.g., water market strategy grants)
Other targeted potential grant programs (e.g., AB 252)	Potential for multi-benefit projects
Local bond issuance	Local borrowing based on agency authority
Private borrowing	Current low interest rate environment may make these options attractive
State or Federal low interest loans	This could include future bond funded loan programs
Funding Sources	**Considerations**
Fee – General	General options for legal authority pre- and post-GSP development: Prop. 26, Prop. 218, Water Code §10730, Water Code §10730.2
Regulatory Fee	Typically, pre-GSP fee that is related to regulatory cost. Prop. 26 and Water Code §10730
Service Fee	Related to cost of service. Prop 218 and Water Code §10730.2. Subject to majority protest vote
Special Tax	Subject to 2/3 majority approval vote
Special Benefit	Special benefit assessment subject to majority protest vote

The ECC Subbasin has been successful in pursuing past grant funding (e.g., Sustainable Groundwater Planning Grant programs). The GSAs will pursue grant opportunities to fund this GSP implementation and local infrastructure projects. The initial funding for GSP implementation will be provided by the seven GSAs and CCWD through a joint agreement.

GSA annual budgets will be reviewed, revised if needed, and approved by the GSAs based on interpreted basin conditions, past actual expenditures, and the immediate future needs. The budget will be adjusted over time as the GSP implementation costs are better understood through sustainable management activities and guidance from DWR on the submitted GSP and subsequent reporting.

9.4 Schedule for Implementation

The GSP implementation schedule allows time for GSAs to develop and implement PMAs and meet all sustainability objectives by 2042. While some sustainability projects began immediately after SGMA became law and are already contributing to Subbasin goals, the GSAs will begin implementing all other planned GSP activities by 2022. Many PMAs will be implemented adaptively on an as-needed basis as explained in **Section 8**.

A general implementation schedule showing the major tasks and estimated timeline during the 20 years of GSP implementation is provided in **Figure 9-1**. This includes key implementation tasks, projects that are either completed or currently under construction, and required reporting. Projects in the planning phase and management actions detailed in **Section 8** are not included because these are going to be implemented on as needed basis, and likely would not occur if the Subbasin continues to exhibit stable and sustainable conditions.

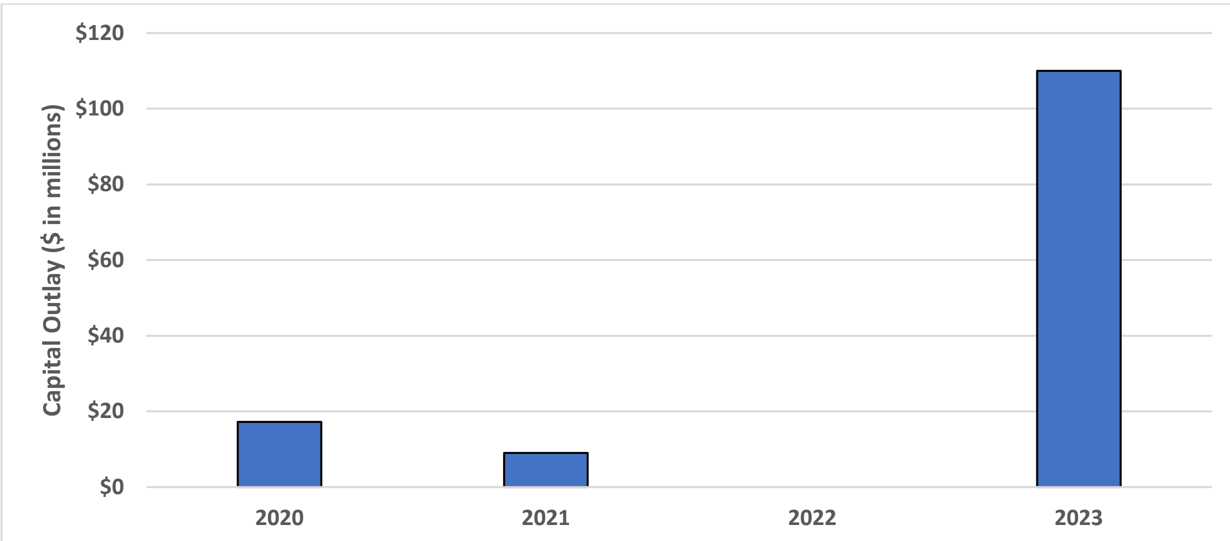
Figure 9-1. General Schedule of 20-year ECC GSP Plan Implementation

Task Name	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Plan Implementation																					
GSP Submittal to DWR	x																				
Joint Implementation Agreement			x																		
Outreach and Communication																					
Monitoring and DMS																					
Projects (Completed or Under Construction)																					
NE Antioch Annexation																					
Non-Potable Storage and Pump Station																					
Dry-Year Water Transfer																					
Brentwood Non-Potable Distribution																					
Antioch Brackish Water Desalination																					
GSP Reporting																					
Annual Reports	x	x	x	x	x		x	x	x	x		x	x	x	x		x	x	x	x	
5-year GSP Evaluation Reports						x					x					x					x

x	Indicates a submittal.
	Indicates ongoing event.

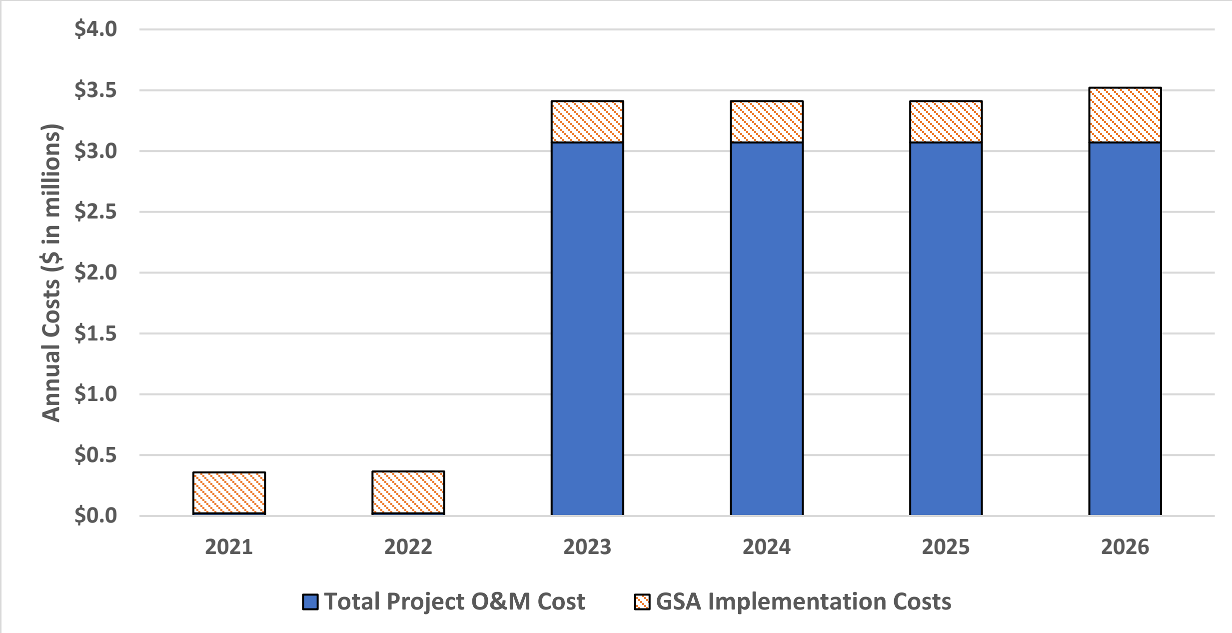
The capital cost of each project and management action is summarized and discussed in more detail in **Section 8**. **Figure 9-2** illustrates the capital outlay required to implement all of the PMAs specified in the GSP that are completed or are under construction. The figure indicates the year that the projects would be completed and begin operation, not when all the capital cost would be incurred. The total capital cost of all these projects equals approximately $136 million. These capital costs do not include the cost of management actions which would be implemented on an as-needed basis.

Figure 9-2. ECC Subbasin Estimated Capital Outlay for Projects



As projects are implemented, GSAs will incur annual operation and maintenance (O&M) costs. **Figure 9-2** illustrates the estimated annual O&M costs (in current dollars) for all GSP projects described in **Section 8** and the GSA annual costs described in **Section 9.2**. Average annual operating costs for projects increase from $21,500 per year in 2022 to over $3 million per year in 2023 when the City of Antioch Brackish Water Desalination Project is expected to go online. Project costs will be refined by GSAs as the GSP is implemented. GSA costs total about $0.3 million per year from 2021 to 2025 and over $0.4 million in 2026 when a 5-year evaluation and report is prepared.

Figure 9-3. ECC Subbasin Estimated Annual Costs for Project O&M and GSA Implementation



9.5 Initial and Subsequent Annual Reporting

Pursuant to CCR §356.2, an annual report shall be submitted to DWR each year by April 1 following adoption of a GSP. The first ECC Subbasin GSP Annual Report is due April 1, 2022 and will cover the period October 1, 2019 through September 30, 2021 and will be annually thereafter. DWR has provided forms and instructions for submitting the materials electronically through the DWR online reporting system[2]. The GSP Annual Report contains both a narrative description and data in DWR provided templates.

The following subsections provide an overview of the basic contents for the Annual Report.

9.5.1 General Information (§356.2(a))

General information includes an executive summary discussing any significant findings or recommendations from the reporting period. Additionally, it will include a map showing the Subbasin and GSA boundaries.

[2] https://sgma.water.ca.gov/portal/#gsp

9.5.2 Subbasin Conditions (§356.2(b))

The subbasin conditions section of the annual report will provide an update on groundwater and surface water conditions in the Subbasin. This will include:

- Groundwater Elevation:
  - Groundwater elevation contour maps by aquifer zone to depict the seasonal high (winter/spring) and seasonal low (late summer/fall).
  - Groundwater elevation hydrographs which illustrate water-year type and incorporate historical data.
- Groundwater Extraction:
  - A table summarizing groundwater extractions by GSAs, estimates of groundwater use by sector (urban, agricultural, industrial, managed wetlands, managed recharge, and native vegetation), measurement method (direct or estimated), and accuracy of the measurements.
  - A map of the general location and quantities of groundwater extractions.
- Surface Water Supply:
- Surface water volume supplied by water source type (e.g., Central Valley Project, State Water Project, Colorado River Project, local supplies, local imported supplies, recycled water, desalination, and others).
- Total Water Use:
- Total water use by source and water use sector.
- Changes in Groundwater Storage:
  - Map of the change in groundwater storage for each principal aquifer in the Subbasin.
  - A graph of historical to the present period showing water-year type, groundwater use, annual change in groundwater storage, and the cumulative change in groundwater storage for the Subbasin.

9.5.3 Plan Implementation Progress (§356.2(c))

The annual report will include a statement of the progress of the GSP implementation with milestones, significant updates or changes, implementation schedule, and implementation tasks and costs which will be reviewed, discussed, and updated as necessary.

9.5.4 GSP Annual Report Module

All parts of the ECC GSP Annual Report are uploaded through the SGMA Portal consisting of the following parts:

- Part A. Groundwater Extractions excel file: volume extracted by water use sector (e.g., urban, industrial, agricultural, managed wetlands, managed recharge, native vegetation, and other).
- Part B. Groundwater Extraction Methods excel file: volume extracted by methods (e.g., meters, electrical records, land use, groundwater model, or other).
- Part C. Surface Water Supply excel file: water supply volume by water source type (e.g., Central Valley Project, State Water Project, Colorado River Project, local supplies, local imported supplies, recycled water, desalination, and other).

- Part D. Total Water Use excel file: total water use volume by water use sector and by water source type.
- Part E. Change in Storage.
- Part F. Monitoring Network Module: information updated as needed.
- Part G. GSP Annual Report PDF and GSP Annual Report Elements Guide Template: upload the GSP Annual Report pdf and populate the Elements Guide template.
- Part H. GSP Annual Report Submittal.

9.6 Periodic (5-Year) Evaluation and Reporting

The GSP will be evaluated every five years in accordance with CCR §356.4, with interim evaluations made in response to significant hydrologic changes or exceedances of minimum thresholds as discussed above. The periodic evaluation will be provided to DWR and shall include elements of the annual reports, GSP implementation progress, and progress toward meeting the sustainability goal of the Subbasin. The periodic evaluations will be available to interested parties and the public through the DWR website.

The following subsections summarize what will be included in the periodic evaluation and report.

9.6.1 Sustainability Evaluation (§356.4(a) - §356.4(d))

An evaluation and description of current groundwater conditions will be included for each applicable sustainability indicator relative to the measurable objectives, interim milestones, minimum thresholds, and undesirable results. A summary of interim milestones and measurable objectives will be included, along with an evaluation of groundwater elevations in relation to minimum thresholds. If any minimum thresholds are found to be exceeded, the GSAs will investigate probable causes and implement actions to correct conditions, as warranted. However, exceedance of a minimum threshold does not automatically trigger corrective action, as the exceedance may be due to factors beyond the control of the GSA. As established in **Section 7**, groundwater conditions in the ECC Subbasin exhibit stability and sustainability, so this scenario is unlikely.

Projects described in **Section 8** will be evaluated to determine their implementation status, success, and progress toward reaching the GSP sustainability goal. If projects or management actions are not performing as expected, and in the unexpected case that sustainable conditions are not maintained in the Subbasin, the update will describe steps the GSAs will take to implement additional projects or demand management. Any changes to the implementation schedule of PMAs will be described in the periodic evaluation.

Elements of the GSP will be evaluated for any potential reconsiderations or revisions, which will be proposed in the periodic evaluation. The sustainability indicators will be evaluated for undesirable results, and minimum thresholds and measurable objectives will be reconsidered with revisions proposed, if necessary. Evaluation will include the progress of the GSP toward meeting the sustainability goal and interim milestones. If conditions become worse than projected because any projects or management actions are not implemented according to the specified timeline, the deviation from the original plan will be documented and to the extent possible, corrective actions will be taken to speed implementation if necessary.

Each periodic evaluation will include an assessment of the basin setting in relation to any significant or unanticipated changes or new information that may have developed during the evaluation period. Also, land uses and economic conditions will change in ways that cannot be anticipated at this time. As such, it may be necessary to revise the GSP to account for these changes. The elements of the GSP including the basin setting, management areas, 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.

9.6.2 Monitoring Network Description (§356.4(e))

A description of the established ECC Subbasin Monitoring Network will be provided in the periodic evaluation and will include a description of potential data gaps, areas within the basin that are represented by data that does not meet the Data and Reporting Standards set by SGMA, and an assessment of the monitoring network functionality. If necessary, the evaluation will include actions necessary to improve the monitoring network, identification of data gaps, a program to acquire additional data sources (and the timing of such), and a plan to install new data collection facilities.

9.6.3 New Information (§356.4(f))

GSAs will continuously monitor Subbasin conditions, and the DMS will allow GSAs to identify additional data gaps and implement procedures to secure additional data. Land use and economic incentives for farming and other water uses in the Subbasin will continue to change as the GSP is implemented. GSAs expect that new information about groundwater conditions, PMAs, and sustainability objectives will continue to be available. Any significant, new information that has been developed since GSP adoption, amendment or the last periodic evaluation will be discussed, and will indicate whether new information warrants changes to any aspect of the GSP, including the basin setting, measurable objectives, minimum thresholds, or undesirable results.

9.6.4 GSA Actions ((§356.4(g) - §356.4(h))

The evaluation will include a description of any relevant actions taken by the GSAs since the last periodic or 5-year assessment including any regulations or ordinances related to the GSP, development of new PMAs, substantial changes in land use, and other actions impacting the implementation of the GSP. Within their allowed authorities, GSAs are evaluating new regulations or ordinances that could be implemented to help maintain sustainable conditions in the Subbasin. The 5-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 sustainability in the Subbasin. The effect on any aspect of the GSP, including the basin setting, measurable objectives, minimum thresholds, or undesirable results will be described.

9.6.5 Plan Amendments, Coordination, and Other Information (§356.4(i) - §356.4(k))

The evaluation will include a description of any completed or proposed Amendments to the GSP. 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, or other Subbasin coordination agreements will be documented and summarized. If necessary, a description of the coordination of GSAs within the Subbasin, coordination between hydrologically connected subbasins, and land use agencies will be presented.

The Periodic Evaluation will include any other appropriate and relevant information pursuant to SGMA, GSP Implementation, and DWR review. The first 5-year GSP update and evaluation of sustainable management are due in 2027.

SECTION 10 CONTENTS

LIST OF TABLES

APPENDICES

10. NOTICE AND COMMUNICATION (§ 354.10)

The ECC Subbasin is governed by seven Groundwater Sustainability Agencies (GSAs) with the active participation of the Contra Costa Water District (**Figure 1-2**). As public agencies, each offers public engagement as part of their decision-making processes. A Memorandum of Understanding guided the development of this East Contra Costa (ECC) Groundwater Sustainability Plan (GSP). As part of this effort an agency Working Group and a Communications Committee were formed to advise the GSP development. The ECC GSP Working Group will continue to meet, at minimum, quarterly during GSP implementation.

10.1 Description of Beneficial Uses and Users of Groundwater in the Basin

The Water Code Section 10723.2 requires the GSAs to consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing the GSP. These interests include, but are not limited to, the following:

1. Holders of overlying groundwater rights, including:
    a. Agricultural users, including farmers, ranchers, and dairy professionals.
    b. Domestic well owners.
2. Municipal well operators.
3. Public water systems.
4. Local land use planning agencies.
5. Environmental users of groundwater.
6. Surface water users where there is a hydrologic connection between surface and groundwater bodies.
7. The federal government, including, but not limited to, the military and managers of federal lands.
8. California Native American tribes.
9. Disadvantaged communities, including, but not limited to, those served by private domestic wells or small community water systems.
    a. Entities listed in Section 10927 that are monitoring and reporting groundwater elevations in all or a part of the ECC Subbasin.

10.1.1 Interest Groups

The ECC Working Group considered each type of interested parties named by SGMA to determine if they were represented in the Subbasin and to include them in the outreach for the GSP.

<u>Agricultural Users</u>: In 2015, agriculture was the primary land use covering 41 percent of the Subbasin. The agricultural sector is primarily served by surface water provided by BBID and ECCID and individual water rights to divert surface water on the delta islands. Both BBID and ECCID are members of the ECC GSP Working Group. Their service areas make up 37 percent of the agricultural land use.

<u>Domestic Well Users</u>: Private residential well owners are estimated to pump approximately 600 afy (**Table 4-2**) from the Subbasin. Private well owner water use is primarily for residential, landscape, and some small-scale farming and livestock. To be considered a de minimis user, one well can pump up to two afy. Private well owner interests are represented by the GSAs that include de minimis users in their area.

Small Water Systems: About 22 small water systems as described in **Section 2.1.1.3** use approximately 500 af (**Table 4-2**) of groundwater pumped every year from the Subbasin. The small public water systems in the Subbasin are represented by Contra Costa County and by the individual GSAs where the systems are located.

Large Public and Municipal Well Operators: As discussed in more detail in **Section 2.1.1.3**, there are four public water systems (PWS) in the Subbasin: The City of Brentwood (a municipal well operator), Diablo Water District, and the Town of Discovery Bay. The City of Antioch is the fourth municipal PWS, but it does not supply groundwater to customers. Most of the water supplied by the City of Brentwood and Diablo Water District is surface water. The Town of Discovery Bay supply is entirely groundwater. The ECC Working Group includes representatives from the City of Antioch and all three of the systems that use groundwater.

Local Land Use Agencies: Four entities in the ECC Subbasin have land use authority: Contra Costa County, the City of Antioch, the City of Brentwood, and the City of Oakley (water provided by DWD). All four entities (DWD for Oakley) are GSAs and participate in the ECC Subbasin Working Group.

Environmental Users: The Subbasin has a generous supply of surface water due to the Bay-Delta setting and includes creeks and streams that are connected to shallow groundwater. The creeks, streams, and shallow groundwater discharge to the Bay-Delta. Environmental users of groundwater include species and habitat reliant on instream flows, wetlands and GDEs. GDEs are mapped in **Figures 3-26a and 3-26b** in **Section 3.3.9**. All vegetative species in the ECC Subbasin are listed in **Table 3-4**. Critical habitat for species in the ECC Subbasin is shown on **Figure 3-27**. Groups interested in environmental restoration of habitats and species within the Subbasin (e.g., Friends of Marsh Creek and DWR that manages Dutch Slough tidal marsh restoration) were called and/or emailed requesting input on the draft sections of this GSP.

Surface Water Users with a Connection to Groundwater: The Subbasin includes several streams that are connected to groundwater in some of their reaches. Marsh Creek is connected to groundwater in part of its watershed, but surface water and groundwater use are limited to individual private users along the creek. Many properties along the creek are served by the City of Brentwood Public Works.

Federal Government: Federal lands in the Subbasin include two small parcels in the City of Antioch (**Figure 2-3**) and are represented by the City of Antioch GSA.

California Native American tribes: There are no tribal lands within the Subbasin (see **Section 2.1.1.4**). However, the GSAs formally contacted the Native American Heritage Commission[1] to verify any potential interests. Additional targeted outreach was made to tribes or tribal representatives with a potential interest due to historic use of subbasin lands for gathering and other traditional practices.

Disadvantaged Communities: The disadvantaged areas (DAs) are described in **Section 2.3.2**. The total DAs population in the Subbasin is approximately 35,600 (**Table 2-5**). All DAs are served by small water systems, municipal water, or individual domestic wells (**Figures 2-13a and 2-13b**). SGMA has limited authority with regards to water quality improvements related to drinking water beneficial uses. Despite these limitations, GSAs represent the interests of the DAs (e.g., the City of Antioch, DWD, Contra Costa County,

[1] Native American Heritage Commission, 1550 Harbor Blvd., Ste. 100, West Sacramento, CA 95691, (916) 373-3710.

and the City of Brentwood). The interests of the DAs are reflected in the sustainability goal and sustainable management criteria described in **Section 7**.

Entities Monitoring and Reporting Groundwater Elevations: The ECC GSP Working Group members are the main entities that monitor groundwater elevations and conduct testing of groundwater quality in the Subbasin (see **Section 2.2.1**). Groundwater contamination sites report groundwater levels and water quality testing results through requirements set forth by other regulatory agencies and can be accessed via GeoTracker.

10.1.2 ECC GSP Advisory Groups

The ECC GSP Working Group was established in 2015 after SGMA legislation was passed. The members are GSA representatives plus a representative from CCWD that meet monthly to coordinate GSP development. **Figure 1-2** provides the management structure.

In September 2018, the ECC GSP Working Group applied for and received facilitation support services (FSS) from DWR. These services are provided by STANTEC through January of 2022. FSS provides assistance from professional facilitators to encourage active involvement of diverse social, cultural, and economic interests and consider all beneficial uses and users of groundwater when developing and implementing GSPs. An ECC GSP Communication Committee was created to target public input required by GSP regulations.

10.2 List of Public Meetings Where the GSP was Discussed

During the development of this GSP, public meetings were held and noticed on the ECC GSP website. Notifications were sent via email to the interested parties and via newspaper ads. **Table 10-1** lists the public meetings where the GSP was discussed from June 2019 to August 2021.

Opportunities for written comment were separately publicized and noticed, see below.

10.2.1 Informational Public Meetings on ECC GSP

Appendix 10a provides the complete list of outreach and communication for the ECC Subbasin and **Table 10-1** provides a summary list of public information meetings and outreach on development of the the draft ECC Subbasin GSP.

Table 10-1. List of Public Information Meetings and Outreach on the Draft ECC Subbasin GSP

Format	Date	Detail	Participation	Purpose
Public Meetings	July 9, 2020 June 23, 2021 September 14, 2021	Online/Virtual Online/Virtual (recorded) Online/Virtual	33 47 ??	1. Review SGMA and Sections 1&2 2. Review Secs 3-9 3. Review entire GSP
Postcard Mailings	September 2018 August 2021	Postcard to public water systems and local agencies	120 of 153	1. Basin Boundary Modification Support & SGMA 2. GSP public comment period
Surveys on ECC GSP Website	Dec. 7, 2018 May 2020 to Oct0ber 2021	On-line survey for individual GSP Sections and entire GSP	Outreach Assessment =21 Chapter comments =28	Learn about GSPs Provided for public comment
Email Listserv	300 emails were mailed to interested parties prior to each public meeting	Notifications to interested parties list	900 emails	Notification of Sections available for review and comment and for public meeting announcements.
Public Board Meetings	January 2015 to August 2021	36 GSA public Board meetings		ECC GSP updates
ECC GSP Working Group Meetings	June 2017 to August 2021	Total of 45 monthly meetings	Varied	Plan GSP Development
ECC GSP Communications Committee Meetings	2019 to 2021	Total of 15 separate meetings	varied	Plan public outreach
Website	August 2019 to present	https://www.eccc-irwm.org/about-sgma	2019:205 views 2020: 506 views 2021: 620 views (to 8/3/21)	Update on GSP Development
Monthly Newsletter	September 2020 to January 2022	1 page pdf posted on ECC GSP Website and distributed to GSAs	To GSAs and posted on Website	Update on GSP Development
Public Meeting Notice	Prior to each public workshop	Newspaper advertising	Circulation to approximately 210,000 homes	Public Notice

10.2.2 Outreach Presentations to Community Groups

Municipal Advisory Councils (MAC) in the unincorporated County within the ECC groundwater basin are the Bethel Island Municipal Improvement District, the Byron Municipal Advisory Council, and the Knightsen Town Advisory Council. Each MAC meets regularly to advise the County of Board of Supervisors on discretionary land use projects, among other things. The County GSA emailed the draft GSP to individual members of each MAC above and presented the draft GSP on the following dates:

- Knightsen Town Advisory Council-September 14, 2021
- Byron Municipal Advisory Council-September 28, 2021
- Bethel Island Municipal Improvement District-October 12, 2021

10.3 Comments on the GSP and a Summary of Responses

Appendix 10b provides the comments on the GSP and a summary of responses.

10.4 Decision-Making Process

On May 9, 2017, the ECC GSAs and CCWD entered into a Memorandum of Understanding (MOU) for the development of a single GSP for the ECC Subbasin and agreed to collaborate to ensure sustainable groundwater management for the subbasin, manage the groundwater subbasin as efficiently as practicable balancing the financial resources of the agencies with the principles of effective and safe groundwater management, while retaining groundwater management authority within their respective jurisdictions. Minor amendments were approved in the MOU on November 16, 2017, and April 13, 2020. By agreement of the GSAs and CCWD, the ECC GSP becomes effective when all parties adopt the GSP for the entire Subbasin. Under SGMA, each GSA Board is responsible to approve the GSP; the entire GSP will be submitted to DWR on or before January 31, 2022.

The ECC Working Group directed the consultant Luhdorff & Scalmanini Consulting Engineers (LSCE) to fulfill the requirements of SGMA. LSCE provided the Working Group with draft GSP Sections, budgets, and other work products as required to complete the GSP. As described in detail below, public involvement of all beneficial users was sought from the start, and their input and feedback are included in the decision-making process for the GSP.

10.5 Opportunities for Public Engagement and How Public Input and Response was Used

The ECC stakeholders and the public were notified and encouraged to participate in the development of the GSP as outlined in the *ECC Subbasin Communications Plan* (**Appendix 10c**). The DWR FSS Program provided assistance to complete this task. Actions to engage the public are identified below, and **Table 10-1** provides a summary of public engagement opportunities.

ECC GSP Website: The ECC GSP website at https://www.eccc-irwm.org/about-sgma has been active since August 2019 and is continually maintained with current and updated documents that comprise the parts of the GSP. Contact information is presented for stakeholders to communicate with the ECC GSAs and the public can be added to the ECC GSP mailing list to receive updates on upcoming events. Meeting information with agendas and summary notes are posted regularly along with technical reports and educational materials. During GSP implementation the website will continue to be active and provide quarterly updates.

East County Times and the Brentwood Press:

ECC GSP Monthly Newsletter: Provides monthly updates on the progress of the GSP, posted to the ECC GSP website.

GSA Board Meetings: ECC GSAs Board meetings where the ECC GSP was discussed presented information to the respective GSA Boards and the public.

Public Workshops: Informational meetings to provide the public with SGMA information and the GSP process (**Table 10-1**).

Public Outreach on Draft ECC Sections: Draft sections of the GSP were posted for public comment as they became available (see **Table 10-2** below) along with two public meetings with Q&A sessions (July 2020 and June 2021). The surveys for each section were "live" and available for public comment through August 2021.

Table 10-2. Public Comment Period for each GSP Section

GSP Section	Public Comment Period
1. Introduction to East Contra Costa GSP	April to July 2020
2. Plan Area	
3. Basin Setting	10/30/2020 to 1/15/2021
4. Historical, Current, and Projected Water Supply	11/2020 to 1/15/2021
5. Water Budget	Aug 9 to Aug 23 2021
6. Monitoring Network, Data Management System and Reporting	4/8/2021 to 5/3/2021
7. Sustainable Management Criteria (SMC)	7/16 to 8/16/2021
8. Projects and Management Actions (PMA)	
9. Plan Implementation	
10. Notice and Communications	

Public Outreach on the Entire Draft ECC Subbasin GSP: The complete draft ECC Subbasin GSP was available for the month of September 2021 for public comment, this included one public meeting with Q&A in September 2021.

Postcard Mailers: Two postcard mailers to about 94 interested parties (public water systems and local agencies) to engage this group (2018) about the basin boundary modification and SGMA.

Surveys: Each Draft Section of the ECC Subbasin GSP when posted to the ECC GSP website included a survey for interested parties to express their needs and concerns. 29 people responded.

Existing Outreach: GSAs use existing outreach networks to provide regular updates about the GSP development. This includes information through bill inserts, newsletters, and presentations to their boards.

10.6 Encouraging Active Involvement

As discussed in **Sections 10.2** and **10.5**, the outreach and education process are important to develop a comprehensive GSP, and the ECC Working Group has prioritized involvement by interested parties in the GSP effort. The following strategies were developed to encourage stakeholder engagement:

- Conduct a comprehensive outreach and education process that facilitates development of a GSP that meets SGMA requirements.
- Keep the stakeholders informed by providing timely and accurate information.
- Provide opportunities for interested parties to provide input during the planning process.
- Provide opportunities for input during every step of the GSP process.
- Update the outreach process throughout the GSP process as needed.
- Multiple opportunities were provided for stakeholders to review and comment on each of the sections as they were being developed (**Table 10-2**).

10.7 Informing the Public on GSP Implementation Progress

The draft GSP was posted to the ECC GSP website on September 1, 2021 and was available for a 30-day public review and comment period. A public meeting was held on September 14, 2021 to provide an overview of the GSP content and an opportunity for stakeholder feedback and comments about the GSP. These comments will be taken into consideration and incorporated into a final version of the GSP that will be adopted by each of the seven GSA Board of Directors before submitting to DWR by the deadline of January 31, 2022. Stakeholders will be given an additional 60-day comment period through DWR's SGMA portal at https://sgma.water.ca.gov/portal/gsp/status following the submittal. Comments will be posted to DWR's website prior to the evaluation and approval by DWR.

The ECC GSP Working Group will continue to meet to guide the GSP implementation process through ongoing monitoring and sustainable groundwater management. The adopted Communication and Engagement Plan will guide future outreach during the GSP implementation process.

10.8 Interbasin Coordination

A list of interbasin coordination meetings with neighboring subbasins is below:

- Tracy Subbasin-February 12, 2020, and September 30, 2020
- Solano Subbasin (LSCE technical consultant for both ECC and Solano Subbasins)
- Eastern San Joaquin Subbasin