EAST
CONTRA COSTA
SUBBASIN

Groundwater Sustainability Plan

Groundwater Sustainability Plan East Contra Costa Subbasin

Draft Section 6

Prepared for ECC GSA Working Group

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Consulting Engineers

March 2021

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Section 6 Contents

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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. **Appendix 6a** lists the required GSP elements (Elements Guide) and their location addressed in Section 6.

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

[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)

frequency, will provide a means to quantify current and future hydrogeological conditions of the ECC Subbasin, as well as within individual GSA jurisdictions.

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 points), 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.

Table 6-3: Basin-wide and Representative Groundwater Level Monitoring Network

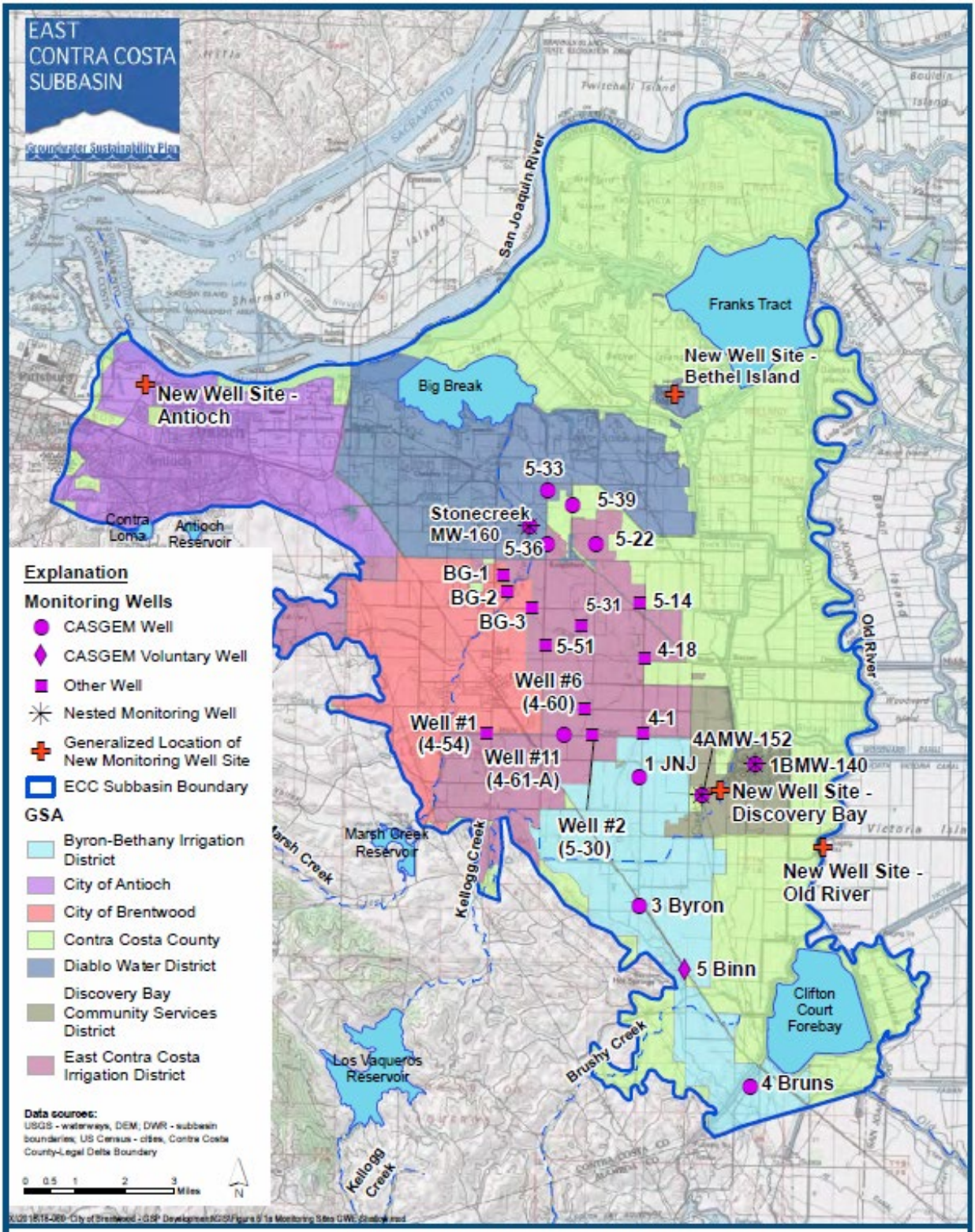
Local Well Name	Well Owner/ GSA	Lat	Long	Reference Point Elevation (ft)	Perforation Depths (ft bgs)	CAS-GEM Well	Freq-uency	Represent ative Well
Shallow Zone Wells								
New Well	Antioch						daily*	X
New Well	Antioch						daily*	
1 JNJ	BBID	37.906128	-121.6419204	26.63	105-120	Yes	monthly	
3 Byron	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						daily*	X
New Well	CCC/CCWD						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	
New Well	DWD						daily*	
New Well	DWD						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
New Well	TODB						daily*	
New Well	TODB						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		

Table 6-3: Basin-wide and Representative Groundwater Level Monitoring Network

Local Well Name	Well Owner/ GSA	Lat	Long	Reference Point Elevation (ft)	Perforation Depths (ft bgs)	CAS-GEM Well	Freq-uency	Represent ative Well
Deep Zone Wells								
New Well-Antioch	Antioch						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

* New wells will be fitted with a SCADA system that will record water level measurements at least daily.



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Basin-wide Groundwater Level Monitoring Network - Shallow Zone

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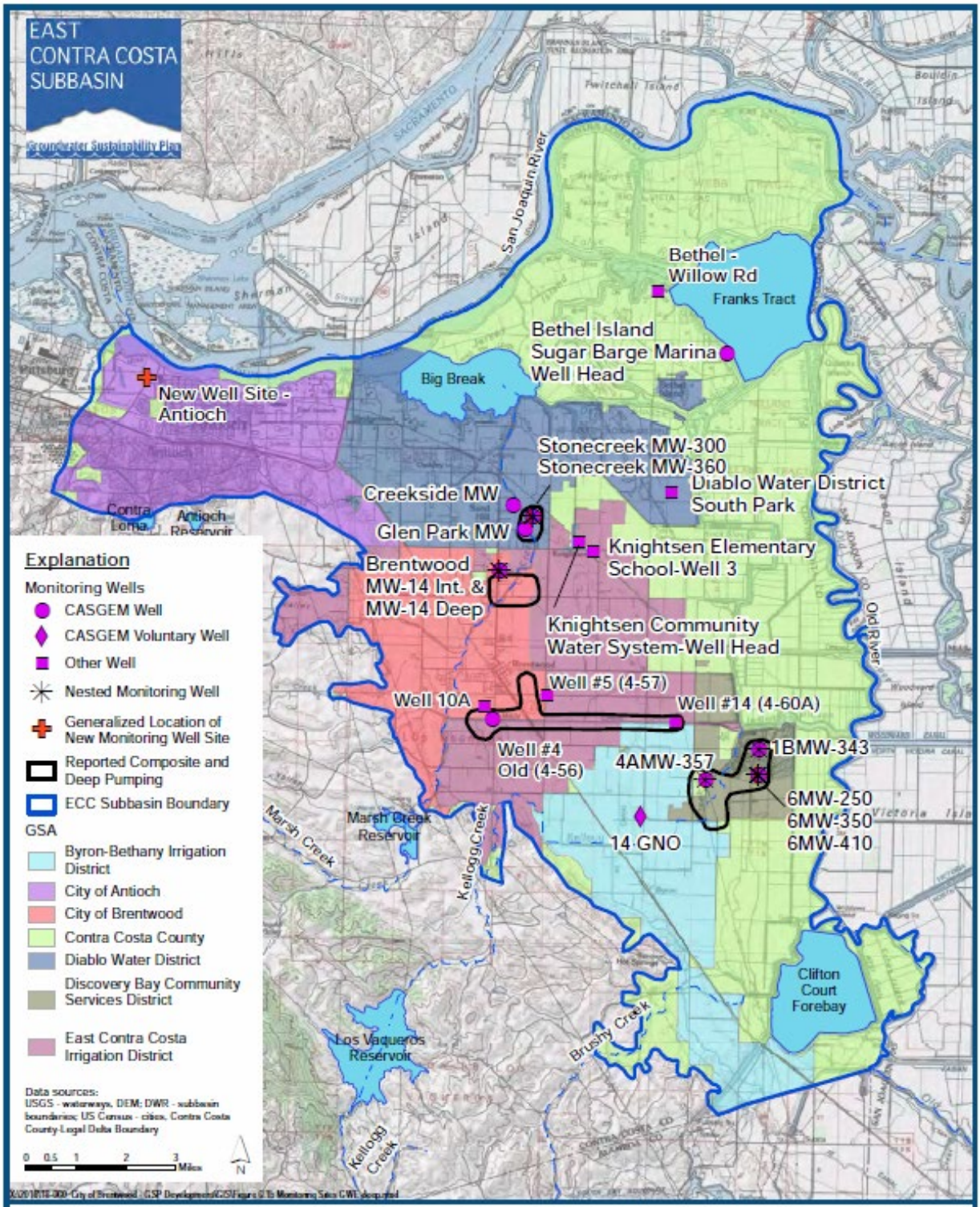
Contra Costa County, California

Figure 6-1a



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Basin-wide Groundwater Level Monitoring Network - Deep Zone

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Contra Costa County, California

Figure 6-1b

6.2.2.2. Representative Monitoring Network

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).

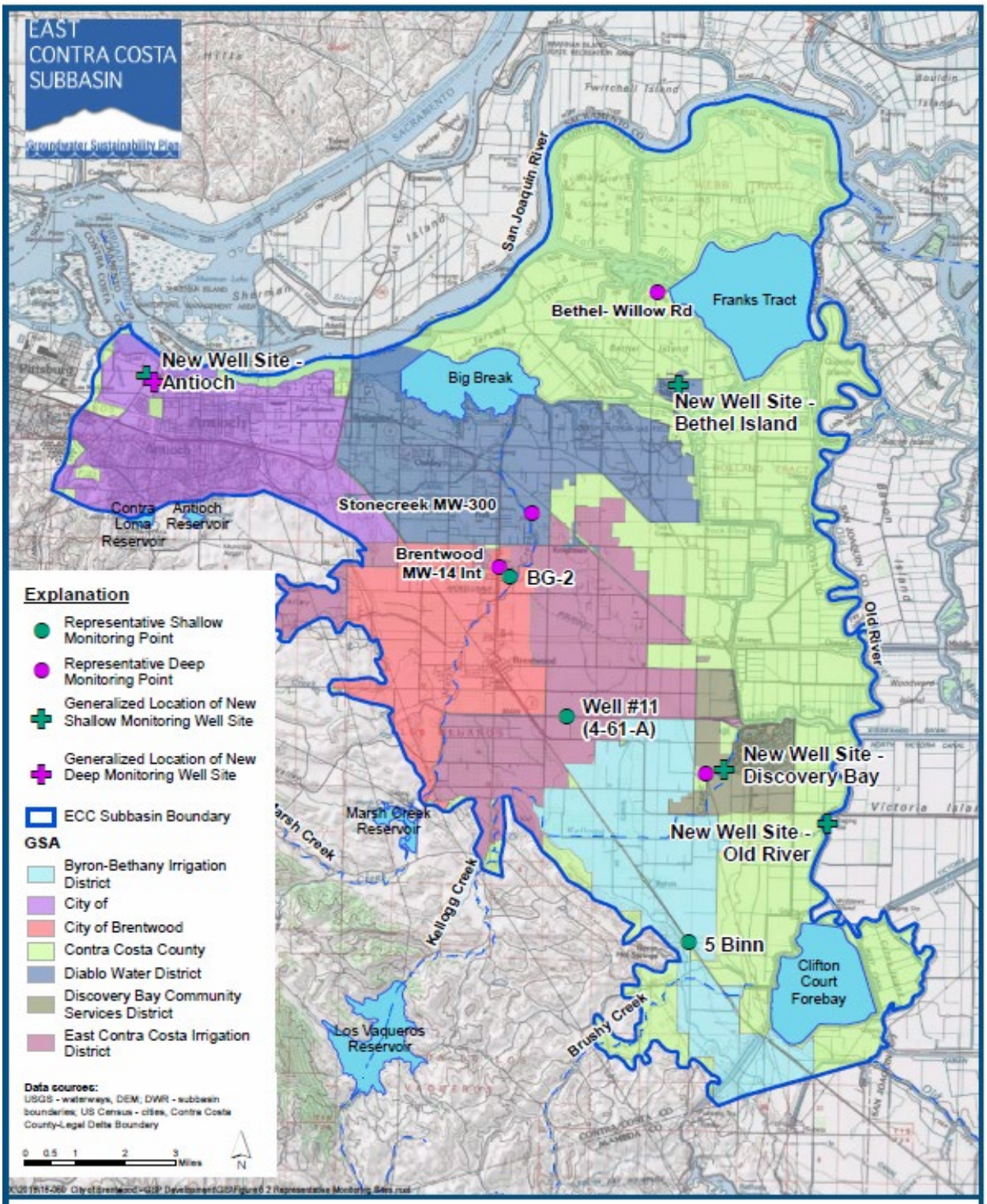
d. Monitored monthly or continuously (i.e., with transducers and data loggers).

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.



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Representative Groundwater Level Monitoring Network

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Contra Costa County, California

Figure 6-2

6.2.3. 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

6.2.3.1. 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.

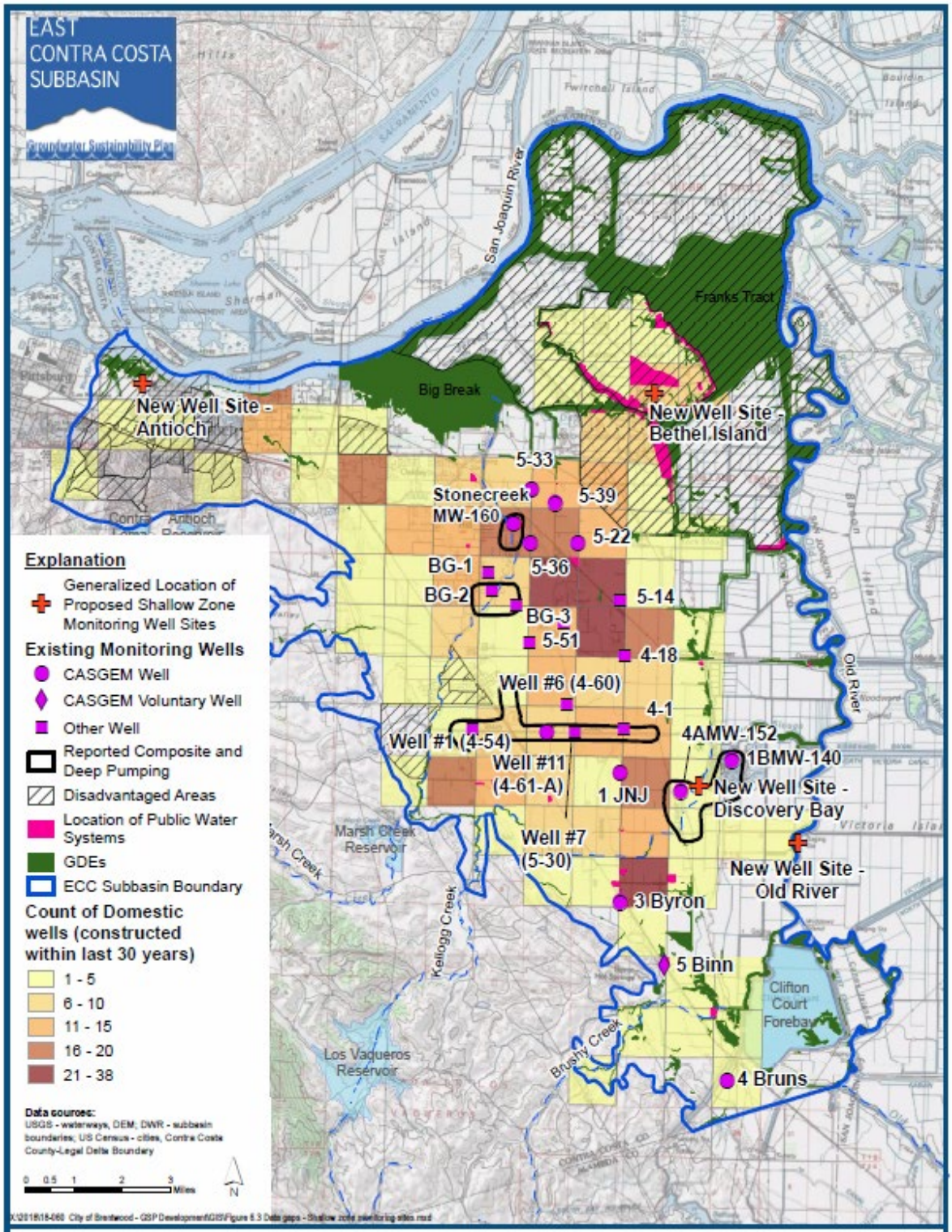
6.2.3.2. Groundwater Level Data Gaps

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.

6.2.3.3. 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 high usage by municipal and agricultural pumpers. 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.



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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.

6.2.4. Groundwater Quality Monitoring Network

The groundwater quality monitoring network consists of 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 groundwater quality conditions in both Shallow Zone and Deep Zone aquifers in the subbasin and in areas of higher groundwater use.
- Use existing groundwater quality monitoring data where possible.
- Provide means to assess groundwater quality impacts to beneficial uses and users.
- Assess changes and trends in groundwater quality (seasonal, short- and long-term trends).
- Identify natural (e.g., climate change) and anthropogenic factors that affect groundwater quality.

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.

6.2.4.1. 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.

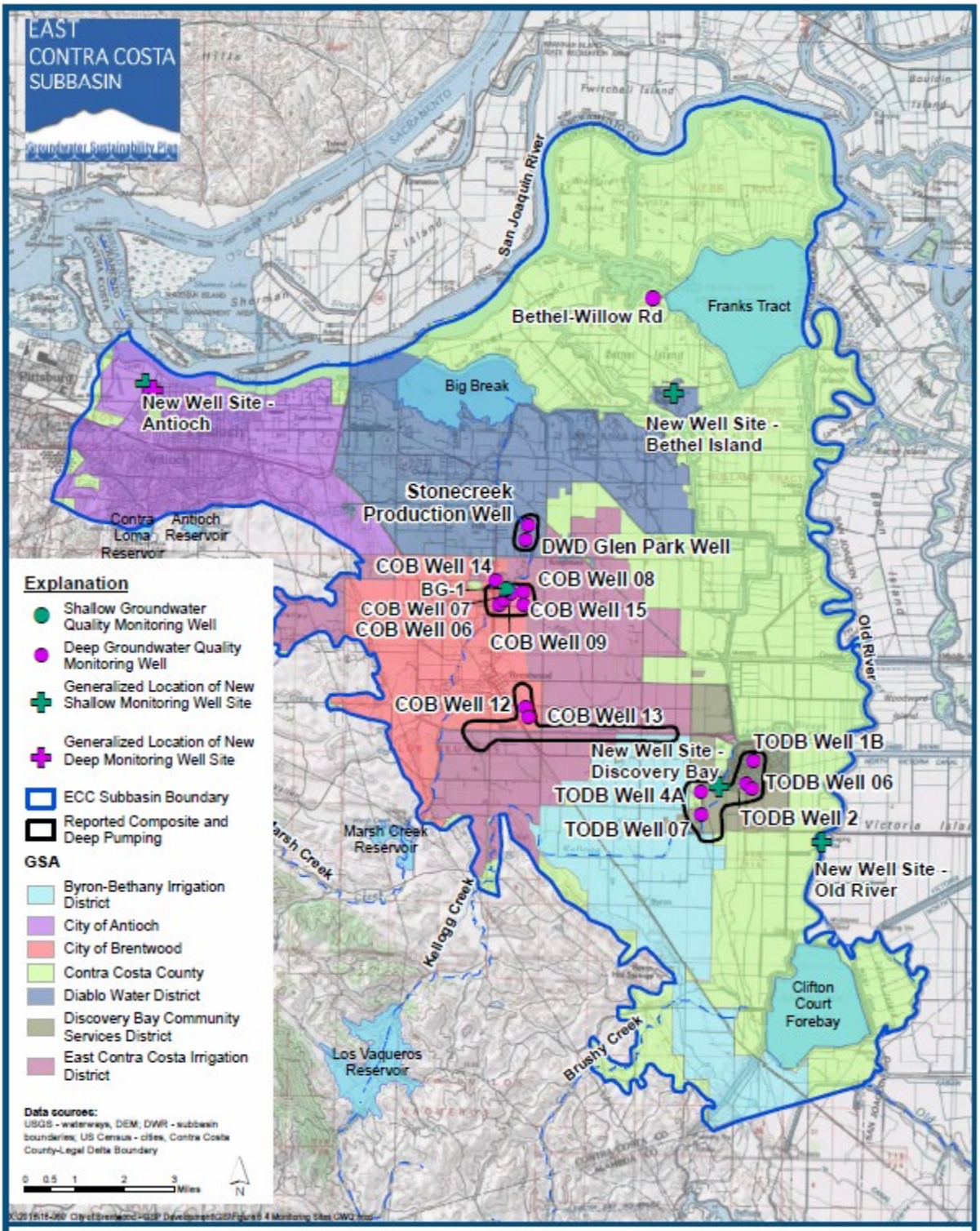
Table 6-8: Basin-wide and Representative Groundwater Quality Monitoring Network

Local Well Name	Owner/ GSA	Perf-oration	Data: First Date	Data: Last Date	Freq-uency	Sea-water Intrusion Monit-oring Network	Repre-sentative Monit-oring Wells
Shallow Zone							
BG-1	Brentwood	40-55	2/17/2008	2/15/2015	Annual[1]		x
New Well Antioch 1 of 2	Antioch				Annual[1]	x	x
New Well Bethel Island 1 of 2	DWD				Annual[1]	x	x
New Well Discovery Bay 1 of 2	TODB				Annual[1]	x	x
New Well Old River 1 of 2	CCC/CCWD				Annual[1]	x	x
Deep Zone							
New well-Antioch	Antioch				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]		
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

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

6.2.4.2. 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.

6.2.4.3. 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.

6.2.5. Seawater Intrusion Monitoring Network

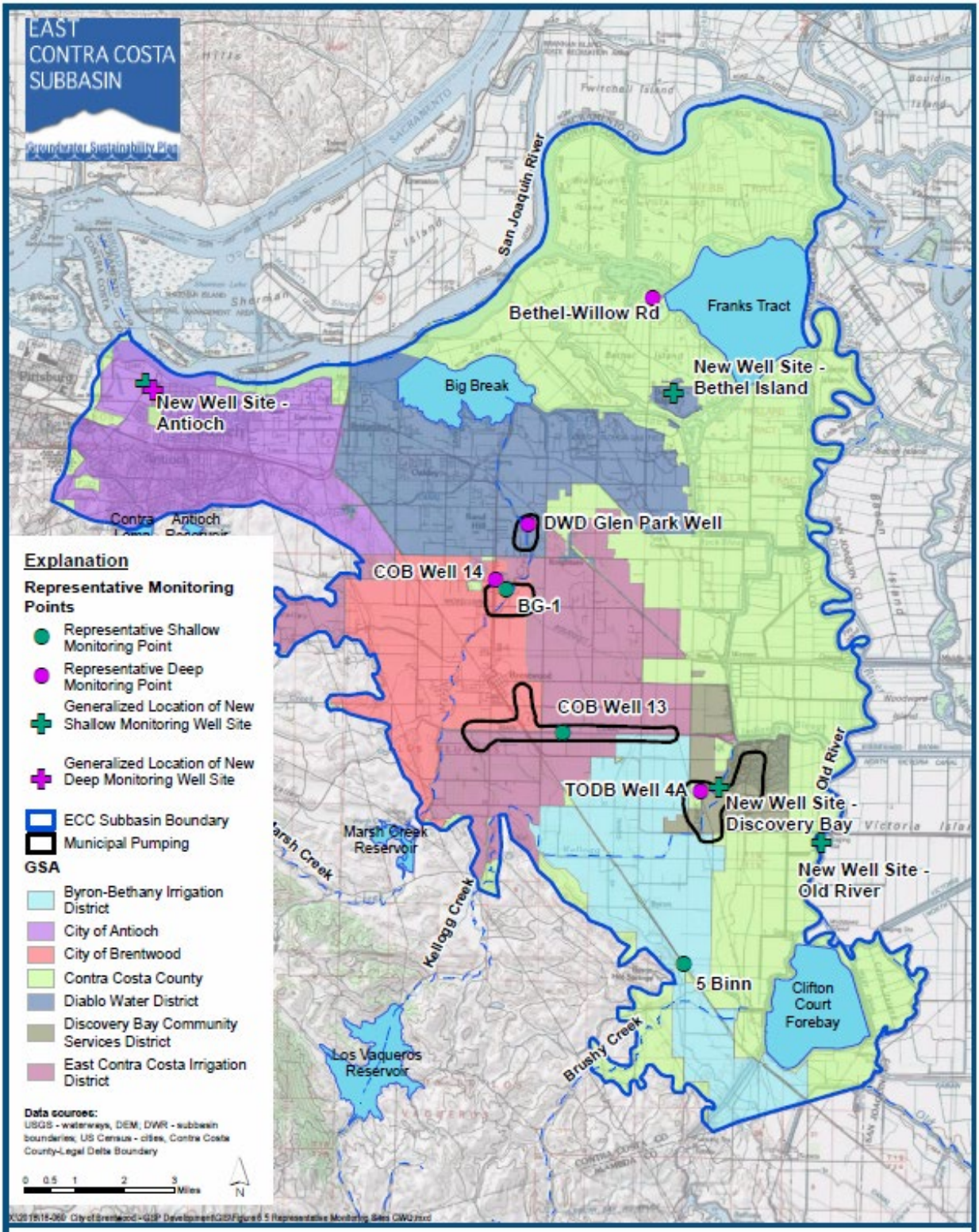
The seawater intrusion monitoring network is designed to address a mechanism by which Delta baywater migrates into shallow groundwater (see discussion in **Section 3.3.4**). The potential for intrusion of saline water into the shallow zone may be exacerbated by sea level rise. These intrusion mechanisms 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) will be evaluated using an isocontour using chloride concentration measured at a new set of dedicated Shallow Zone monitoring wells that will act as sentinels. **Table 6-8** lists the Shallow Zone Wells used to monitor chloride concentration and **Figure 6-5** shows the locations of these wells. There is currently no chloride concentration map since the monitoring wells have not been installed but will be by the time the GSP is implemented. 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 by sampling 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 will be set at either 500 mg/L, which is the Upper Limit Secondary Maximum Contaminant Level (SMCL) for chloride as defined by the EPA, or another value

above the background concentration using professional judgement to determine potential adverse effects to sustainability.

Seawater Intrusion Monitoring Protocols are the same as for those used for groundwater quality (**Appendix 6-1**). 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

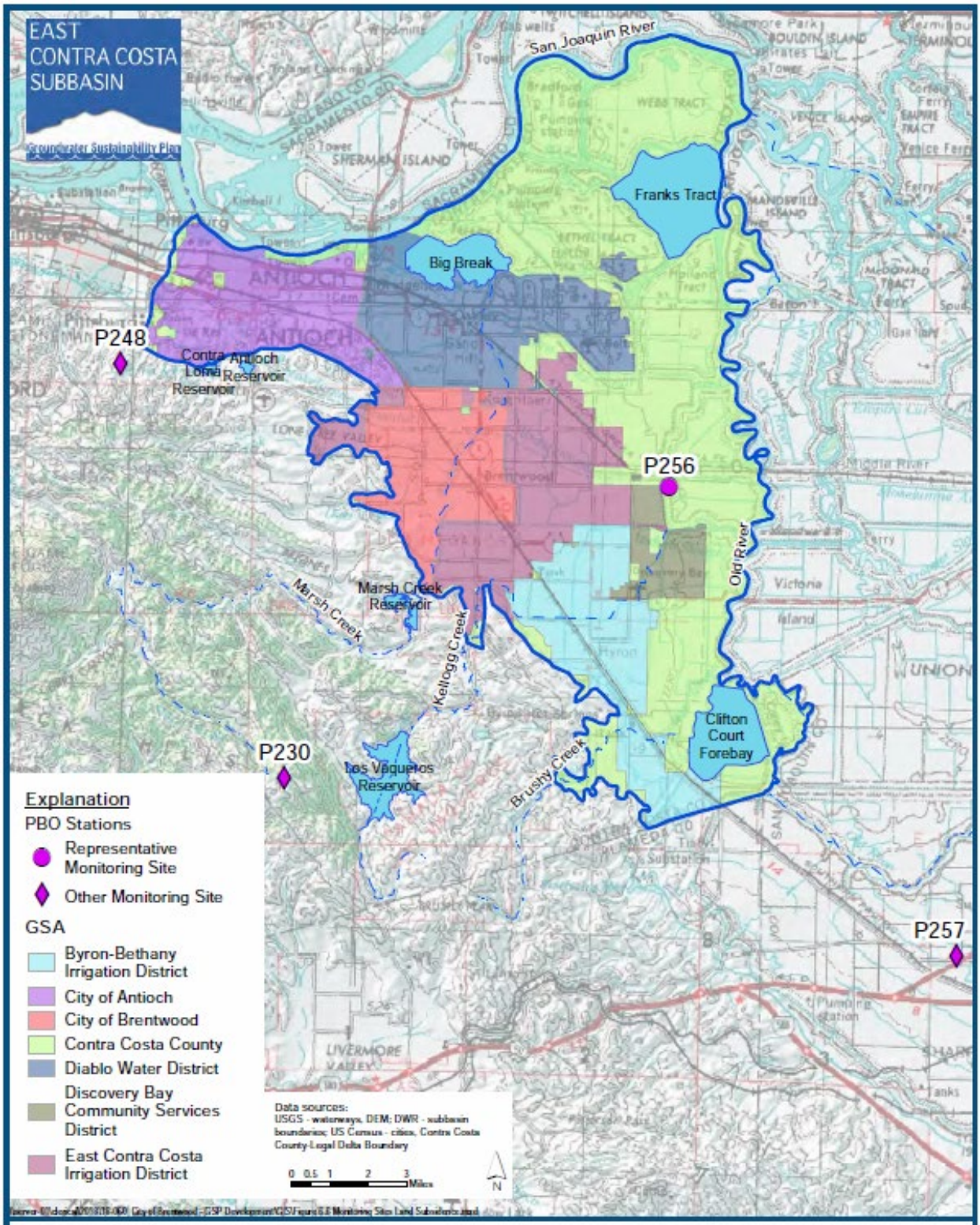
East Contra Costa Subbasin Groundwater Sustainability Plan
Contra Costa County, California

Figure 6-5

6.2.6. 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. 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 data from P256 is considered sufficient based on the lack of historical subsidence and lack of lithologies generally associated with caused by pumping. In addition, the groundwater level monitoring will serve as a proxy to assess the sufficiency of the subsidence monitoring networks. 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. NASA JPL InSAR subsidence data is currently not available for the ECC Subbasin but is concentrated in the San Joaquin Valley where documented subsidence has occurred since the 1960s. When these data become available for the ECC Subbasin they will be included in the ECC Subbasin land subsidence monitoring network.



Luhdorff & Scalmanini Consulting Engineers

Land Subsidence Monitoring Network

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

Figure 6-6

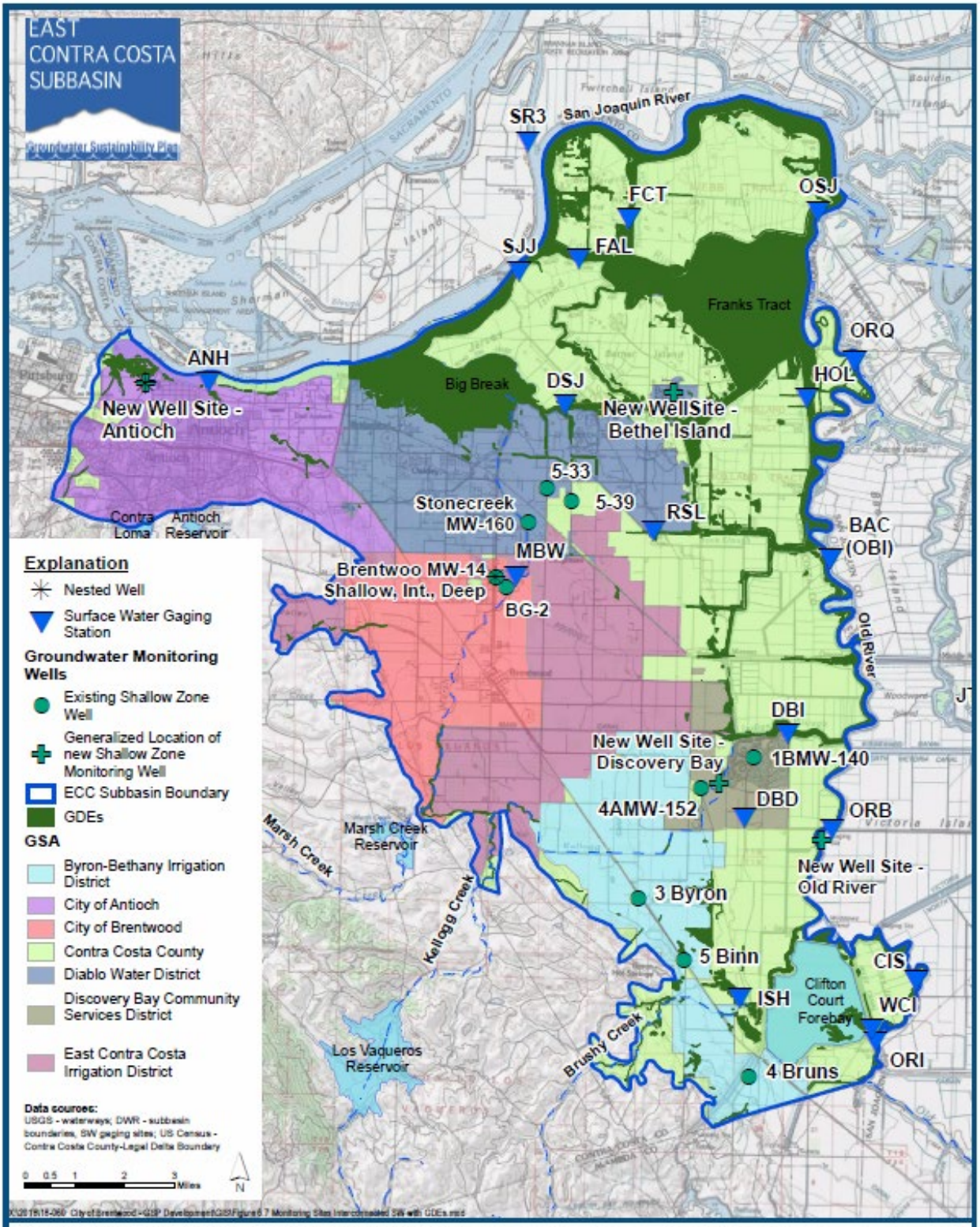
6.2.7. Interconnected Surface Water Monitoring Network

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, 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.



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	15 minutes
Old River at Bacon Island (USGS)	OBI[3]	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

[3] Same as Bacon Island at Old River (BAC).

6.4 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).

6.5 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 five applicable sustainability indicators: chronic lowering of groundwater level, reduction of groundwater storage, degraded water quality, land subsidence, and interconnected surface waters, across the Subbasin.

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.

6.6 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.

6.7 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.

6.8 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.

6.9 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.

6.10 Data Submittals

Monitoring data will be submitted to DWR in electronic formats utilizing the forms provided by the DWR (GSP Reg. § 353.4).

6.11 Reporting

Annual reporting and periodic evaluation for the ECC GSP monitoring networks are detailed in **Section 9**.

6.12 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.

Appendix 6a

Section 6 Elements
Guide-Required
Plan Contents

Elements Guide Template

Enter the Bulletin 118 Basin or Subbasin name here: **San Joaquin Valley-East Contra Costa (5-022.19)**

This Groundwater Sustainability Plan Elements Guide is developed directly from the Sustainable Groundwater Management Act (Act) and the Groundwater Sustainability Plan Emergency Regulations (GSP regulations).

It is provided to support local agencies, Groundwater Sustainability Agencies (GSA), or other entities during preparation and submission of their GSP to the Department of Water Resources (DWR). The guide is organized according to the California Code of Regulation Sections of the GSP Emergency Regulations. In particular, the "Elements of the Plan" tab contains all of the elements of Article 5 of the DWR's GSP Emergency Regulations. In the event that information or recommendations in this guide are inconsistent with, conflicts with, or omits the requirements of the Act, applicable laws, or the GSP Emergency Regulations, the Act, other laws, or the GSP Emergency Regulations shall prevail. More information about the GSP Emergency Regulations can be found at this web link.

Rows that are highlighted in grey do not require page numbers of the GSP to be identified by the GSA(s).

DATA ENTRY INSTRUCTION/GUIDE		
Page Numbers of Plan		Provide the PDF page number(s). Page ranges should be separated by a ':'. Additional pages should be separated by a ','. Note that the page number(s) are those tracked by the PDF document, and may not correspond to the page numbers in the printed document. If multiple PDF files are uploaded for the GSP, an explanation needs to be provided in the Notes field that associates the page numbers of plan with the appropriate PDF file. 'N/A' can be entered but if used an explanation needs to be provided in the Notes field. Example: If the information is found on pages 24 through 29 and also on page 36 and pages 40 through 45, the user would enter '24:29, 36, 40:45'. Page Number is a required field.
Or Section Numbers		Provide the section numbers. Section ranges should be separated by a ':'. Additional sections should be separated by a ','. Example: If the information is found in sections 3-5 through 3-7 and also in section 4-1, the user would enter '3-5:3-7, 4-1'. Section Numbers is not a required field.
Or Figure Numbers		Provide the figure numbers. Figure number ranges should be separated by a ':'. Additional figures should be separated by a ','. Example: If the information is found in figures 2-6 through 2-10 and also in figure 5-3, the user would enter '2-6:2-10, 5-3'. Figure numbers is not a required field.
Or Table Numbers		Provide the table numbers. Table number ranges should be separated by a ':'. Additional tables should be separated by a ','. Example: If the information is found in tables 2-6 through 2-10 and also in tables 5-3, the user would enter '2-6:2-10, 5-3'. Table numbers is not a required field.
Notes		Enter notes related to the element here. Notes can be entered as any free text. Example: "A map of seawater intrusion is not included because the basin is not located near a seawater body." Notes is not a required field, unless "N/A" is entered for the page number, or if multiple PDF files are uploaded for the GSP, then an explanation needs to be provided.

Last Modified Auguest 14, 2019
Version 201909011

Article 5.			Plan Contents for San Joaquin Valley-East Contra Costa (5-022.19) Basin	GSP Document References					
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes	GIS Files Required?
SubArticle 4.			**Monitoring Networks**						
§ 354.32.			**Introduction to Monitoring Networks**						
			This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.						
			Note: Authority cited: Section 10733.2, Water Code.						
			Reference: Section 10733.2, Water Code.						
§ 354.34.			**Monitoring Network**						
(a)			Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation.		6.2	6-1, 6-2, 6-4,6-5	Tables 6-2 and 6-7		
(b)			Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:						
	(1)		Demonstrate progress toward achieving measurable objectives described in the Plan.		6.1				
	(2)		Monitor impacts to the beneficial uses or users of groundwater.		6.1				
	(3)		Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.		6.1				
	(4)		Quantify annual changes in water budget components.		6.1				
(c)			Each monitoring network shall be designed to accomplish the following for each sustainability indicator:						
	(1)		Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:						
		(A)	A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.		6.2.2, 6.2.2.1	6-1	6-2, 6-3		
		(B)	Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.		6.2.2.4		6-3		
	(2)		Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.		6.2.1				
	(3)		Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.		6.2.4, 6.2.3	6-5	6-8		
	(4)		Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.		6.2.3				

Article 5.			Plan Contents for San Joaquin Valley-East Contra Costa (5-022.19) Basin	GSP Document References					
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes	GIS Files Required?
	(5)		Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.		6.2.5	6-6			
	(6)		Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:						
		(A)	Flow conditions including surface water discharge, surface water head, and baseflow contribution.		6.2.6				
		(B)	Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.		6.2.6				
		(C)	Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.		6.2.6				
		(D)	Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.		6.2.6				
(d)			The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.		6.2.6				
(e)			A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.		6.2.6	6-7	6-9		
(f)			The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:						
	(1)		Amount of current and projected groundwater use.		6.2.3				
	(2)		Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.		6.2.2.1				
	(3)		Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.		6.5				
	(4)		Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.		6.2.2.1				
(g)			Each Plan shall describe the following information about the monitoring network:						
	(1)		Scientific rationale for the monitoring site selection process.		6.2.2.2, 6.2.2.3				
	(2)		Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.					Appendix 6b	
	(3)		For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.						

Article 5.			Plan Contents for San Joaquin Valley-East Contra Costa (5-022.19) Basin	GSP Document References					
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes	GIS Files Required?
(h)			The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.			6-1, 6-2, 6-4, 6-5	6-3, 6-8		Y
(i)			The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.					Appendix 6b	
(j)			An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.				6-1		
			Note: Authority cited: Section 10733.2, Water Code.						
			Reference: Sections 10723.2, 10727.2, 10727.4, 10728, 10733, 10733.2, and 10733.8, Water Code						
§ 354.36.			**Representative Monitoring**						
			Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:						
(a)			Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.		6.2.2.2, 6.2.3.2	6-2, 6-5	6-3, 6-8		
(b)			(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:						
	(1)		Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.		6.2.1				
	(2)		Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.		6.2.2.2, 6.2.3.2				
(c)			The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.		6.2.2.2, 6.2.3.2				
			Note: Authority cited: Section 10733.2, Water Code.						
			Reference: Sections 10727.2 and 10733.2, Water Code						
§ 354.38.			**Assessment and Improvement of Monitoring Network**						
(a)			Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.		6.4,6.5	6-3	6-5		
(b)			Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.		6.2.2.5, 6.2.2.6, 6.2.3.3,6.4	6-3	6-5		
(c)			If the monitoring network contains data gaps, the Plan shall include a description of the following:						

Article 5.			Plan Contents for San Joaquin Valley-East Contra Costa (5-022.19) Basin	GSP Document References					
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes	GIS Files Required?
	(1)		The location and reason for data gaps in the monitoring network.		6.2.2.5, 6.2.2.6, 6.2.3.3,6.4	6-3			
	(2)		Local issues and circumstances that limit or prevent monitoring.		6.2.2.6, 6.2.3.3,6.4				
(d)			Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.		6.2.2.5, 6.2.2.6, 6.2.3.3,6.4	6-6			
(e)			Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:						
	(1)		Minimum threshold exceedances.		6.5				
	(2)		Highly variable spatial or temporal conditions.		6.5				
	(3)		Adverse impacts to beneficial uses and users of groundwater.		6.5				
	(4)		The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.		6.5				
			Note: Authority cited: Section 10733.2, Water Code.						
			Reference: Sections 10723.2, 10727.2, 10728.2, 10733, 10733.2, and 10733.8, Water Code						
§ 354.40.			**Reporting Monitoring Data to the Department**						
			Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.		6-8				
			Note: Authority cited: Section 10733.2, Water Code.						
			Reference: Sections 10728, 10728.2, 10733.2, and 10733.8, Water Code.						

Chapter 6

Appendix 6b

Protocols for Data Collection and Monitoring

1. Protocols for Data Collection and Monitoring

1.1 Protocols for Measuring Groundwater Levels

- Measure depth to water in the well using procedures appropriate for the measuring device. Equipment must be operated and maintained in accordance with manufacturer's instructions. Groundwater levels shall be measured to the nearest 0.1 foot relative to the Reference Point.
- For measuring wells that are under pressure, allow a period of time for the groundwater levels to stabilize. In these cases, multiple measurements shall be collected to ensure the well reached equilibrium such that no significant changes in water level are observed. Every effort shall be made to ensure that a representative stable depth to groundwater is recorded. If a well does not stabilize, the quality of the value shall be appropriately qualified as a questionable measurement.
- The groundwater elevation will be calculated using the following equation.

  GWE = RPE − DTW

  Where:
  GWE = Groundwater Elevation in NAVD88 datum
  RPE = Reference Point Elevation in NAVD88 datum
  DTW = Depth to Water from the reference point

- The measurements of depth to water shall be consistent in units of feet, to an accuracy of tenths of feet or hundredths of feet.
- The well caps or plugs shall be secured following depth to water measurement.
- Groundwater level measurements are to be made on a semi-annual basis during periods of seasonal highs and lows.

1.1.1. Protocols for Recording Groundwater Level Measurements

- The field personnel shall record the well identifier, date, time (24-hour format), RPE, height of the reference point above or below ground surface, DTW, GWE, and provide comments regarding any factors that may influence the depth to water readings such as weather, nearby irrigation, pumping, flooding, potential for tidal influence, or well condition. If there is a questionable measurement or the measurement cannot be obtained, it shall be noted. Standardized field forms shall be used for all data collection.
- All data shall be entered into the GSP data management system (DMS) as soon as possible. Care shall be taken to avoid data entry errors and the entries shall be checked by a second person.
- Semi-annual groundwater level data collected from the wells in the CASGEM network will be submitted to DWR by March 31 (spring data) and October 31 (fall data) by the database manager.

1.1.2. Protocols for Installing Pressure Transducers and Downloading Data

- The field personnel must use an electronic sounder or chalked steel tape and follow the protocols listed above to measure the groundwater level and calculate the groundwater elevation in the monitoring well to properly program and reference the transducer. It is recommended that transducers record measured groundwater levels to conserve data storage capacity; groundwater elevations can be calculated at a later time after downloading.
- The field personnel must note the well identifier, the associated transducer serial number, transducer range, transducer accuracy, and cable serial number.
- Transducers must be able to record groundwater levels with an accuracy of at least 0.1 foot. Professional judgment will be used to ensure that the data being collected is meeting the Data Quality Objectives (DQO) and that the instrument is capable. Consideration of the battery life, data storage capacity, range of groundwater level fluctuations, and natural pressure drift of the transducers shall be included in the evaluation.
- The field personnel must note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. Vented cables are preferred, but non-vented units provide accurate data if properly corrected for natural barometric pressure changes. This requires the consistent logging of barometric pressures to coincide with measurement intervals.
- Follow manufacturer specifications for installation, calibration, data logging intervals, battery life, correction procedure (if non-vented cables used), and anticipated life expectancy to assure that DQOs are being met for the GSP.
- Secure the cable to the well head with a well dock or another reliable method. Mark the cable at the elevation of the reference point with tape or an indelible marker to verify that the cable has not slipped.
- The transducer data shall periodically be checked against manually measured groundwater levels to monitor electronic drift or cable movement. This shall happen during routine site visits, at least annually to maintain data integrity.
- The data shall be downloaded as necessary to ensure no data is lost. Downloaded data shall be entered into the GSP DMS following the quality assurance/quality control (QA/QC) program established for the GSP. Data collected with non-vented data logger cables shall be corrected for atmospheric barometric pressure changes, as appropriate. After the field personnel is confident that the transducer data have been safely downloaded and stored, the data shall be deleted from the data logger to ensure that adequate data logger memory remains for new data.

1.1.3. Protocols for Groundwater Storage Measurements

Groundwater storage shall be determined from groundwater elevation measurements. Groundwater elevation contours shall be created annually and compared to the groundwater contours generated in the previous year. The change in groundwater elevation at each monitoring site will also be analyzed on annual basis to understand where the greatest decline in storage is occurring spatially. For the comparison of annual groundwater conditions, the highest groundwater elevations recorded in the spring of each year will be used.

Where groundwater levels indicate a change in storage, storage change in the unconfined to semi-confined Shallow Zone will be calculated as follows:

$$\Delta Qs = (\Delta H) \times (Sy) \times (A)$$

Where:
ΔQs = Change in Shallow Zone Storage
ΔH = change in groundwater elevation (or hydraulic head)
Sy = specific yield of the unconfined aquifer
A = surface area of the aquifer

Groundwater storage change in the semi-confined to confined Deep Zone shall be calculated with the equation below:

$$\Delta Qd = (\Delta H) \times (Ss \times B) \times (A)$$

Where:
ΔQd = Change in deep Zone Storage
ΔH = change in groundwater elevation (or hydraulic head)
Ss = specific storage of the confined aquifer
B = aquifer thickness
A = surface area of the aquifer

1.2 Protocols for Groundwater Quality Measurements including Seawater Intrusion

Water quality monitoring of production wells that are part of municipal and other public water systems are incorporated into the groundwater quality monitoring network. Data from these sources include initial monitoring and ongoing compliance monitoring. The data is comprised of regulated primary and secondary drinking water constituents from which a baseline of water quality conditions in the Deep Aquifer water supply source is derived. Selected key constituents identified as having the potential to influence sustainable management in the ECC Subbasin are discussed, along with baseline maps and tables, under Basin Setting **Section 3.5.5**. The key constituents are total dissolved solids (TDS), nitrate, chloride, arsenic, boron, and mercury. While there may be localized constituents of concern, including point-source contamination sites, within GSAs, the key constituents are intended to satisfy monitoring for the water quality degradation sustainability indicator. Annual monitoring of groundwater quality in new and existing dedicated monitoring wells will include sampling and laboratory analysis of the key constituents on an annual basis while recognizing that monitoring in the public supply sources may be less frequent. At the 5-year periodic evaluation (see **Section 6.10**), the monitoring frequency and the list of key constituents will be assessed with respect to sustainable management. At that time, for example, monitoring frequency in the dedicated wells might be adjusted to coincide with drinking water compliance monitoring frequency.

During sampling events, field parameters shall be measured and recorded. The field parameters shall include electrical conductivity at 25 °C (EC) in µS/cm, pH, temperature (in °C), and dissolved oxygen (DO) in mg/L.

The GSP monitoring program will utilize the following protocols for collecting groundwater quality samples:

- Prior to sampling, the analytical laboratory will be contacted to schedule laboratory time, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements.
- Verify well identification at the monitoring site (the well identifier may appear on the well housing or the well casing).
- In the case of wells with dedicated pumps, samples shall be collected at or near the wellhead following purging.
- Prior to sampling, the sampling port and sampling equipment shall be cleaned to remove any contaminants. The equipment shall be decontaminated between each sampling locations or wells to avoid cross-contamination.
- The groundwater elevation in the well shall be measured following appropriate protocols described above in the groundwater level measuring protocols.
- For any well not equipped with low-flow or passive sampling equipment, an adequate volume of water shall be purged from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. Purging three well casing volumes is generally considered adequate. Professional judgment will be employed to determine the proper configuration of the sampling equipment with respect to well construction such that a representative ambient groundwater sample is collected. If pumping causes a well to be evacuated (go dry), document the condition and allow well to recover to at least 90% of original water level prior to sampling.
- Field parameters of pH, electrical conductivity and temperature shall be collected during purging and prior to the collection of each sample. Field parameters monitored during the purging of the well shall stabilize prior to sampling. Measurements of pH shall only be taken in the field; laboratory pH analyses are typically unachievable due to short hold times. Other parameters, such as Oxidation-Reduction Potential (ORP), Dissolved Oxygen (DO) (in situ measurements preferable), or turbidity, may also be useful for assessing purge conditions. All field instruments shall be calibrated daily and evaluated for drift throughout the day.
- Sample containers shall be labeled prior to sample collection. The sample label must include sample ID (often well ID), sample date and time, sample personnel, sample location, preservative used, and analytes and analytical method.
- Samples shall be collected under laminar flow conditions. This may require reducing pumping rates prior to sample collection.
- All samples requiring preservation must be preserved as soon as practically possible, ideally at the time of sample collection. Ensure that samples are appropriately filtered as recommended for the specific analyte. Entrained solids can be dissolved by preservative leading to inconsistent results of dissolve analytes. Specifically, samples to be analyzed for metals shall be field filtered prior to preservation; do not collect an unfiltered sample in a preserved container.

- Samples should be chilled and maintained at 4 °C to prevent degradation of the sample. The laboratory's Quality Assurance Management Plan shall be followed.
- Samples must be shipped under chain of custody documentation to the appropriate laboratory promptly to avoid violating holding time restrictions.
- Groundwater quality samples shall be collected annually in new wells per **Table 6-8**.
- All data shall be entered into the GSP DMS as soon as possible. Data entries should be checked by a second person for quality assurance.

1.3 Protocols for Groundwater Pumping Measurements

Measurements of groundwater pumping are conducted in all public supply wells but pumping at privately-owned domestic and irrigation wells are not monitored. The following protocols shall be followed when recording groundwater pumping totals:

- Groundwater pumping amounts shall be reported in units of acre-feet on monthly basis.
- Amounts are to be determined by a totalizer/flowmeter or calculated using electric consumption records.
- Groundwater pumping totals shall be sourced from the well owner.
- Meters shall be periodically checked for accuracy utilizing manufacturers recommendations. If necessary, meters shall be periodically calibrated according to manufacturer specifications.
- All data shall be entered into the GSP DMS annually.

1.4 Protocols for Subsidence Measurements

Subsidence in the ECC Subbasin will be evaluated using the available data from UNAVCO PBO stations. The GSAs will not be responsible for collecting subsidence data. Available subsidence data from the four selected UNAVCO PBO stations (P256, P230, P248 and P257) will be downloaded annually and entered into the GSP DMS for inclusion in an Annual Report.

1.5 Protocols for Interconnected Surface Water Measurements

Shallow groundwater levels associated with Interconnected surface water measurements will be made by collecting groundwater elevation measurements from adjacent (or nested) Shallow and Deep Zone wells. Protocols for groundwater level measuring and groundwater level recording shall be followed when measuring and recording groundwater levels.

Vertical hydraulic gradient associated with the groundwater-surface water system will be calculated as follows:

$$\Delta h = (h1 - h2) / (m1 - m2)$$

Where:
Δh = vertical gradient
h1 and h2 = groundwater elevation in deep and shallow wells, respectively
m1 and m2 = mid-point elevations of the screens in deep and shallow wells, respectively

Surface flow data of interconnected surface waters shall be downloaded by the database manager from public databases for annual reporting. Groundwater elevations, calculated vertical gradients, surface water flow rates (daily or monthly mean flow in cubic feet per second) and stage of surface water (elevation relative to NAVD88) shall be entered into the GSP DMS on an annual basis.