Appendix A. State well number, local well name, USGS station number, latitude and longitude, construction, and altitude data for selected wells in the East Bay Plain, Alameda County, California

[Latitude and longitude in degrees, minutes, and seconds referenced to North American Datum, 1983; decimal seconds given for wells having location determined by differential GPS; land-surface altitude and measuring-point altitude referenced to North American Datum, 1929; altitude given to nearest hundredths of a foot if measured by differential GPS; well-construction data from driller's information. USGS, U.S. Geological Survey; ft, foot; LSD, land-surface datum; —, not applicable]

State well No.	Local name	USGS station No.	Latitude	Longitude	Well depth (ft)	Depth of perforations		Land-surface altitude (ft)
						Upper-most (ft)	Lower-most (ft)	
Domestic, industrial, and other existing wells								
1S/3W-31N1	Eugene Peck	—	—	—	160	100	160	—
1S/4W-34F4	Red Star Yeast	—	—	—	400	200	380	—
2S/3W-8D4	—	—	—	—	—	—	—	—
2S/3W-16R1	American Brass & Iron	374504122112201	374504	1221126	495	324	479	9
2S/3W-19Q3	Alameda Golf Course	374433122135501	374432.09	1221359.36	1,000	400	980	0
2S/3W-22K8	Granny Goose	374412122104901	374412	1221053	551	—	—	—
2S/3W-22L3	Fleischman's Yeast #3	374425122104201	374423.41	1221046.62	945	187	930	23
2S/3W-22Q2	Fleischman's Yeast #2	374418122104201	374418	1221046	—	320	682	25
2S/3W-25B3	Brad Jones	374354122082601	374354	1220830	88	48	88	125
2S/3W-26C3	Terry Pate	374358122094301	374358	1220947	100	68	96	53
2S/3W-26M1	Cherry City Nursery	374339122100601	374339	1221010	300	113	293	37
2S/3W-28G1	Ratto Brothers	374346122113801	374348.52	1221142.11	250	—	—	8.85
2S/3W-34F1	Davis Street	374304122105701	374304	1221101	490	420	480	14
2S/3W-34K7	Chapman/Kellog Co.	374241122104101	374240.31	1221044.80	475	—	—	26.47
2S/3W-34R12	Domtar Gypsum	374229122103601	374229.36	1221035.60	610	—	—	25.80
2S/4W-3E1	Alameda Point Well	374716122175701	374716	1221801	353	269	345	8
3S/2W-7E1	Farmhouse-1	374107122075301	374107.20	1220752.56	540	500	530	33
3S/2W-7E2	Farmhouse-2	374107122075202	374107	1220752	—	—	—	33
3S/2W-7G12	San Lorenzo High School	374113122071901	374113	1220723	595	250	590	40
3S/2W-8L3	Knapp's Nursery	374103122063901	374103.37	1220639.55	211	—	—	61.89
3S/2W-8M3	Mr. Busk	374100122065101	374100	1220655	85	30	80	48
3S/2W-18K3	Kennedy Park	374008122072001	374008	1220724	155	35	155	37
3S/2W-18L1	Sky West Golf Course	374002122074001	374001.98	1220739.88	300	—	—	29.44
3S/2W-19L2	Sierraline Industries	—	—	—	160	—	—	—
3S/2W-19R4	Kruger Pickle	373904122070301	373908.54	1220709.49	112	43	93	43.43
3S/2W-21D3	Centennial Park	373948122054601	373948	1220550	220	40	220	70
3S/2W-21E13	Hayward Police Station	373930122054701	373930	1220551	550	245	530	70
3S/2W-25R3	—	373811122080101	373810.68	1220800.83	—	—	—	9.40
3S/2W-30G5	Gushman	373840122072901	373839.77	1220732.41	—	—	—	34.63
3S/2W-30R14	Al Mateo	373823122065901	373823.07	1220659.01	—	—	—	28.99
3S/2W-35J11	Mission Hills Golf Course	—	—	—	—	—	—	—
3S/3W-3L23	Marina Golf Course	374151122111201	374151.06	1221111.52	630	290	610	5.51
3S/3W-12C1	Washington Manor Park	374123122083901	374123	1220843	106	—	—	18
3S/3W-15M19	Lorenzo Park	373955122083401	373955	1220838	600	—	—	—
3S/3W-13A5	San Lorenzo Community Church	374039122080201	374039	1220806	90	50	90	23
4S/2W-4F6	City Yard Well B	373700122052301	373700	1220527	534	358	524	5

Appendix A. State well number, local well name, USGS station number, latitude and longitude, construction, and altitude data for selected wells in the East Bay Plain, Alameda County, California—Continued

State well No.	Local name	USGS station No.	Latitude	Longitude	Well depth (ft)	Depth of perforations		Land-surface altitude (ft)
						Upper-most (ft)	Lower-most (ft)	
Wells at Oakport injection/recovery site								
2S/3W-17G1	SA-MWS-2 (Deep)	374531122124701	374530.54	1221246.78	200	145	195	9.17
2S/3W-17G2	SA-MWS-1 (Shallow)	374531122124702	374530.54	1221246.78	80	45	75	9.16
2S/3W-17G3	S1-MWD-1	374536122125801	374535.87	1221258.42	530	460	520	9.68
2S/3W-17J6	SB-MWS-2	374522122124001	374521.83	1221240.16	145	110	140	5
2S/3W-17J7	SB-MWS-1	374522122124002	374521.83	1221240.16	85	60	80	5
2S/3W-17J8	SB-MWM-2	374522122124003	374521.80	1221240.43	320	299	314	5
2S/3W-17J9	SB-MWM-1	374522122124004	374521.80	1221240.43	265	228	238	5
2S/3W-17K1	S2-MWS-2	374524122124501	374523.95	1221249.06	205	140	180	10.33
2S/3W-17K2	S2-MWS-1	374524122124502	374523.95	1221249.06	85	50	80	10.33
2S/3W-17K3	S2-MWM-2	374525122124801	374525.05	1221248.39	360	260	350	12.52
2S/3W-17K4	S2-MWD-1	374525122124901	374524.77	1221248.86	555	480	550	8.15
2S/3W-17K5	S2-MWD-2	374524122124902	374523.77	1221249.09	550	470	550	9.60
2S/3W-17K6	S2-TW-1	374525122124902	374524.55	1221249.26	350	260	350	9.73
2S/3W-17K7	S2-TW-2	374524122124901	374524.44	1221249.47	560	480	550	9.95
Wells at Bayside injection/recovery site								
3S/3W-14K2	Robert's Landing #10, Old Ora Loma well	374006122092301	374006.61	1220923.71	993	162	813	5
3S/3W-14K5	Phase III Demonstration Well	374007122092901	374006.55	1220933.15	781	—	—	1
3S/3W-14K6	OW-3	374005122092601	374005.08	1220926.40	660	525	655	7.43
3S/3W-14K7	OW-4	374005122092501	374004.77	1220928.84	660	520	650	11.08
3S/3W-14K8	OW-1	374005122092502	374004.76	1220925.46	650	520	640	9.37
3S/3W-14K9	Phase II Test Well	374001122092701	374004.96	1220926.36	660	540	650	7.50
3S/3W-14K10	OW-2D	374005122092202	374004.83	1220925.38	200	160	190	6.78
3S/3W-14K11	OW-2S	374005122092203	374005.85	1220926.38	60	40	60	6.78
3S/3W-14K12	OW-5	374011122093001	344011.17	1220930.61	650	520	650	16
3S/3W-14K13	OW-6	374003122091501	374003	1220919	653	523	653	7

Appendix B. Physical-property, major-ion, selected trace-element, and oxygen-18 and deuterium data for ground-water samples analyzed by the U.S. Geological Survey (USGS), East Bay Plain, Alameda County, California, 1997–2000

[Location of sites shown in figure 1; µS/cm, microsiemens per centimeter at 25 degrees Celsius; ºC, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; <, actual value less than value shown; E, approximate value;—, no data]

State well No.	USGS identification No.	Date	Time	Dissolved oxygen (mg/L)	pH, (standard units)		Specific conductance, (µS/cm)		Temperature water (ºC)
					Field	Lab	Field	Lab	
2S/3W-16R1	374504122112201	08/12/98	1100	—	7.1	7.7	—	2,600	22.5
		12/11/98	1400	—	7.2	7.5	1,600	1,740	18.9
2S/3W-17K1	374524122124501	12/08/98	1010	0.6	6.5	6.8	9,870	10,200	18.0
2S/3W-17K2	374524122124502	12/08/98	1140	.7	6.4	6.7	41,400	41,100	17.9
2S/3W-17K3	374525122124801	03/23/99	1615	2.4	7.1	7.2	1,800	1,860	18.9
2S/3W-17K4	374525122124901	03/23/99	1330	—	7.8	7.8	1,210	1,120	20.0
2S/3W-19Q3	374433122135501	120/8/98	1540	10.2	8.4	7.9	1,310	1,360	23.0
		12/08/99	1430	—	8.0	8.0	1,270	1,330	—
		12/08/99	1445	—	8.2	8.0	856	882	—
		12/08/99	1545	—	8.0	7.9	1,450	1,500	17.7
2S/3W-19Q3	374433122135501	12/08/99	1715	—	7.8	7.7	1,950	2,040	—
		12/08/99	1745	—	7.8	7.7	2,020	2,130	—
		12/08/99	1830	—	8.2	7.9	2,400	2,450	—
2S/3W-22K8	374412122104901	08/12/98	1300	—	6.9	8.3	860	845	22.0
2S/3W-22L3	374425122104201	08/12/98	0900	—	7.3	8.2	1,210	1,180	21.0
2S/3W-22L3	374425122104201	12/11/98	1000	.6	7.6	7.6	1,050	1,020	20.4
		03/24/99	0930	—	7.0	—	1,160	—	20.1
2S/3W-22Q2	374418122104201	12/06/99	1530	—	7.2	7.4	1,430	1,490	—
		12/06/99	1600	—	7.3	7.4	1,230	1,240	—
		12/06/99	1640	—	7.3	7.4	1,170	1,160	—
2S/3W-22Q2	374418122104201	12/06/99	1715	—	7.4	7.6	946	951	—
		12/06/99	1940	—	7.4	7.6	940	943	—
		12/07/99	1700	—	7.6	7.6	929	981	20.0
		12/07/99	1800	—	7.5	7.7	940	967	—
		12/07/99	1845	—	7.6	7.6	833	852	—
2S/3W-22Q2	374418122104201	12/07/99	2000	—	7.4	7.5	1,120	1,140	—
		12/07/99	2040	—	7.5	7.6	945	962	—
2S/3W-25B3	374354122082601	11/17/98	1200	—	7.5	—	790	—	19.5
		12/10/98	1210	2.7	6.7	7.7	670	780	16.1
2S/3W-25B3	374354122082601	03/24/99	1300	—	7.4	—	750	—	16.9
2S/3W-26C3	374358122094301	11/23/98	1130	—	6.3	6.9	620	604	17.1
		03/25/99	1100	4.1	6.2	6.7	579	591	17.6
2S/3W-28G1	374346122113801	11/24/98	1330	—	7.3	7.5	—	4,830	18.5
		08/25/99	1140	—	7.2	7.4	4,390	4,810	18.2
2S/4W-3E1	374716122175701	12/23/98	1020	—	7.4	7.9	800	780	18.5
		08/26/99	0930	—	7.3	7.5	890	912	21.3
3S/2W-7E1	374107122075301	02/10/00	1600	8.2	7.3	7.5	838	893	21.9
3S/2W-7G12	374113122071901	11/15/99	0945	< .2	7.4	7.5	774	767	19.5
3S/2W-8M3	374100122065101	11/18/98	1100	—	6.9	7.4	1,070	1,090	19.0
3S/2W-8M3	374100122065101	12/09/98	1250	—	6.8	7.1	990	1,110	18.1

Appendix B. Physical-property, major-ion, selected trace-element, and oxygen-18 and deuterium data for ground-water samples analyzed by the U.S. Geological Survey (USGS), East Bay Plain, Alameda County, California, 1997–2000—*Continued*

State well No.	USGS identification No.	Date	Time	Dissolved oxygen (mg/L)	pH, (standard units)		Specific conductance, (µS/cm)		Temperature water (°C)
					Field	Lab	Field	Lab	
		03/24/99	1545	—	6.8	7.0	1,050	1,080	17.6
3S/2W-18K3	374008122072001	10/23/98	1400	—	7.4	7.5	1,000	1,020	—
		08/24/99	1400	.6	6.9	7.1	926	940	18.1
3S/2W-18L1	374002122074001	03/31/99	1300	—	7.6	7.9	870	767	19.0
3S/2W-19R4	373904122070301	11/16/98	1100	—	7.4	7.6	950	932	19.5
3S/2W-21D3	373948122054601	03/31/99	1430	—	7.1	7.7	720	690	17.0
3S/2W-21E13	373930122054701	12/09/98	0900	—	8.0	8.1	760	827	—
		08/25/99	0900	—	7.5	7.6	818	826	20.2
3S/3W-14K7	374005122092501	12/07/98	1150	1.8	7.5	7.7	599	621	19.4
3S/3W-14K9	374001122092701	11/13/97	1100	—	7.7	7.8	740	751	20.9
		12/07/98	1245	—	—	—	—	—	—
3S/3W-14K10	374005122092202	12/07/98	1430	.5	7.8	7.7	1,080	1,060	17.9
3S/3W-14K11	374005122092203	12/07/98	1700	.7	6.6	6.8	96,300	89,300	18.6
3S/3W-15M19	373955122083401	12/01/98	1030	—	7.6	8.1	800	800	17.0
		08/25/99	1430	—	7.7	7.9	752	772	22.7
3S/3W-13A5	374039122080201	12/09/98	0910	—	7.5	7.7	728	785	17.3
4S/2W-4F6	373700122052301	12/09/98	1000	—	8.2	8.2	556	589	—

Appendix B.Physical-property, major-ion, selected trace-element, and oxygen-18 and deuterium data for ground-water samples analyzed by the U.S. Geological Survey (USGS), East Bay Plain, Alameda County, California, 1997–2000—*Continued*

State well No.	Date	Hardness, total (mg/L as $CaCO_3$)	Calcium dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium dissolved (mg/L as K)	Sodium, dissolved (mg/L as Na)	Alkalinity, dissolved (mg/L as $CaCO_3$)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
2S/3W-16R1	08/12/98	—	—	—	—	—	—	700	—
	12/11/98	510	120	48	3.6	126	174	420	<0.10
2S/3W-17K1	12/08/98	4,800	1,000	522	7.8	415	185	3,600	<.10
2S/3W-17K2	12/08/98	16,000	3,100	1,910	26	6,090	740	17,000	<.10
2S/3W-17K3	03/23/99	600	150	53	3.0	127	250	380	<.10
2S/3W-17K4	03/23/99	120	31	9.5	1.8	189	260	190	.11
2S/3W-19Q3	12/08/98	110	26	11	1.4	239	292	250	.23
	12/08/99	110	26	11	1.4	230	265	230	—
	12/08/99	84	22	6.8	1.2	145	252	96	—
	12/08/99	120	27	13	1.4	263	282	290	—
2S/3W-19Q3	12/08/99	160	33	17	1.6	344	306	450	—
	12/08/99	160	33	19	1.7	377	298	500	—
	12/08/99	190	37	22	2.1	417	208	640	<.10
2S/3W-22K8	08/12/98	—	—	—	—	—	—	99	—
2S/3W-22L3	08/12/98	—	—	—	—	—	—	220	—
2S/3W-22L3	12/11/98	350	88	33	2.2	104	206	230	.13
	03/24/99	—	—	—	—	—	—	—	—
2S/3W-22Q2	12/06/99	540	130	52	2.6	79	208	300	—
	12/06/99	410	110	36	2.8	85	183	250	—
	12/06/99	380	97	33	2.6	84	180	220	—
2S/3W-22Q2	12/06/99	280	73	24	2.2	87	206	150	—
	12/06/99	280	72	24	2.2	87	199	150	—
	12/07/99	290	76	25	2.3	86	203	160	<.10
	12/07/99	260	68	22	2.3	82	173	160	—
	12/07/99	230	59	19	1.9	85	191	110	—
2S/3W-22Q2	12/07/99	340	85	31	2.3	90	188	210	—
	12/07/99	270	71	23	2.2	80	190	150	—
2S/3W-25B3	11/17/98	—	—	—	—	—	—	—	—
	12/10/98	—	—	—	—	—	296	34	—
2S/3W-25B3	03/24/99	—	—	—	—	—	—	—	—
2S/3W-26C3	11/23/98	—	—	—	—	—	—	26	—
	03/25/99	—	—	—	—	—	194	26	—
2S/3W-28G1	11/24/98	—	—	—	—	—	—	1,400	—
	08/25/99	1,900	470	173	5.8	188	220	1,500	< .10
2S/4W-3E1	12/23/98	—	—	—	—	—	—	95	—
	08/26/99	200	43	22	1.7	113	210	150	.10
3S/2W-7E1	02/10/00	170	44	15	1.8	—	210	100	.28
3S/2W-7G12	11/15/99	240	64	21	1.9	65	268	60	.26
3S/2W-8M3	11/18/98	—	—	—	—	—	—	51	—
3S/2W-8M3	12/09/98	—	—	—	—	—	338	48	—
	03/24/99	—	—	—	—	—	—	46	—
3S/2W-18K3	10/23/98	—	—	—	—	—	—	60	—

Appendix B.Physical-property, major-ion, selected trace-element, and oxygen-18 and deuterium data for ground-water samples analyzed by the U.S. Geological Survey (USGS), East Bay Plain, Alameda County, California, 1997–2000—*Continued*

State well No.	Date	Hardness, total (mg/L as $CaCO_3$)	Calcium dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium dissolved (mg/L as K)	Sodium, dissolved (mg/L as Na)	Alkalinity, dissolved (mg/L as $CaCO_3$)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)
	08/24/99	380	99	32	1.1	61	310	61	.26
3S/2W-18L1	03/31/99	—	—	—	—	—	—	65	—
3S/2W-19R4	11/16/98	—	—	—	—	—	—	61	—
3S/2W-21D3	03/31/99	—	—	—	—	—	—	18	—
3S/2W-21E13	12/09/98	—	—	—	—	—	—	58	—
	08/25/99	270	71	24	1.5	75	280	59	.16
3S/3W-14K7	12/07/98	81	21	6.8	1.4	103	174	61	.31
3S/3W-14K9	11/13/97	120	32	8.8	1.6	116	240	57	.12
	12/07/98	—	—	—	—	—	—	—	—
3S/3W-14K10	12/07/98	110	18	16	6.3	201	336	140	.39
3S/3W-14K11	12/07/98	18,000	1,500	3,500	470	30,700	382	42,000	< .10
3S/3W-15M19	12/01/98	—	—	—	—	—	—	66	—
	08/25/99	170	43	16	2.1	96	250	71	.18
3S/3W-13A5	120/9/98	300	78	26	1.8	64	296	58	.26
4S/2W-4F6	12/09/98	—	—	—	—	—	—	37	—

Appendix B.Physical-property, major-ion, selected trace-element, and oxygen-18 and deuterium data for ground-water samples analyzed by the U.S. Geological Survey (USGS), East Bay Plain, Alameda County, California, 1997–2000—*Continued*

State well No.	Date	Silica, dissolved (mg/L as SiO_2)	Sulfate, dissolved (mg/L as SO_4)	Sulfide, dissolved (mg/L as SO_2)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia + organic, dissolved (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrate + nitrite, dissolved (mg/L as N)	Nitrogen, nitrite, dissolved (mg/L as N)
2S/3W-16R1	08/12/98	—	—	—	—	—	—	—	—
	12/11/98	37	46	< 0.5	—	—	—	—	—
2S/3W-17K1	12/08/98	34	110	<.5	0.05	<0.10	—	1.4	<0.02
2S/3W-17K2	12/08/98	27	1,200	<.5	1.2	.28	—	< .05	<.02
2S/3W-17K3	03/23/99	39	54	—	.04	<.10	—	10	<.02
2S/3W-17K4	03/23/99	37	18	—	.39	.44	—	< .05	<.02
2S/3W-19Q3	12/08/98	26	19	—	.21	.18	—	< .05	<.02
	12/08/99	—	20	—	—	—	<0.02	—	<.02
	12/08/99	23	32	—	—	—	.09	—	<.02
	12/08/99	—	18	—	—	—	<.02	—	.02
2S/3W-19Q3	12/08/99	—	18	—	—	—	<.02	—	<.02
	12/08/99	—	14	—	—	—	<.02	—	<.02
	12/08/99	24	.98	—	.16	.19	<.02	<.05	<.02
2S/3W-22K8	08/12/98	—	—	—	—	—	—	—	—
2S/3W-22L3	08/12/98	—	—	—	—	—	—	—	—
2S/3W-22L3	12/11/98	36	49	—	—	—	—	—	—
	03/24/99	—	—	—	—	—	—	—	—
2S/3W-22Q2	12/06/99	—	38	—	—	—	2.6	—	.27
	12/06/99	—	48	—	—	—	7.1	—	.02
	12/06/99	—	43	—	—	—	1.4	—	<.02
2S/3W-22Q2	12/06/99	—	38	—	—	—	1.5	—	<.02
	12/06/99	—	40	—	—	—	2.2	—	.02
	12/07/99	36	40	—	<.02	<.10	1.3	1.3	<.02
	12/07/99	—	12	—	—	—	<.02	—	.02
	12/07/99	—	41	—	—	—	1.4	—	.23
2S/3W-22Q2	12/07/99	—	54	—	—	—	.72	—	<.02
	12/07/99	—	42	—	—	—	.54	—	—
2S/3W-25B3	11/17/98	—	—	—	—	—	—	—	—
	12/10/99	—	—	3.0	—	—	—	—	—
2S/3W-25B3	03/24/99	—	—	—	—	—	—	—	—
2S/3W-26C3	11/23/98	—	—	—	—	—	—	—	—
	03/25/99	—	—	—	—	—	—	—	—
2S/3W-28G1	11/24/98	—	—	—	—	—	—	—	—
	08/25/99	35	86	—	0.06	E0.10	—	0.18	< 0.02
2S/4W-3E1	12/23/98	—	—	—	—	—	—	—	—
	08/26/99	40	26	—	<.02	<.10	—	<.05	.02
3S/2W-7E1	02/10/00	28	41	—	.04	E.10	—	<.05	<.02
3S/2W-7G12	11/15/99	36	47	—	<.02	<.10	—	.22	<.02
3S/2W-8M3	11/18/98	—	—	—	—	—	—	—	—
3S/2W-8M3	12/09/98	—	—	—	—	—	—	—	—
	03/24/99	—	—	—	—	—	—	—	—
3S/2W-18K3	10/23/98	—	—	—	—	—	—	—	—

Appendix B.Physical-property, major-ion, selected trace-element, and oxygen-18 and deuterium data for ground-water samples analyzed by the U.S. Geological Survey (USGS), East Bay Plain, Alameda County, California, 1997–2000—*Continued*

State well No.	Date	Silica, dissolved (mg/L as SiO_2)	Sulfate, dissolved (mg/L as SO_4)	Sulfide, dissolved (mg/L as SO_2)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia + organic, dissolved (mg/L as N)	Nitrogen, nitrate dissolved (mg/L as N)	Nitrogen, nitrate + nitrite, dissolved (mg/L as N)	Nitrogen, nitrite, dissolved (mg/L as N)
	08/24/99	<.10	59	—	<.02	E .10	—	10	<.02
3S/2W-18L1	03/31/99	—	—	—	—	—	—	—	—
3S/2W-19R4	11/16/98	—	—	—	—	—	—	—	—
3S/2W-21D3	03/31/99	—	—	—	—	—	—	—	—
3S/2W-21E13	12/09/98	—	—	—	—	—	—	—	—
	08/25/99	37	45	—	<.02	< 0.10	—	2.6	<.02
3S/3W-14K7	12/07/98	25	40	<0.5	.03	< 0.10	< 0.02	.15	.14
3S/3W-14K9	11/13/97	18	40	—	<.02	< 0.10	—	<.05	<.02
	12/07/98	—	—	—	—	—	—	—	—
3S/3W-14K10	12/07/98	47	17	—	.91	1.1	—	<.05	<.02
3S/3W-14K11	12/07/98	20	5,500	—	2.3	2.7	—	<.05	<.02
3S/3W-15M19	12/01/98	—	—	—	—	—	—	—	—
	08/25/99	35	48	—	.06	.12	—	<.05	<.02
3S/3W-13A5	12/09/98	30	43	< .5	.12	.13	—	<.05	<.02
4S/2W-4F6	12/09/98	—	—	—	—	—	—	—	—

Appendix B.Physical-property, major-ion, selected trace-element, and oxygen-18 and deuterium data for ground-water samples analyzed by the U.S. Geological Survey (USGS), East Bay Plain, Alameda County, California, 1997–2000—*Continued*

State well No.	Date	Phosphorous, total, dissolved (mg/L as P)	Phosphorous, ortho, dissolved (mg/L as PO_4)	Solids, residue at 180°C, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Boron, dissolved (µg/L as B)	Bromide, dissolved (mg/L as Br)
2S/3W-16R1	08/12/98	—	—	—	—	—	180	440	2.5
	12/11/98	—	—	1,010	913	<2	150	420	1.5
2S/3W-17K1	12/08/98	0.12	0.09	7,880	5,880	1	1,400	420	13
2S/3W-17K2	12/08/98	.94	.71	31,400	30,300	7	460	1,200	52
2S/3W-17K3	03/23/99	.07	.05	1,190	1,010	<2	310	280	1.4
2S/3W-17K4	03/23/99	.16	.18	652	633	32	160	650	.092
2S/3W-19Q3	12/08/98	.27	.28	740	753	37	480	2,000	.63
	12/08/99	—	—	—	682	—	480	2,100	.31
	12/08/99	—	—	—	480	—	150	620	.086
	12/08/99	—	—	—	786	—	600	2,600	.43
2S/3W-19Q3	12/08/99	—	—	—	1,060	—	1,100	4,200	.9
	12/08/99	—	—	—	1,130	—	1,200	5,000	2.1
	12/08/99	.17	.15	1,310	1,280	13	2,300	9,300	1.5
2S/3W-22K8	08/12/98	—	—	—	—	—	170	310	.39
2S/3W-22L3	08/12/98	—	—	—	—	—	130	380	.64
2S/3W-22L3	12/11/98	—	—	678	664	2	130	380	.76
	03/24/99	—	—	—	—	—	—	—	—
2S/3W-22Q2	12/06/99	—	—	—	736	—	180	320	1.1
	12/06/99	—	—	—	672	—	150	380	.9
	12/06/99	—	—	—	598	—	140	380	.78
2S/3W-22Q2	12/06/99	—	—	—	503	—	110	400	.47
	12/06/99	—	—	—	505	—	100	400	.51
	12/07/99	.05	.04	554	554	<2	110	400	.48
	12/07/99	—	—	—	449	—	99	370	.57
	12/07/99	—	—	—	438	—	82	390	.29
2S/3W-22Q2	12/07/99	—	—	—	585	—	120	360	.71
	12/07/99	—	—	—	487	—	97	370	.49
2S/3W-25B3	11/17/98	—	—	—	—	—	—	—	—
	12/10/98	—	—	—	—	—	6.2	310	.34
2S/3W-25B3	03/24/99	—	—	—	—	—	—	—	—
2S/3W-26C3	11/23/98	—	—	—	—	—	130	210	0.13
	03/25/99	—	—	—	—	—	140	210	.14
2S/3W-28G1	11/24/98	—	—	—	—	—	380	370	5
	08/25/99	0.06	0.06	2,940	2,570	2	370	340	4.9
2S/4W-3E1	12/23/98	—	—	—	—	—	140	280	.21
	08/26/99	E.05	.06	516	525	< 2	150	300	.43
3S/2W-7E1	02/10/00	.09	.08	514	480	< 2	99	500	.13
3S/2W-7G12M	11/15/99	E.05	.06	454	458	E 2	95	330	.15
3S/2W-8M3	11/18/98	—	—	—	—	—	170	420	.36
3S/2W-8M3	12/09/98	—	—	—	—	—	180	450	.36
	03/24/99	—	—	—	—	—	170	440	.34
3S/2W-18K3	10/23/98	—	—	—	—	—	160	300	.28

Appendix B.Physical-property, major-ion, selected trace-element, and oxygen-18 and deuterium data for ground-water samples analyzed by the U.S. Geological Survey (USGS), East Bay Plain, Alameda County, California, 1997–2000—*Continued*

State well No.	Date	Phosphorous, total, dissolved (mg/L as P)	Phosphorous, ortho, dissolved (mg/L as PO_4)	Solids, residue at 180°C, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Boron, dissolved (µg/L as B)	Bromide, dissolved (mg/L as Br)
	08/24/99	.13	.13	398	551	< 2	140	310	.24
3S/2W-18L1	03/31/99	—	—	—	—	—	72	420	.11
3S/2W-19R4	11/16/98	—	—	—	—	—	150	250	.25
3S/2W-21D3	03/31/99	—	—	—	—	—	120	310	.15
3S/2W-21E13	12/09/98	—	—	—	—	—	79	350	.18
	08/25/99	.06	.07	481	496	< 2	83	340	.16
3S/3W-14K7	12/07/98	.24	.20	358	365	< 2	45	390	.14
3S/3W-14K9	11/13/97	.12	.12	—	418	—	—	460	—
	12/07/98	—	—	—	—	—	—	—	—
3S/3W-14K10	12/07/98	.35	.37	612	647	4	27	600	.48
3S/3W-14K11	12/07/98	.08	.22	77,300	84,000	6	80	6,600	130
3S/3W-15M19	12/01/98	—	—	—	—	—	72	440	.17
	08/25/99	.07	.08	451	464	3	75	450	.16
3S/3W-13A5	12/09/98	.15	.18	477	482	6	99	390	.21
4S/2W-4F6	12/09/98	—	—	—	—	—	86	410	.09

Appendix B.Physical-property, major-ion, selected trace-element, and oxygen-18 and deuterium data for ground-water samples analyzed by the U.S. Geological Survey (USGS), East Bay Plain, Alameda County, California, 1997–2000 — *Continued*

State well No.	Date	Iodide, dissolved (mg/L as I)	Iron, dissolved (µg/L as Fe)	Manganese dissolved (µg/L as Mn)	Strontium dissolved (µg/L as Sr)	Delta deuterium (per mil)	Delta oxygen-18 (per mil)	Depth of sample collection (feet)	Well depth (feet)
2S/3W-16R1	08/12/98	0.091	—	—	—	-43	-6.2	—	495
	12/11/98	.12	130	300	1,200	-43	-6.4	—	495
2S/3W-17K1	12/08/98	.023	<100	<30	8,600	-38	-5.6	—	205
2S/3W-17K2	12/08/98	.43	<500	7,000	24,000	-25	-3.4	—	80
2S/3W-17K3	03/23/99	.042	<10	4.5	1,500	-43	-6.5	—	360
2S/3W-17K4	03/23/99	.046	10	95	440	-47	-7.0	—	555
2S/3W-19Q3	12/08/98	1.5	<10	200	600	-48	-7.1	—	1,000
	12/08/99	1.5	54	250	—	-48	-7.2	—	1,000
	12/08/99	1.0	59	190	—	-49	-7.2	450	1,000
	12/08/99	1.7	210	290	—	-45	-7.1	630	1,000
2S/3W-19Q3	12/08/99	2.2	37	390	—	-46	-7.0	700	1,000
	12/08/99	1.2	340	440	—	-44	-7.0	820	1,000
	12/08/99	2.4	190	85	1,400	-44	-6.8	910	1,000
2S/3W-22K8	08/12/98	.007	—	—	—	-42	-6.3	—	551
2S/3W-22L3	08/12/98	.279	—	—	—	-45	-6.6	—	809
2S/3W-22L3	12/11/98	.245	5.6	51	810	-45	-6.6	—	809
	03/24/99	—	—	—	—	—	—	—	809
2S/3W-22Q2	12/06/99	.021	<10	130	—	-41	-6.3	280	740
	12/06/99	.061	<10	230	—	-42	-6.3	360	740
	12/06/99	.081	<10	210	—	-42	-6.4	460	740
2S/3W-22Q2	12/06/99	.17	<10	130	—	-44	-6.6	540	740
	12/06/99	.17	<10	140	—	-46	-6.6	650	740
	12/07/99	.16	E7.1	130	740	-45	-6.5	—	740
	12/07/99	.17	<10	130	—	-44	-6.6	282	740
	12/07/99	.23	<10	38	—	-46	-6.8	360	740
2S/3W-22Q2	12/07/99	.18	E5.2	100	—	-46	-6.7	540	740
	12/07/99	.17	<10	120	—	-44	-6.3	640	740
2S/3W-25B3	11/17/98	—	—	—	—	-39	-5.6	—	88
	12/10/98	.006	—	—	—	-39	-5.6	—	88
2S/3W-25B3	03/24/99	—	—	—	—	—	—	—	88
2S/3W-26C3	11/23/98	.001	—	—	—	-51	-7.4	—	100
	03/25/99	0.001	—	—	—	-50	-7.4	—	100
2S/3W-28G1	11/24/98	.11	—	—	—	-40	-6.0	—	250
	08/25/99	.11	<10	2,900	4,800	-39	-6.0	—	250
2S/4W-3E1	12/23/98	.32	—	—	—	-48	-7.0	—	353
	08/26/99	.30	130	39	520	-47	-6.9	—	353
3S/2W-7E1	02/10/00	.41	<10	390	440	-50	-7.3	—	540
3S/2W-7G12M	11/15/99	.086	51	190	700	-40	-5.9	—	610
3S/2W-8M3	11/18/98	.006	—	—	—	-47	-6.8	—	85
3S/2W-8M3	12/09/98	.006	—	—	—	-47	-6.9	—	85
	03/24/99	.005	—	—	—	-44	-6.9	—	85
3S/2W-18K3	10/23/98	.008	—	—	—	-46	-6.9	—	155
	08/24/99	.016	<10	6.8	800	-44	-6.7	—	155

Appendix B.Physical-property, major-ion, selected trace-element, and oxygen-18 and deuterium data for ground-water samples analyzed by the U.S. Geological Survey (USGS), East Bay Plain, Alameda County, California, 1997–2000 — *Continued*

State well No.	Date	Iodide, dissolved (mg/L as I)	Iron, dissolved (µg/L as Fe)	Manganese dissolved (µg/L as Mn)	Strontium dissolved (µg/L as Sr)	Delta deuterium (per mil)	Delta oxygen-18 (per mil)	Depth of sample collection (feet)	Well depth (feet)
3S/2W-18L1	03/31/99	.16	—	—	—	-39	-6.0	—	—
3S/2W-19R4	11/16/98	.013	—	—	—	-44	-6.5	—	112
3S/2W-21D3	03/31/99	.008	—	—	—	-49	-7.3	—	220
3S/2W-21E13	12/09/98	.087	—	—	—	-40	-6.1	—	550
	08/25/99	.091	36	400	660	-39	-6.1	—	550
3S/3W-14K7	12/07/98	.24	<10	81	270	-59	-8.4	—	660
3S/3W-14K9	11/13/97	—	32	120	—	-46	-7.1	—	660
	12/07/98	—	—	—	—	-82	-11.1	—	660
3S/3W-14K10	12/07/98	.28	41	108	300	-41	-6.3	—	200
3S/3W-14K11	12/07/98	.96	<500	39,000	25,000	-23	-2.7	—	60
3S/3W-15M19	12/01/98	.16	—	—	—	-40	-6.0	—	600
	08/25/99	.23	<10	120	640	-43	-6.4	—	600
3S/3W-13A5	12/09/98	.07	11	500	820	-39	-5.9	—	90
4S/2W-4F6	12/09/98	.12	—	—	—	-48	-7.2	—	534

Appendix C. Physical-property, major-ion, and selected trace-element data for ground-water samples collected and analyzed by other agencies, East Bay Plain, Alameda County, California, 1998–99

[Location of sites shown in figure 1; DWR, California Department of Water Resources; EBMUD, East Bay Municipal Utility District; µS/cm, microsiemens per centimeter at 25 degrees Celsius, ºC, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; <, actual value less than value shown; —, no data; values have been rounded from original data]

State well No.	Date	Agency that analyzed sample	pH, field (standard units)	pH, lab (standard units)	Specific conductance, field (µS/cm)	Specific conductance, lab (µS/cm)	Temperature water ºC	Hardness, total (mg/L as $CaCO_3$)
1S/3W-31N1	11/19/98	DWR	—	7.5	—	1,750	—	—
1S/4W-34F4	11/19/98	DWR	—	7.0	—	1,240	—	280
2S/3W-8D4	11/17/98	DWR	—	7.1	—	484	—	210
2S/3W-16R1	08/12/98	EBMUD	—	7.7	—	1,950	—	600
2S/3W-19Q3	09/02/98	EBMUD	—	8.2	—	847	—	120
2S/3W-19Q3	10/18/99	EBMUD	8	8.2	832	856	23	89
2S/3W-22K8	09/12/98	EBMUD	—	7.9	—	870	—	310
2S/3W-22L3	09/12/98	EBMUD	—	7.8	—	1,180	—	350
2S/3W-25B3	11/17/98	EBMUD	7.5	7.6	790	680	19.5	330
2S/3W-26C3	11/23/98	EBMUD	6.3	7	620	578	—	220
2S/3W-28G1	11/24/98	EBMUD	7.3	7.3	—	4,250	18.5	2,100
	10/18/99	EBMUD	6.5	7.7	3,780	3,900	19	1,540
2S/3W-34K7	11/18/98	DWR	—	7.8	—	662	—	130
2S/3W-34R12	11/17/98	DWR	—	7.7	—	803	—	150
3S/1W-18K3	12/23/98	EBMUD	—	7.2	—	—	—	380
3S/2W-8M3	11/18/98	EBMUD	6.9	7.5	1,070	1,080	18	410
	10/20/99	EBMUD	6	7.5	1,030	1,030	19	400
3S/2W-15M19	12/01/98	EBMUD	7.6	8	800	730	17	210
3S/3W-13A5	12/01/98	EBMUD	7.5	7.9	780	730	15.5	270
3S/2W-19L2	11/18/98	DWR	—	7.7	—	730	—	—
3S/2W-19R4	11/16/98	EBMUD	7.4	7.5	950	910	19.5	370
3S/2W-21D3	03/31/99	EBMUD	—	7.5	—	666	—	250
3S/2W-21E13	09/12/98	EBMUD	—	7.8	—	760	17	260
3S/2W-30R14	11/16/98	DWR	—	7.3	—	1,360	—	—
	10/19/99	EBMUD	6	7.7	1,260	1,290	18	—
3S/2W-35J11	10/20/99	EBMUD	6.3	7.9	954	974	20	190
3S/3W-3L23	12/01/98	DWR	—	7.8	—	832	—	140
4S/2W-4F6	12/09/98	DWR	8.2	7.9	580	590	20	140

Appendix C. Physical-property, major-ion, and selected trace-element data for ground-water samples collected and analyzed by other agencies, East Bay Plain, Alameda County, California, 1998–99—Continued

State well No.	Date	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Sodium, dissolved (mg/L as Na)	Alkalinity, unfiltered, lab (mg/L as $CaCO_3$)	Chloride, dissolved (mg/L as C)	Fluoride, dissolved (mg/L as F)
1S/3W-31N1	11/19/98	—	—	—	160	260	390	—
1S/4W-34F4	11/19/98	46	41	—	140	200	250	—
2S/3W-8D4	11/17/98	19	39	—	27	180	16	—
2S/3W-16R1	08/12/98	190	75	4.1	160	170	460	0.10
2S/3W-19Q3	09/02/98	28	12	1.4	250	270	230	.10
2S/3W-19Q3	10/18/99	24	7	0.5	150	270	94	—
2S/3W-22K8	09/12/98	77	34	1.8	55	220	98	.14
2S/3W-22L3	08/12/98	95	34	2.2	100	210	200	.10
2S/3W-25B3	11/17/98	69	43	.93	40	250	43	.17
2S/3W-26C3	11/23/98	49	30	.62	35	180	28	.18
2S/3W-28G1	11/24/98	430	180	5.0	180	200	1,500	.12
	10/19/99	400	130	4.1	160	230	1,200	—
2S/3W-34K7	11/18/98	30	13	—	100	270	34	—
2S/3W-34R12	11/17/98	38	14	—	120	260	79	—
3S/1W-18K3	12/23/98	110	38	1.4	64	310	61	.26
3S/2W-8M3	11/18/98	110	36	1.1	61	320	55	.27
	10/20/99	100	32	<.5	63	320	46	—
3S/2W-15M19	12/01/98	57	200	2.4	87	250	58	.24
3S/3W-13A5	12/01/98	82	24	1.8	56	270	52	.23
3S/2W-19L2	11/18/98	—	—	—	73	280	50	—
3S/2W-19R4	11/16/98	100	29	1.3	58	320	57	—
3S/2W-21D3	03/31/99	55	21	.69	49	260	62	.26
3S/2W-21E13	09/12/98	75	26	1.6	73	270	64	.18
3S/2W-30R14	11/16/98	—	—	—	100	430	120	—
	10/19/99	120	36	<.5	93	420	100	—
3S/2W-35J11	10/20/99	47	17	1.4	140	340	79	—
3S/3W-3L23	12/01/98	41	9	—	120	240	86	—
4S/2W-4F6	12/01/98	41	9	—	74	210	38	—

Appendix C. Physical-property, major-ion, and selected trace-element data for ground-water samples collected and analyzed by other agencies, East Bay Plain, Alameda County, California, 1998–99—Continued

State well No.	Date	Silica, dissolved (mg/L as CiO_2)	Sulfate, dissolved (mg/L as SO_4)	Sulfide, dissolved (mg/L as SO_2)	Ammonia dissolved (mg/L as N)	Nitrate, dissolved (mg/L as N)	Phosphorus, total, dissolved (mg/L as P)	Phosphorus, orthos, dissolved (mg/L as PO_4)
1S/3W-31N1	11/19/98	—	48	—	—	—	—	—
1S/4W-34F4	11/19/98	—	30	—	—	—	—	—
2S/3W-8D4	11/17/98	—	33	—	—	—	—	—
2S/3W-16R1	08/12/98	34	14	<0.1	<0.3	1.0	0.08	0.03
2S/3W-19Q3	09/02/98	23	16	<.1	<.3	<.003	.36	.33
2S/3W-19Q3	10/18/99	—	31	—	—	—	—	—
2S/3W-22K8	09/12/98	30	44	<.1	<.3	5.4	.10	.10
2S/3W-22L3	08/12/98	34	50	<.1	<.3	3.2	.15	.05
2S/3W-25B3	11/17/98	43	50	<.1	<.3	5.3	.02	.03
2S/3W-26C3	11/23/98	32	48	<.1	<.3	8.9	.05	.05
2S/3W-28G1	11/24/98	32	92	<.1	<.3	.14	.09	.07
	10/18/99	—	61	—	—	—	—	—
2S/3W-34K7	11/18/98	—	34	—	—	—	—	—
2S/3W-34R12	11/17/98	—	23	—	—	—	—	—
3S/1W-18K3	12/23/98	33	49	<.1	<.3	12	.13	.12
3S/2W-8M3	11/18/98	27	100	<.1	<.3	25	.15	.14
	10/20/99	—	82	—	—	—	—	—
3S/2W-15M19	12/01/98	34	50	<.1	<.3	.42	.08	.07
3S/3W-13A5	12/01/98	28	42	<.1	<.3	<.003	.16	.15
2S/3W-19L2	11/18/98	—	36	—	—	—	—	—
3S/2W-19R4	11/16/98	30	43	<.1	<.3	9.7	.13	.11
3S/2W-21D3	03/31/99	33	45	<.1	<.3	—	.11	.10
3S/2W-21E13	12/09/98	35	46	<.1	<.3	2.5	.09	.08
3S/2W-30R14	11/16/98	—	91	—	—	—	—	—
	10/19/99	—	80	—	—	—	—	—
3S/2W-35J11	10/20/99	—	59	—	—	—	—	—
3S/3W-3L23	12/01/98	—	44	—	—	—	—	—

Appendix C. Physical-property, major-ion, and selected trace-element data for ground-water samples collected and analyzed by other agencies, East Bay Plain, Alameda County, California, 1998–99—Continued

State well No.	Date	Solids, residue at 180°C, dissolved (mg/L)	Aluminum, dissolved (µg/L as Al)	Arsenic, dissolved (µg/L as As)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Well depth (feet)
1S/3W-31N1	11/19/98	—	—	—	—	—	180
1S/4W-34F4	11/19/98	—	—	—	—	—	400
2S/3W-8D4	11/17/98	—	—	—	—	—	200
2S/3W-16R1	08/12/98	1,300	<22	<11	<36	590	495
2S/3W-19Q3	090/2/98	750	<22	33	<36	210	1,000
2S/3W-19Q3	10/18/99	—	—	—	—	—	1,000
2S/3W-22K8	09/12/98	520	<22	<11	42	1.9	551
2S/3W-22L3	08/12/98	690	<22	<11	<36	54	944
2S/3W-25B3	11/17/98	480	<22	<11	<36	.62	88
2S/3W-26C3	11/23/98	370	<22	<11	43	4.1	100
2S/3W-28G1	11/24/98	3,700	<22	<11	<36	3,000	250
	10/18/99	—	—	—	—	—	250
2S/3W-34K7	11/18/98	—	—	—	—	—	475
2S/3W-34R12	11/17/98	—	—	—	—	—	610
3S/1W-18K3	12/23/98	630	<22	<11	<36	13	155
3S/2W-8M3	11/18/98	660	<22	<11	<36	6.6	85
	10/20/98	—	—	—	—	—	85
3S/2W-15M19	12/01/98	450	<22	<11	38	481	—
3S/3W-13A5	12/01/98	440	<22	<11	<36	13	90
3S/2W-19L2	11/18/98	—	—	—	—	—	—
3S/2W-19R4	11/16/98	570	<22	<11	<36	13	112
3S/2W-21D3	03/31/99	410	<22	<11	326	28	—
3S/2W-21E13	09/12/98	490	<22	<11	74	420	550
3S/2W-30R14	11/16/98	—	—	—	—	—	80
	10/19/99	—	—	—	—	—	—
3S/2W-35J11	10/20/99	—	—	—	—	—	—
3S/3W-3L23	120/1/98	—	—	—	—	—	630
4S/2W-4F6	12/01/98	—	—	—	—	—	534

Appendix D: Sample collection, preservation, and analytical methods

Samples were collected by the U.S. Geological Survey, East Bay Municipal Utility District (EBMUD), and Alameda County Flood Control and Water Conservation District (ACWFC&WCD) during 1997–2000. Samples from domestic and industrial wells were collected using existing pumping systems; samples from unused wells and monitoring wells were collected using a small diameter, stainless steel, submersible pump (Wilde and others, 1999a). Depth-dependent samples were collected using a flexible small-diameter sampler (U.S. Patent Number 6,131,451).

Field parameters (pH, specific conductance, temperature, and alkalinity) were measured for each sample collected by the U.S. Geological Survey. Selected samples were processed in the field and sent to the U.S. Geological Survey's National Water Quality Laboratory (NWQL) for analysis. Samples for inorganic analysis of dissolved constituents were filtered in the field using a capsule filter having a pore size of 0.45-mm (Wilde and others, 1999b) Nutrients were preserved by chilling at 4oC and were analyzed within 7 days. Trace elements were preserved by acidification to pH < 2.0. Stable isotope samples were sent to the USGS stable isotope laboratory. Tritium samples were sent to the USGS tritium laboratory. Carbon isotope samples were sent to the University of Waterloo isotope laboratory. Dissolved gas samples were collected in copper tubing, cold welded in the field, and sent to the University of Rochester for analyses. Analytical methods and associated reporting limits are listed in table D1. Field parameters (pH, specific conductance, temperature) occasionally were measured for samples collected by other agencies. Samples collected by these agencies were processed in the field and sent to their respective laboratories for analyses. Analytical methods and their respective reporting levels used by the EBMUD and the California Department of Water Resources are listed in tables D2 and D3, respectively.

Selected depth dependent samples were analyzed in the USGS San Diego Projects Office laboratory for anions (chloride, sulfate, nitrate) using ion chromatography (U.S. Environmental Protection Agency, 1998).

Table D1. Analytical methods and reporting limits for water samples submitted to the U.S. Geological Survey National Water Quality Laboratory

[µS/cm, microsiemens per centimeter at 25ºC; µg/L, micrograms per liter; mg/L, milligrams per liter, ºC, degrees Celsius; ASF, automated-segmented flow; pCi/L, picocuries per liter]

Constituent	Methodology	Reporting limit	Reference
Field parameters			
pH	pH electrode	0.1 std units	Fishman and Friedman, 1989
Specific conductance	Wheatstone bridge	1.0 µS/cm	Fishman and Friedman, 1989
Alkalinity	Titrimetry with sulfuric acid	1.0 mg/L	Fishman and Friedman, 1989
Major ions			
Calcium, dissolved	Inductively coupled plasma	.011 mg/L	Fishman, 1993
Chloride, dissolved	Ion chromatography	.08 mg/L	Fishman and Friedman, 1989
Dissolved solids	Gravimetric, residue on evaporation at 180ºC	10. mg/l	Fishman and Friedman, 1989
Magnesium, dissolved	Inductively coupled plasma	.008 mg/L	Fishman, 1993
Potassium, dissolved	Atomic adsorption, flame	.09 mg/L	Fishman and Friedman, 1989
Silica, dissolved	Colorimetry, ASF	.48 mg/L	Fishman and Friedman, 1989
Sodium, dissolved	Inductively coupled plasma	.06 mg/L	Fishman, 1993
Sulfate, dissolved	Ion chromatography	.11 mg/L	Fishman and Friedman, 1989
Nutrients			
Nitrite, dissolved	Colorimetry, ASF,	.006 mg/L	Fishman, 1993
Nitrite + nitrate, dissolved	Colorimetry, ASF, cadmium reduction-diazotization	.047 mg/L	Fishman, 1993
Ammonia, dissolved	Colorimetry, ASF, salicylate-hypochlorite	.041 mg/L	Fishman, 1993
Ammonia + organic nitrogen, dissolved	Colorimetry, ASF, microkjeldahl digestion	.10 mg/L	Patton and Truitt, 1992
Phosphorus, dissolved	Colorimetry, ASF, microkjeldahl digestion	.05 mg/L	Patton and Truitt, 1992
Orthophosphate, dissolved	Colorimetry, ASF, phosphomolybdate	.018 mg/L	Fishman, 1993
Trace elements			
Arsenic, dissolved	Graphite furnace atomic adsorption	2.0 µg/L	Jones and Garbarino, 1999
Barium, dissolved	Inductively coupled plasma	.9 µg/L	Fishman,, 1993
Boron, dissolved	Inductively coupled plasma	13.0 µg/L	Struzeski and others, 1996
Bromide, dissolved	Colorimetry, ASF	.01 mg/L	Fishman and Friedman, 1989
Fluoride, dissolved	ASF, ion-selective electrode	.16 mg/l	Fishman and Friedman, 1989
Iodide, dissolved	Colorimetry, ASF, ceric-arseneous	.001 mg/L	Fishman and Friedman, 1989
Iron, dissolved	Inductively coupled plasma	10. µg/L	Fishman, 1993
Manganese, dissolved	Inductively coupled plasma	3.2 µg/L	Fishman, 1993
Isotopes			
Carbon-14	Accelerator Mass Spectrometry	.3 percent	Beukens, R.P., 1992
Carbon-13/Carbon-12	Mass Spectrometry	.15 permil	Gleason and others, 1969
Deuterium/Protium	Mass Spectrometry	2. permil	Coplen and others, 1991
Oxygen-18/Oxygen-16	Mass Spectrometry	.2 permil	Epstein and Mayeda, 1953
Tritium	Electrolytic enrichment and liquid scintillation	1.0 pCi/L	Thatcher and others, 1977

Table D2. Analytical methods and reporting limits for water samples submitted to the East Bay Municipal Utility District Laboratory

[µS/cm, microsiemens per centimeter at 25 degrees Centigrade; µg/L, micrograms per liter; µg/L, milligrams per liter]

Constituent	Methodology	Method	Reporting limit	Reference
pH	pH electrode	EPA 150.1	0.1 std units	U.S. Environmental Protection Agency,1983
Specific conductance	Wheatstone bridge	EPA 120.1	1.0 µS/cm	U.S. Environmental Protection Agency,1983
Alkalinity	Titrimetry with sulfuric acid	SM 2320B	5. mg/L	American Public Health Association, 1992
Hardness, total	Titrimetry with EDTA	EPA 130.2	2. mg/L	U.S. Environmental Protection Agency,1983
Major ions				
Calcium, dissolved	Inductively coupled plasma	EPA 200.7	65. µg/L	U.S. Environmental Protection Agency, 1993
Chloride, dissolved	Ion chromatagraphy	EPA 300.0	.015 mg/L	U.S. Environmental Protection Agency, 1993
Dissolved solids	Gravimetric, residue on evaporation at 180ºC	EPA 160.1	6. mg/L	U.S. Environmental Protection Agency,1983
Magnesium, dissolved	Inductively coupled plasma	EPA 200.7	20. µg/L	U.S. Environmental Protection Agency, 1993
Potassium, dissolved	Inductively coupled plasma	EPA 200.7	4. µg/L	U.S. Environmental Protection Agency, 1993
Silica, dissolved	Inductively coupled plasma	EPA 200.7	120. µg/L	U.S. Environmental Protection Agency, 1993
Sodium, dissolved	Inductively coupled plasma	EPA 200.7	15. µg/L	U.S. Environmental Protection Agency, 1993
Sulfate, dissolved	Ion chromatagraphy	EPA 300.0	.015 mg/l	U.S. Environmental Protection Agency, 1993
Nutrients				
Nitrate, dissolved	Ion chromatagraphy	EPA 300.0	.004 mg/L	U.S. Environmental Protection Agency, 1993
Ammonia, dissolved	Distillation and titration with sulfuric acid	EPA 350.2	.3 mg/L	U.S. Environmental Protection Agency, 1993
PhosphorU.S., dissolved	Spectrophotometry	EPA 365.2	.005 mg/L	U.S. Environmental Protection Agency, 1993
Orthophosphate, dissolved	Spectrophotometry	EPA 365.2	.005 mg/L	U.S. Environmental Protection Agency, 1993
Trace elements				
Sulfide, dissolved	Colorimetry with methylene blue	EPA 376.2	.1 mg/L	U.S. Environmental Protection Agency,1983
Fluoride, dissolved	Ion chromatagraphy	EPA 300.0	.014 mg/L	U.S. Environmental Protection Agency, 1993
Aluminum, dissolved	Inductively coupled plasma	EPA 200.7	30. µg/L	U.S. Environmental Protection Agency, 1993
Arsenic, dissolved	Inductively coupled plasma	EPA 200.7	7. µg/L	U.S. Environmental Protection Agency, 1993
Iron, dissolved	Inductively coupled plasma	EPA 200.7	21. µg/L	U.S. Environmental Protection Agency, 1993
Manganese, dissolved	Inductively coupled plasma	EPA 200.7	.6 µg/L	U.S. Environmental Protection Agency, 1993

Table D3. Analytical methods and reporting limits for water samples submitted to the California Department of Water Resources Laboratory

[µS/cm, microsiemens per centimeter at 25 degrees Centigrade; mg/L, milligrams per liter]

Constituent	Methodology	Method	Reporting limit	Reference
pH	pH electrode	SM 4500 H, B	0.1 pH unit	American Public Health Association, 1992
Specific conductance	Wheatstone bridge	SM 2510 B	1.0 mS/cm	American Public Health Association, 1992
Hardness	Calculation	SM 2340 B	1.0 mg/L	American Public Health Association, 1992
Major ions				
Alkalinity	Titrimetry with H_2SO_4	SM 2320 B	1.0 mg/L	American Public Health Association, 1992
Calcium, dissolved	Inductively coupled plasma	EPA 200.7, Rev 3.3, 1991	1.0 mg/L	U.S. Environmental Protection Agency, 1991
Chloride, dissolved	Automated ferric thiocyanate	EPA 325.2	1.0 mg/L	U.S. Environmental Protection Agency, 1991
Magnesium, dissolved	Inductively coupled plasma	EPA 200.7, Rev 3.3, 1991	1.0 mg/L	U.S. Environmental Protection Agency, 1991
Potassium, dissolved	Inductively coupled plasma	EPA 200.7, Rev 3.3, 1991	.5 mg/L	U.S. Environmental Protection Agency, 1991
Sodium, dissolved	Inductively coupled plasma	EPA 200.7, Rev 3.3, 1991	1.0 mg/L	U.S. Environmental Protection Agency, 1991
Sulfate, dissolved	Automated methylthymol blue	SM 4500-SO4, F	1.0 mg/L	American Public Health Association, 1992

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Appendix E: Aquifer mineralogy, East Bay Plain, Alameda County, California

The mineralogy of selected cores and cuttings was determined by x-ray diffraction (Amonette and Zelazny, 1990). Images of selected materials were obtained using a scanning electron microscope equipped with a spectral analyzer to determine the elemental composition of aquifer materials (Amonette and Zelazny, 1990). Eight samples of core material and cuttings, collected by Fugro Inc. during well installation at proposed injection and recovery sites in the East Bay Plain, were analyzed as part of this study (table E1). These data were supplemented with x-ray diffraction, scanning electron microscopy, and thin-section petrographic analysis of cuttings by Mineralogy Inc. (1997). Mineralogic data were used as inputs to the computer program NETPATH for interpretation of carbon-14 data discussed in this report. Although limited in number, these data were believed to be suitable for that purpose.

Table E1. Samples of core material and cuttings analyzed by x-ray diffraction and scanning electron microscopy, East Bay Plain, Alameda County, California

[Wells drilld by Fugro West, Inc. using mud rotary; ft, foot]

State well No.	Type of sample	Depth (ft)
3S/3W-14K9	cuttings	140
3S/3W-14K9	cuttings	290
3S/3W-14K9	cuttings	360
3S/3W-14K9	cuttings	520
3S/3W-14K9	cuttings	610
3S/3W-14K12	core	447
3S/3W-14K12	core	540
3S/3W-14K12	core	600
3S/3W-14K12	core	660
3S/2W-7E1	core	501

The semi-quantative mineral percentage estimates were obtained by x-ray diffraction on eight samples analyzed by Steven Sutley, U.S. Geological Survey, Lakewood, Colorado, using methods described by Klug and Alexander (1974), Azaroff and others (1958), Jenkins and Snyder (1995), and Buhrke and others (1998). Using these methods, samples were split to obtain a three-gram subsample representative of the bulk sample. This subsample was then pulverized in a micronizing mill to grind the material to an average particle size of 5 microns using an inert organic solvent (such as propoanol or toluene) or water as a buffering agent to diminish crystal-lattice sheer. The subsample was then packed into an aluminum sample holder or placed on a glass slide and analyzed using an automated goniometer with a copper target. The subsample was analyzed at a power setting of 40 kilovolts at a stepping size of 0.03 degrees 2-theta for a 10 second counting time. These parameters were adjusted when necessary to optimize analytical results. Mineral presence was interpreted from the x-ray diffraction pattern, and relative abundance was inferred from the intensity of the diffraction pattern using analytical software linked to computerized database of mineral diffraction patterns. Samples represent the bulk mineralogy and were not pretreated to increase the clay-mineral percentages or isolate the heavy-mineral fraction. Results are summarized in table E2 and illustrated in figure E1.

Results are similar to previous analyses of core material in the East Bay Plain (Mineralogy Inc., 1997) in that quartz is the dominant mineral and a smaller amount of feldspar minerals are present. Other common accessory minerals present in aquifer deposits include mica, chlorite, hematite, calcite, amphibole, gypsum, zoelite, and kaolinite. Siderite, chlorapatite, pyrite, and a wide variety of layered clay minerals were previously detected in aquifer materials (Mineralogy Inc., 1997) but were not detected in core material and cuttings analyzed by the U.S. Geological Survey. The accessory minerals are not distributed evenly throughout the aquifer deposit. For example, calcite and gypsum abundances are greater in fine-grained deposits than in coarser grained deposits. With the exception of chlorapatite, none of the minerals detected within the aquifer deposits are uncommon or unusual for alluvial or nearshore marine deposits.

Scanning electron microscope images show little evidence of weathering or dissolution of mineral grains in cores and cuttings. Grain morphology and spectral analysis suggest that the bulk of the aquifer is composed of relatively non-reactive quartz (fig. E2). This is consistent with x-ray diffraction data in table E2 and figure E1. On the basis of spectral analysis data, most feldspar minerals appear to be a high anorthite feldspar, although albite and orthoclase also were present. Although most of the aquifer appears to be relatively non-reactive, selective dissolution of feldspar minerals was identified as voids within rock fragments by petrographic analysis (Mineralogy Inc., 1997).

On the basis of spectral analysis data, most mineral grains were coated with iron, possibly accounting for the presence of hematite in the x-ray diffraction analyses (table E2). A small amount of material having morphology and spectral compositions similar to organic material was present in core material and cuttings from greater depths (fig. E2). Reactions between ground water and aquifer materials would be expected to increase in areas where organic material is present.

Previous work suggests that most layered clay minerals observed in the samples by x-ray diffraction were believed to have originated within rock fragments composing the aquifer deposits rather than as secondary precipitation of clay minerals within the aquifer (Mineralogy Inc., 1997). Scanning electron microscope images collected as part of this study show evidence of secondary precipitation of calcite (fig. E2), suggesting that this may be an important reaction between ground water and aquifer materials. Calcite formed in this manner contained little magnesium substituted within the mineral structure.

On the basis of scanning electron microscopy with spectral analysis, small amounts of chloride were present in aquifer deposits. Highly soluble chloride minerals are not likely to be present within freshwater aquifers underlying the East Bay Plain. These data are consistent with the presence of a small amount of chlorapatite within the aquifer indicated on the basis of x-ray diffraction data (table D2). Chlorapatite forms as a result of substitution of chloride for fluoride or hydroxide in the common mineral apatite (Hurlbut and Klein, 1971). Dissolution of chlorapatite, or recyrstalization into the more common form apatite, may explain small increases in chloride concentrations that alter chloride-to-bromide and chloride-to-iodide ratios (fig.16) as ground water flows through aquifer deposits. These increases are not nearly as large as chloride concentrations measured in water from underlying aquifers or increases resulting from seawater intrusion.

Table E2. Semi-quantitative mineral abundance in selected samples by x-ray diffraction, East Bay Plain, Alameda County, California

[Data from Steven Sutley, U.S. Geological Survey, Denver, Colarado. Percent abundanceds are relative and absolute values are ± 15 percent. Chemical composition from Hurlbut and Klein, 1971, and Dixon and Weed, 1989, —. not identified; 1/—, identified in samples analyzed by Mineralogy Incorporated (1977)]

Mineral	Chemical composition	Percent of samples present	Median percent abundance	Maximum percent abundance
Quartz	SiO_2	100	50	69
Feldspar group	(an undifferentiated solid solution of 3 end members)	100	34	41
Albite	$NaAlSi_3O_8$			
Anorthite	$CaAl_2Si_2O_8$			
Orthoclase	$KAlSi_3O_8$			
Mica group	(identified as muscovite, biotite identified optically)	100	3	5
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$			
Biotite	$K(Mg, Fe)_2(AlSi_3O_{10})(OH)_2$			
Chlorite	$(Mg,Fe)_3(Si,Al)_4O_{10}(OH)_2>(Mg,Fe)_3(OH)_6$	100	2	5
Hematite	Fe_2O_3	100	1	3
Calcite	$CaCO_3$	50	—	27
Amphibole group	(identified as hornblende)			
Hornblende	$(Ca,Na)_{2-3}(Mg,Fe,Al)_5Si_6(Si,Al)_2O_{22}(OH)_2$		50	<1
Gypsum	$CaSO_4$	25	—	11
Zeolite group	(identified as clinoptilolite and heulandite)	25	—	2
Clinoptilolite	$(Na_3K_3)(Al_6Si_{30}O_{72})>24H_2O$			
Heulandite	$Ca_4(Al_8Si_{22}O_{72})>24H_2O$			
Kaolinite	$Al_2Si_2O_5(OH)_4$	12	—	3
Siderite	FeCO3	1/—	—	—
Chlorapatite	Ca5(PO4)3Cl	1/—	—	—
Pyrite	FeS_2	1/—	—	—

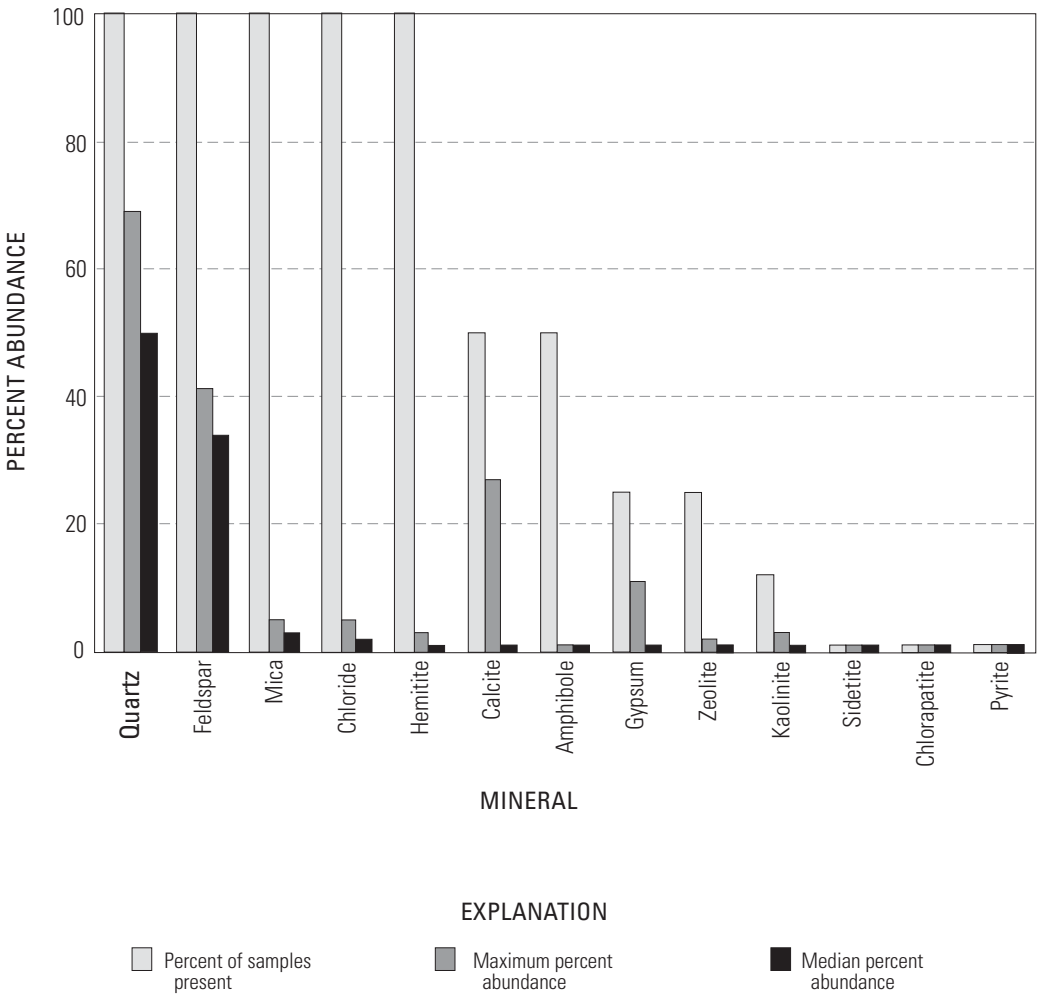

Figure E1. Semi-quantitative mineral adbundance in selectged samples by x-ray diffraction, East Bay Plain, Alameda County, California.

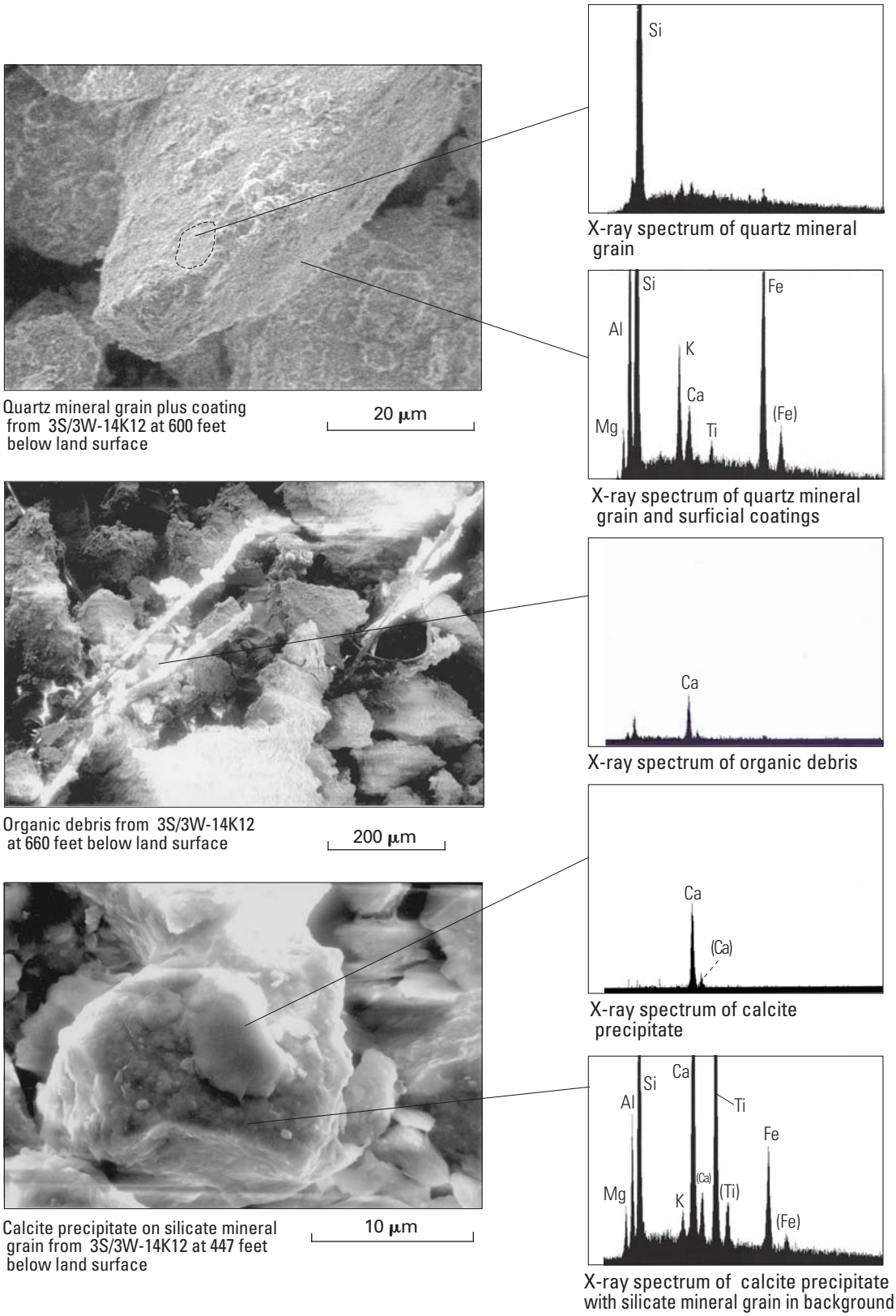

Figure E2. Scanning electron photomocrographs of selected core material, East Bay Plain, Alameda County, California.

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