East Bay Plain Subbasin
Groundwater Sustainability Plan Development

Technical Advisory Committee Meeting

November 18, 2020

PURPOSE OF MEETING

- To provide overview of completed Hydrogeologic Conceptual Model (HCM) Technical Memorandum
- To update on groundwater model development
- To address TAC members' comments
- To outline next steps

DISCUSSION ITEMS

1. GSP Development Updates (10 min.)
2. Summary of Subtask 4.2 HCM Technical Memorandum (60 min.)
3. Groundwater Model Development Update (30 min.)
4. Wrap up and next steps (15 min.)

GSP Development Update – Completed Tasks

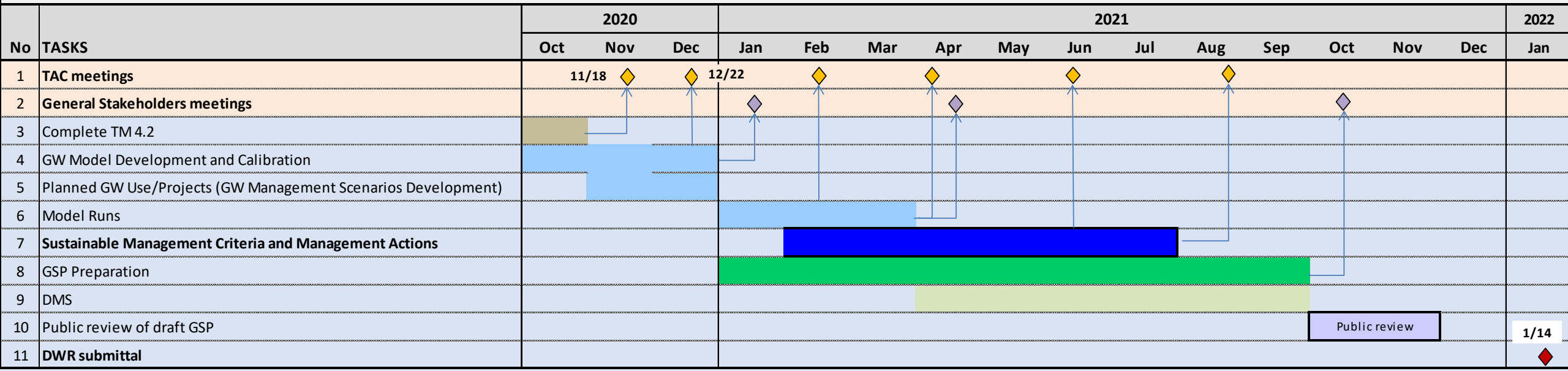
- Executed the Prop 68 grant agreement with DWR on 5/15/2020
- Finalized Subtask 4.1 (Data Analysis) and 4.3 (Model objective and selection) TMs
- Completed the draft Technical Memorandum for Subtask 4.2: Hydrogeologic Conceptual Model (HCM)
- Made progress in the East Bay Plain groundwater model development
- Started the preparation of Salt and Nutrient Management equivalent plan

GSP Development Update - Upcoming Tasks

- Awarding consulting and drilling contracts on 12/8/20
- Starting field work in December
- Completing the groundwater model
- Calibrating the groundwater model
- Running the groundwater model for scenarios
- Acquiring a Data Management System

Schedule for GSP Activities

EAST BAY PLAIN SUBBASIN GSP DEVELOPMENT SCHEDULE
(Updated 11/16/20)



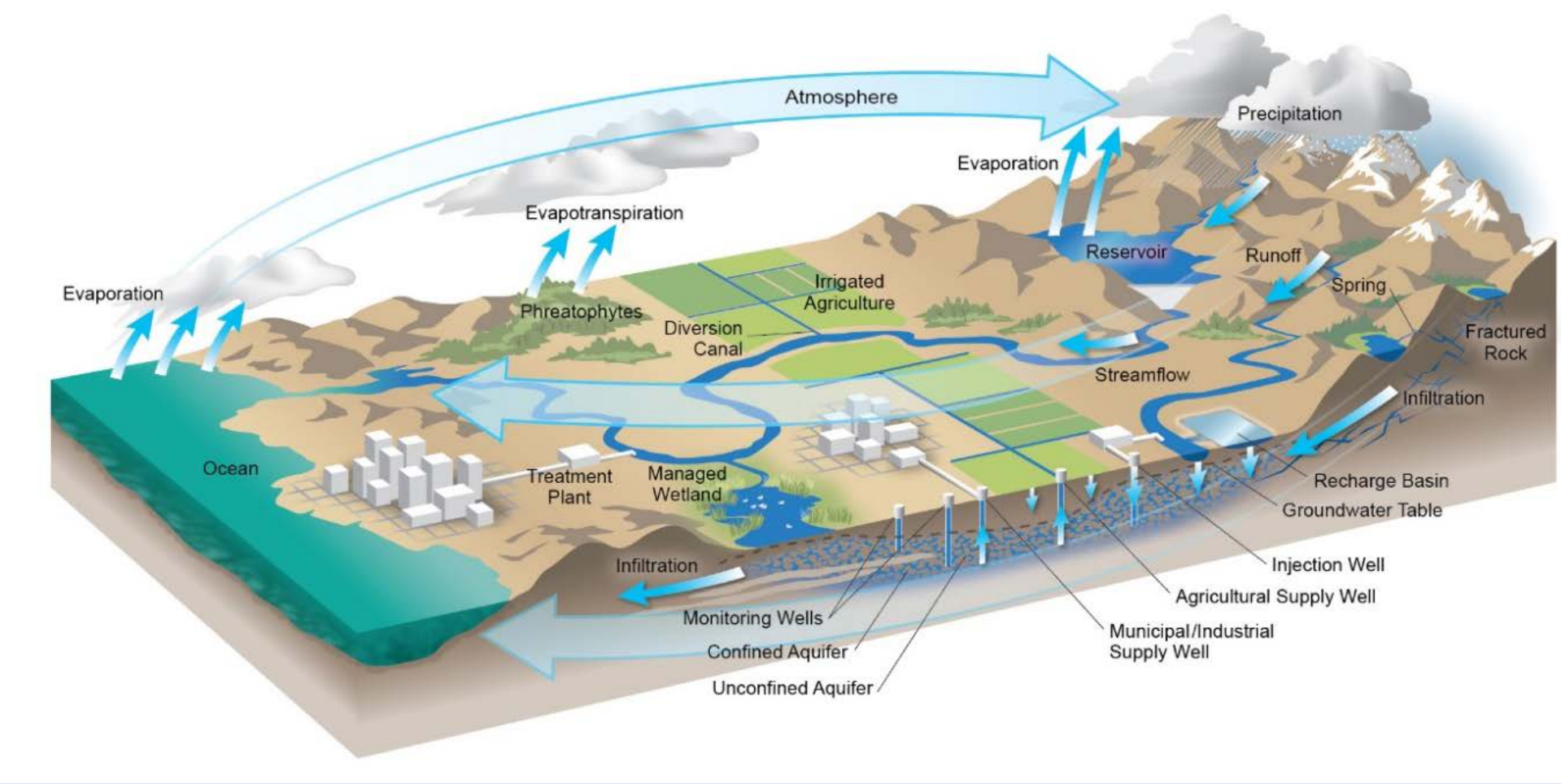
Acronyms:

BOD - EBMUD Board of Directors

TAC - Techinical Advisory Committee

IWG - Interbasin Working Group

Questions: GSP Development



The Hydrologic Cycle, DWR Water Budget BMP, 2016

EBP Subbasin GSP Progress Update

Peter Leffler
Principal Hydrogeologist
Luhdorff & Scalmanini, Consulting Engineers

Gordon Thrupp
Principal Hydrogeologist
Geosyntec Consultants

East Bay Plain Subbasin – Groundwater Sustainability Plan
Technical Advisory Committee Meeting

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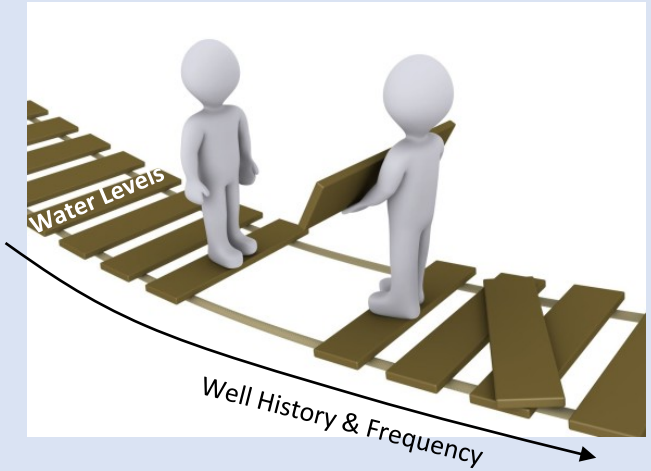
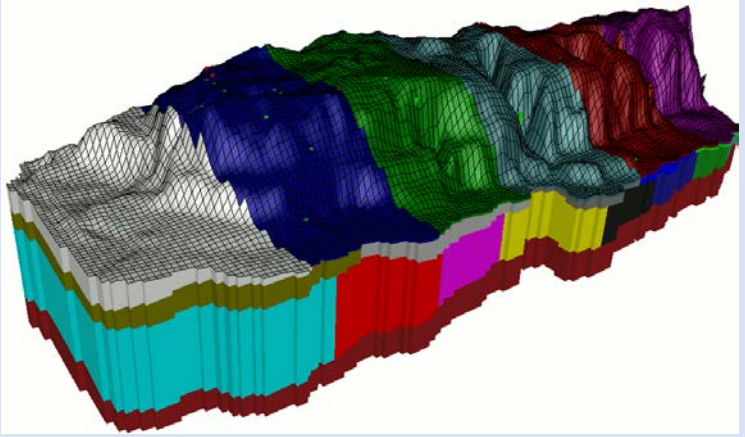
Completed Tasks

Subtask 4.1
Data Compilation and Data Gap Analysis



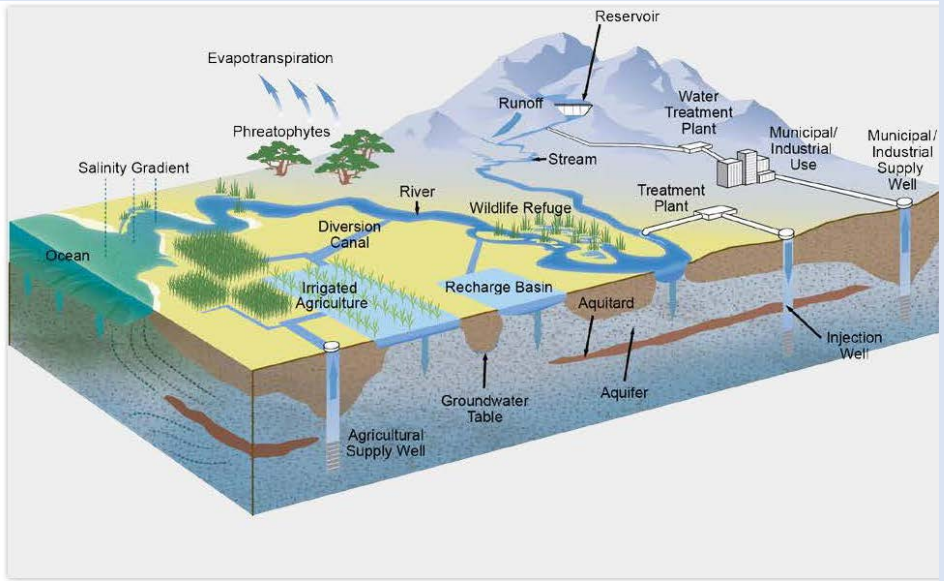
Subtask 4.3:
Model Objectives and Model Selection



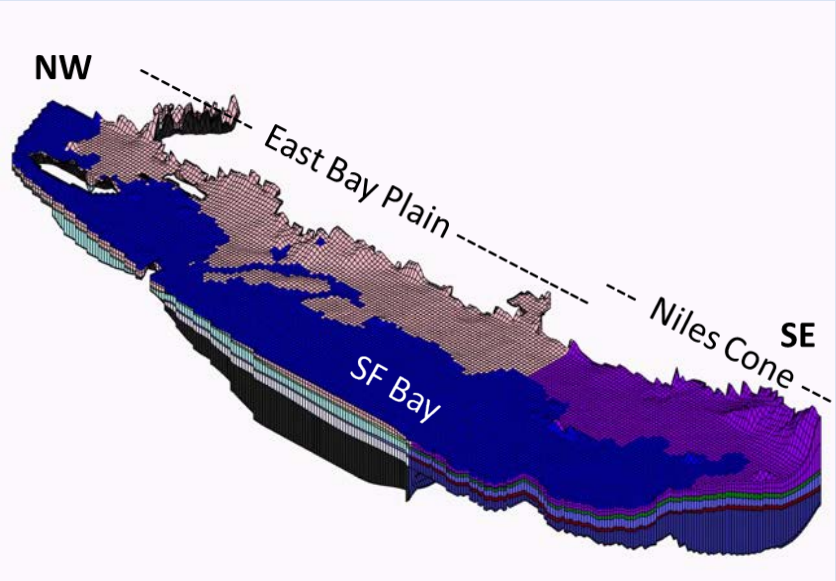
Tasks in Progress

Start w/ 4.2

Subtask 4.2: Hydrogeologic Conceptual Model (HCM)



Subtask 4.4: Model Development



Subtask 4.2 Hydrogeologic Conceptual Model (HCM)

California Code of Regulations

§ 354.14

§ 354.16

§ 354.18

- Geologic Conditions
- Groundwater Conditions
- Water Balance

Subtask 4.2 Hydrogeologic Conceptual Model (HCM)

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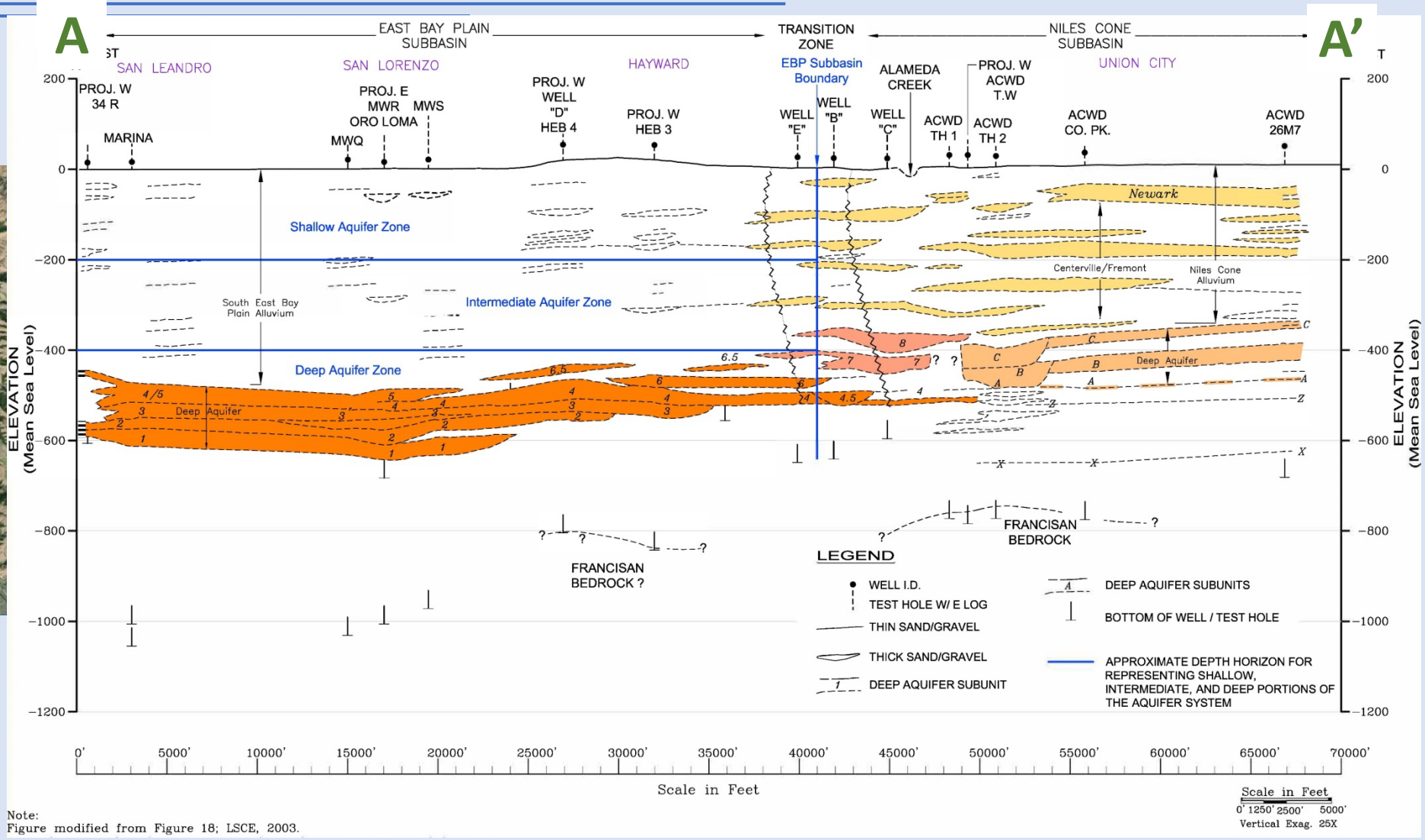
Subtask 4.2 Geologic Conditions – Cross-Section A-A'



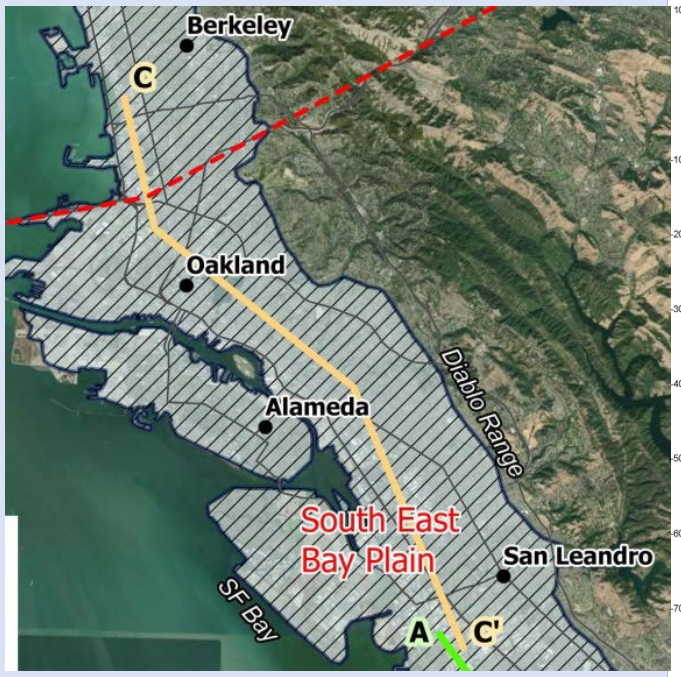
Note:
Figure modified from Figure 18; LSCE, 2003.

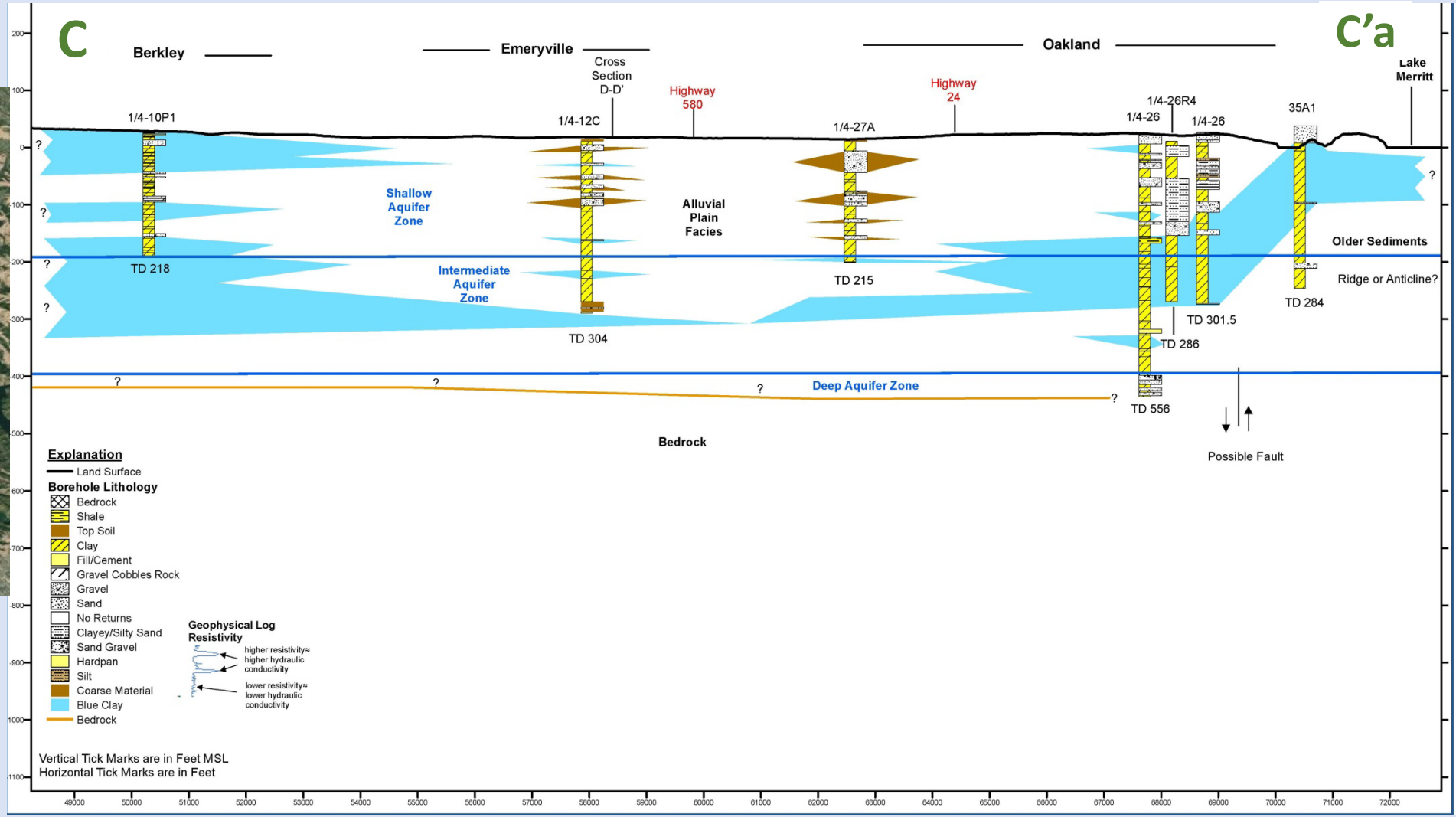
Subtask 4.2 Geologic Conditions – Cross-Section B-B’

B

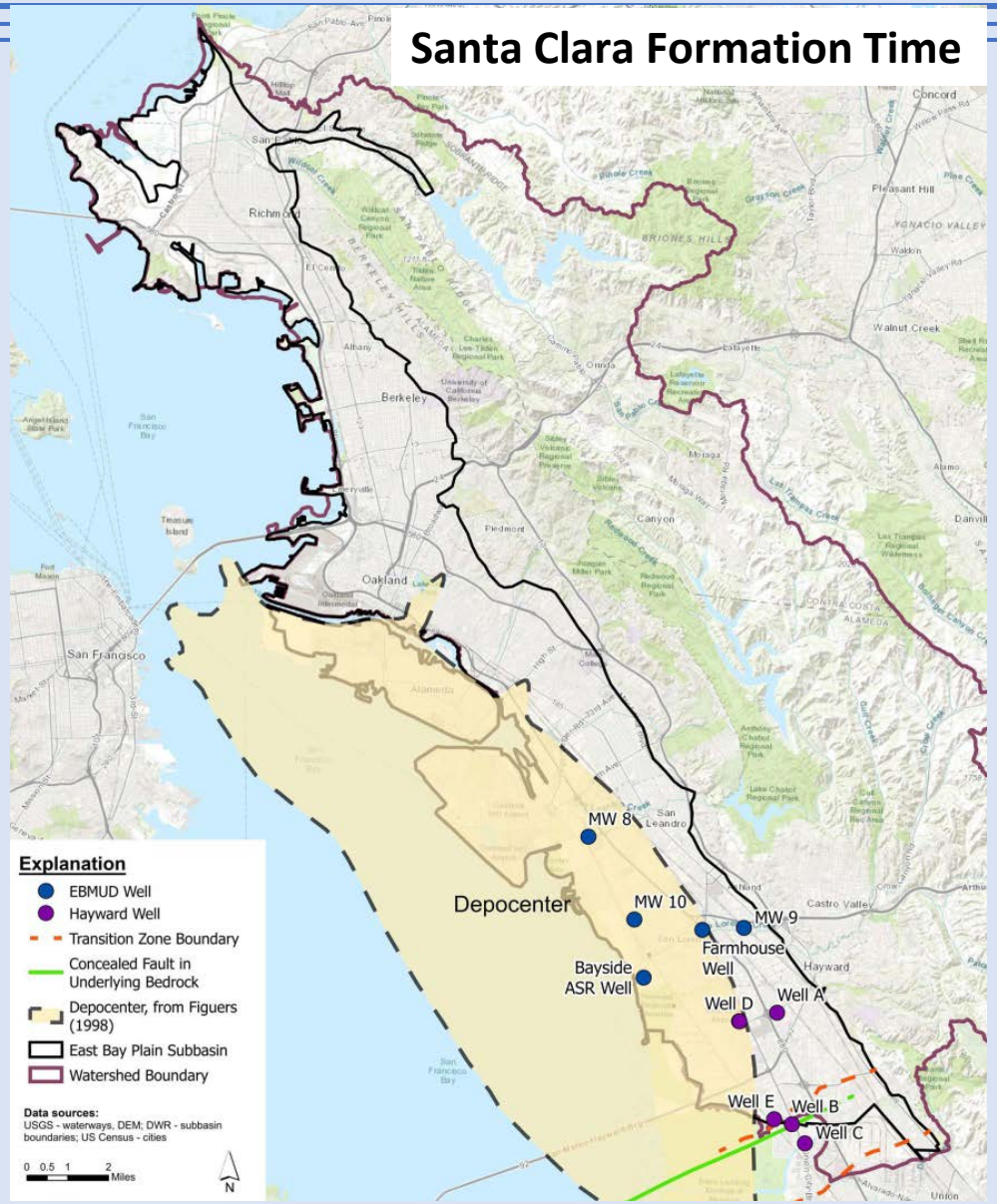
B’

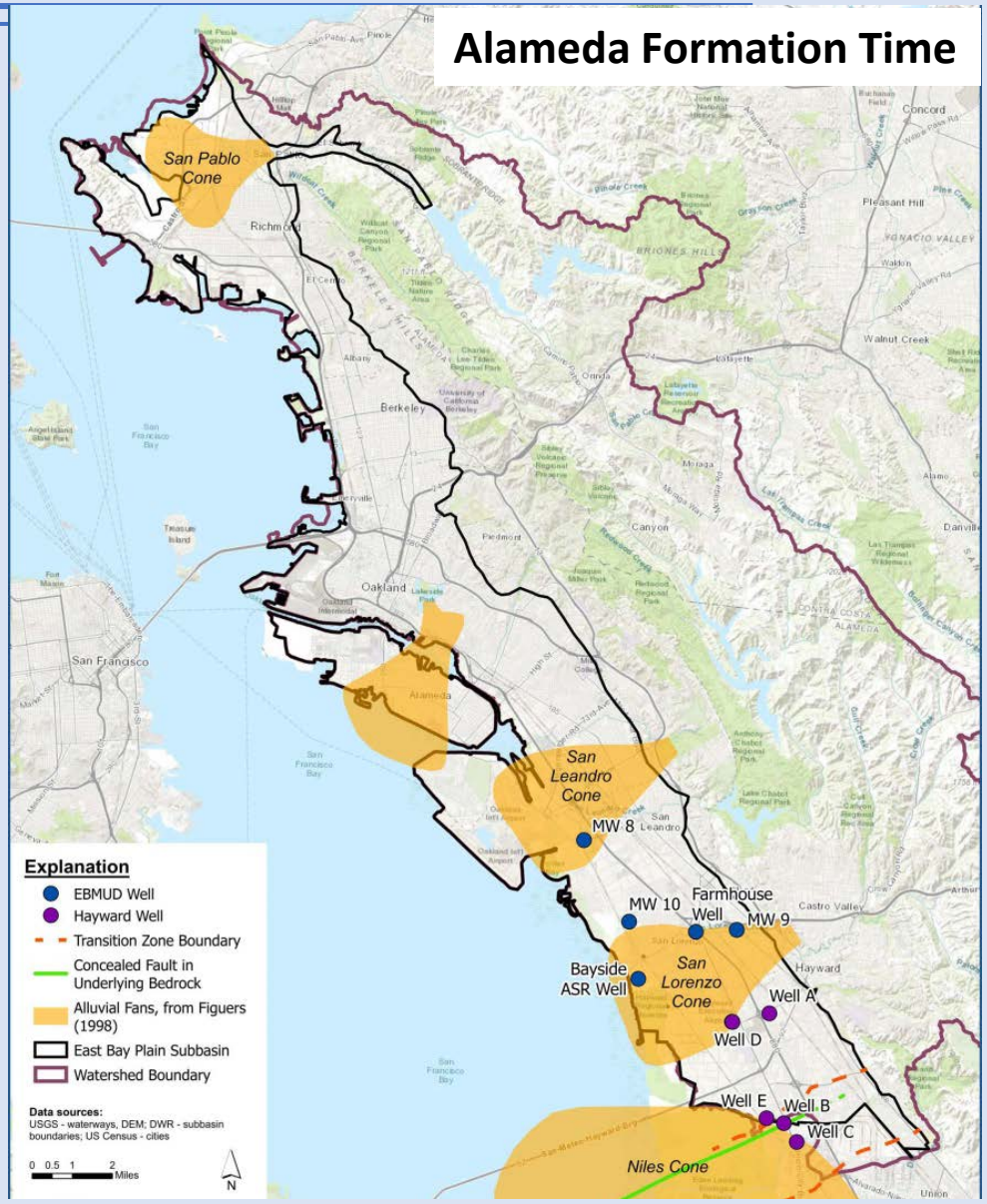
Subtask 4.2 Geologic Conditions – Cross-Section C-C’





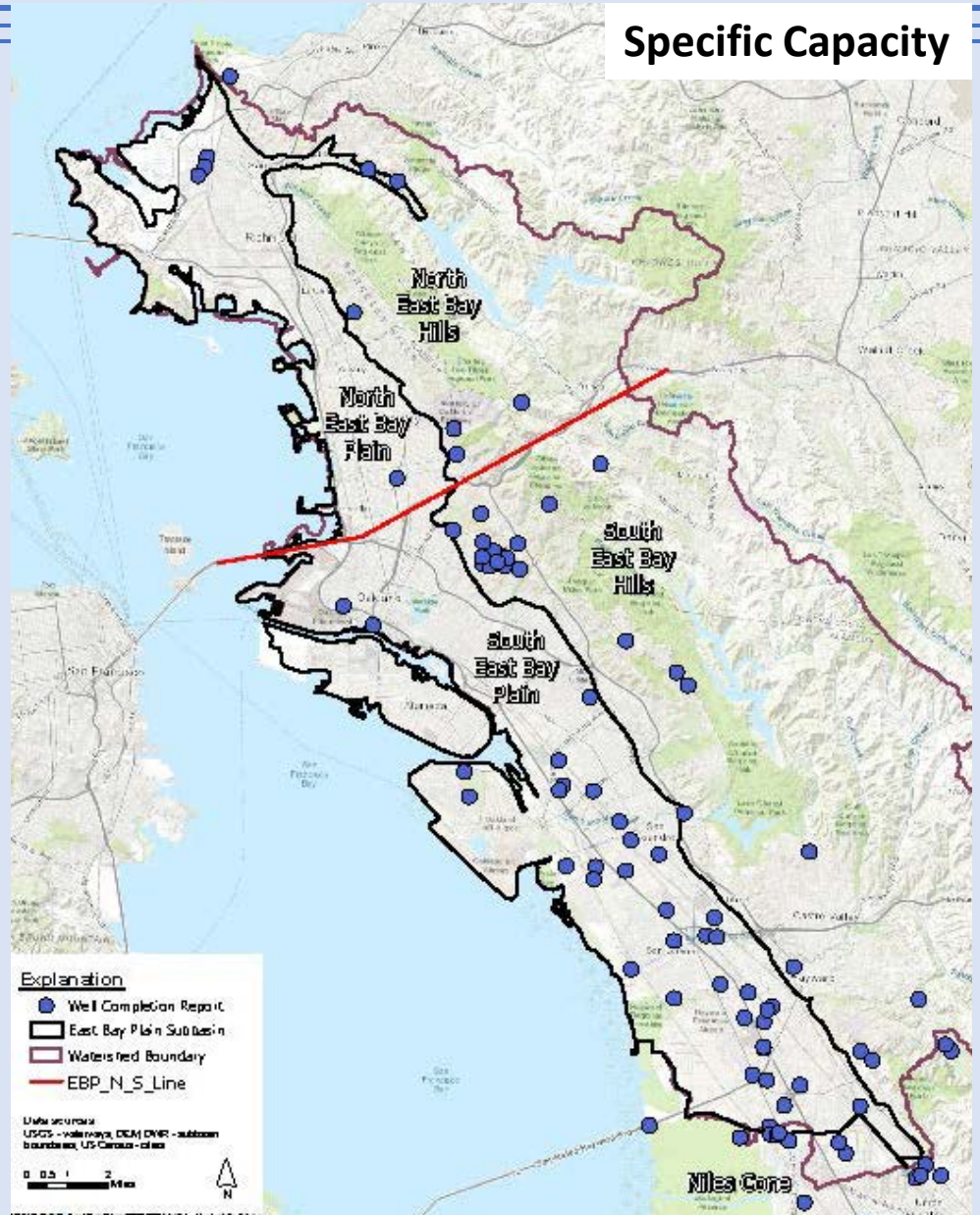
Subtask 4.2 Geologic Conditions – Sediment Deposition Centers





Subtask 4.2 Geologic Conditions – Aquifer Parameter Data

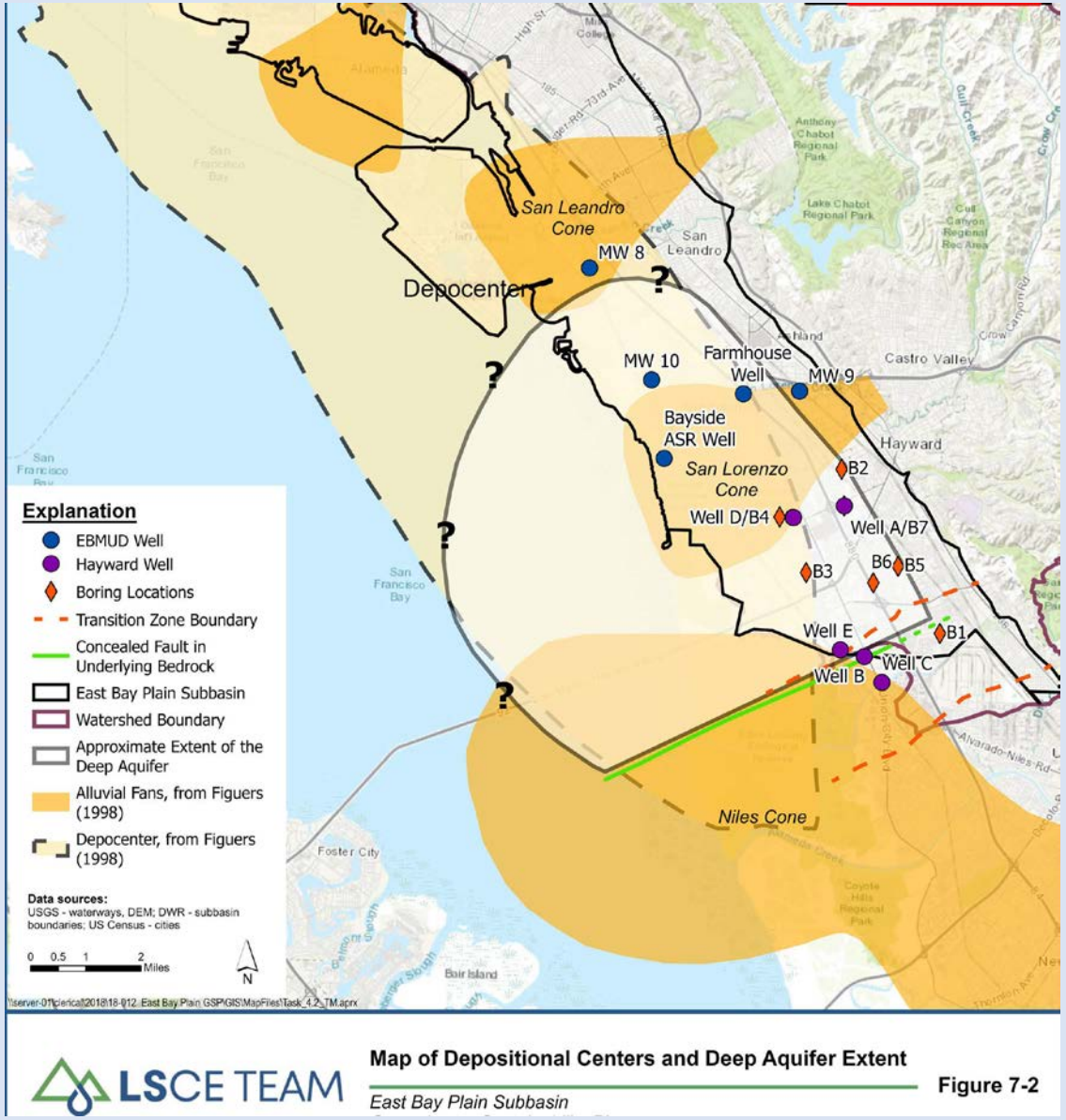
Specific Capacity



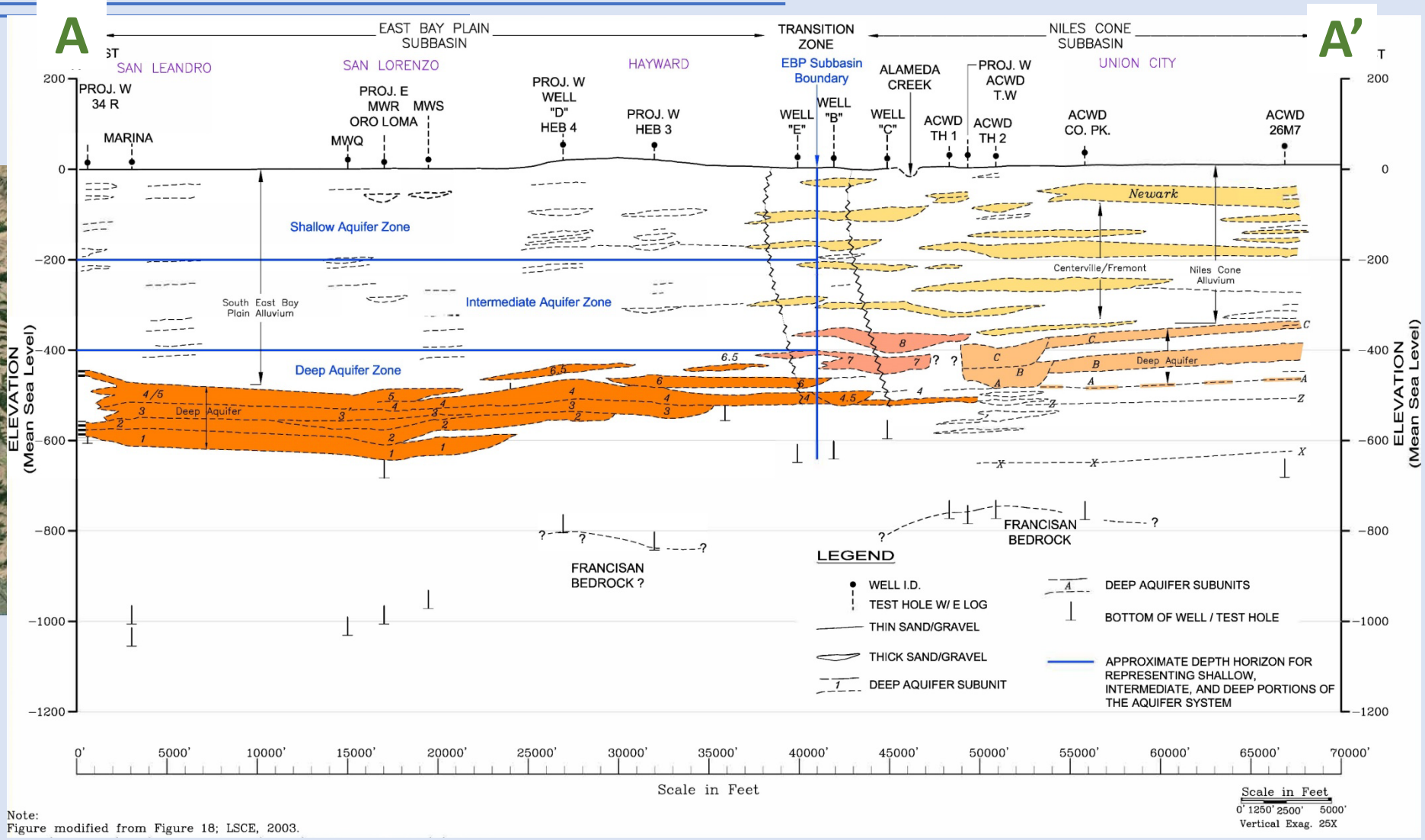
Aquifer Tests

Subtask 4.2 Geologic Conditions – Transition Zone

- Depositional Environments in Transition Zone Area
  - Southern end of Santa Clara Fm time depo center in transition zone
  - Northern end of Niles Cone in transition zone and extends west along San Mateo bridge
  - Two different depositional environments overlap in transition zone



Subtask 4.2 Geologic Conditions – Cross-Section A-A'



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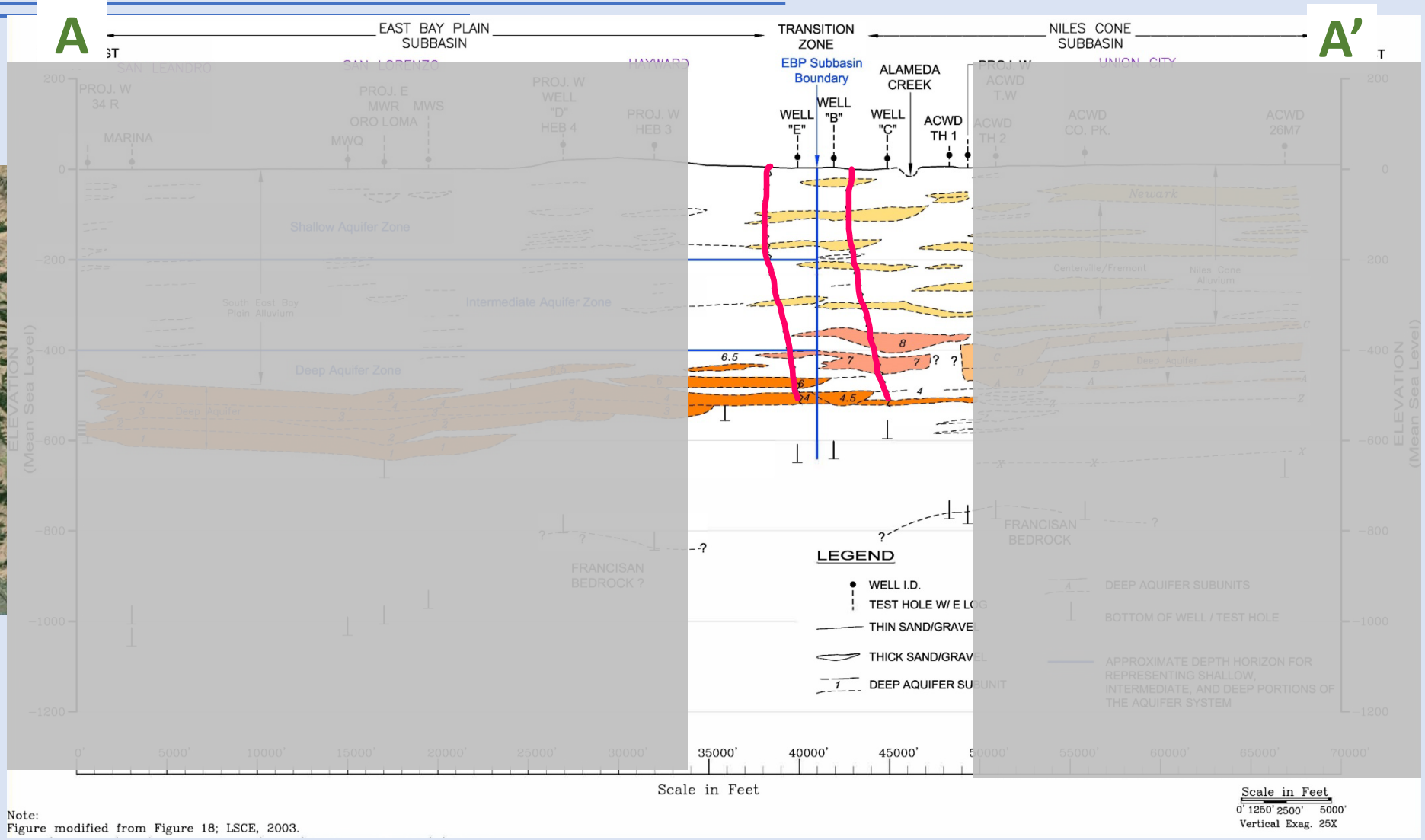
Subtask 4.2 Geologic Conditions – Cross-Section A-A'



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

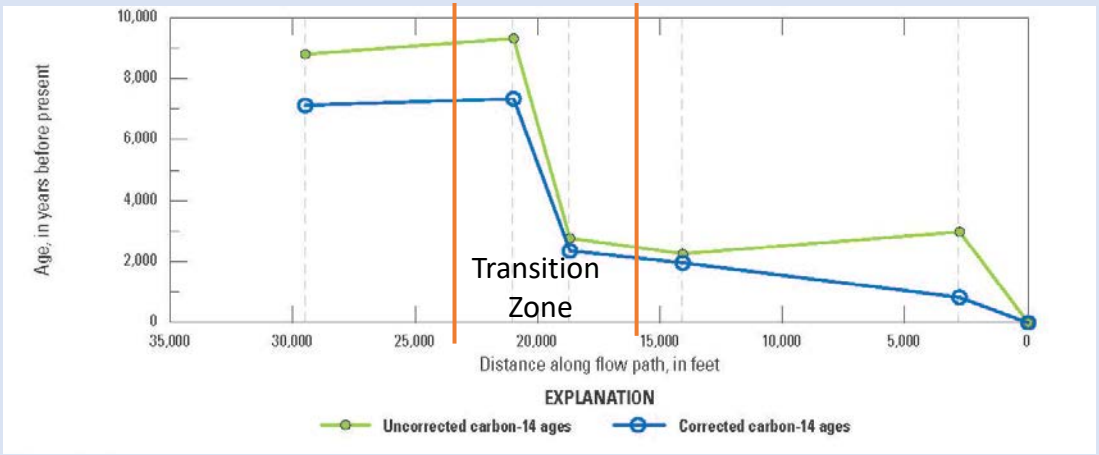
Subtask 4.2 Southern Subbasin Geologic Condition Refinement

- EBMUD 8-week regional aquifer test
  - Significant drawdown response from the EBMUD Bayside pumping well (DD = 27 feet) to Hayward Well E (DD = 7 feet)
  - No distinguishable drawdown for all wells south of Well E (red star on map), including Well B (orange star on map)
  - Indicates partial to significant barrier to GW flow in Deep Aquifer between Wells E and B

Subtask 4.2 Southern Subbasin Geologic Condition Refinement

- USGS Geochemical/Isotope Study
  - Large changes is major ion composition occur between Hayward Well B and Well E
  - GW velocities range from 3 to 12 ft/year in Niles Cone GW Basin to as little at 0.5 ft/year near Transition Zone in EBP Subbasin
  - Isotope results are consistent with lithologic changes documented in LSCE (2003) within transition zone
  - Water recharged at Quarry Lakes in Niles Cone likely remains in Niles Cone Subbasin

Transition Zone



Subtask 4.2 Hydrogeologic Conceptual Model (HCM)

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- Geologic Conditions
- Groundwater Conditions
- Water Balance

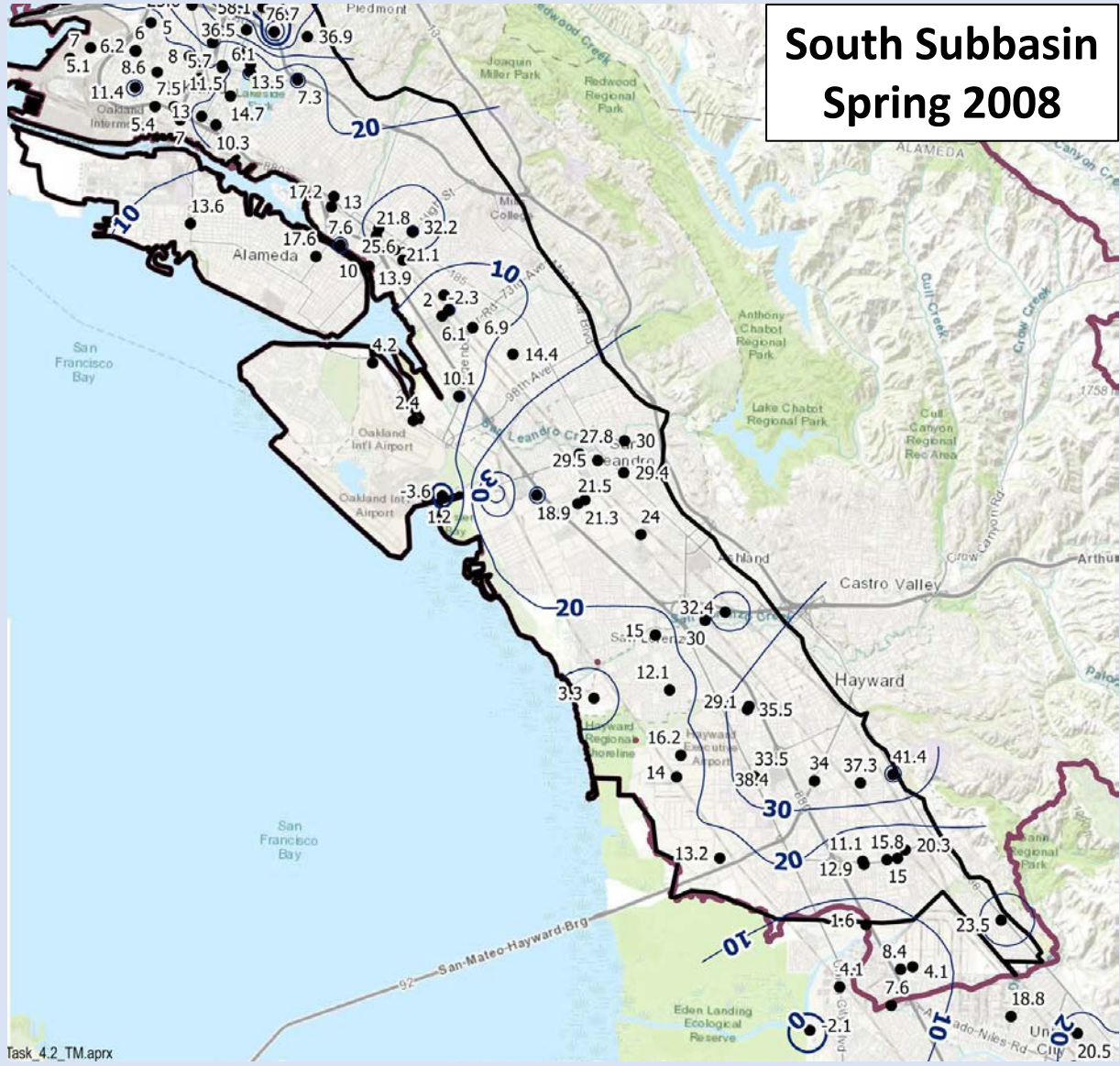
Subtask 4.2 Groundwater Conditions

- Definition of zones for water level and water quality data
  - Water Table Aquifer Zone (upper 50 feet)
  - Shallow Aquifer Zone (50 to 200 feet)
  - Intermediate Aquifer Zone (200 to 400 feet)
  - Deep Aquifer Zone (greater than 400 feet)

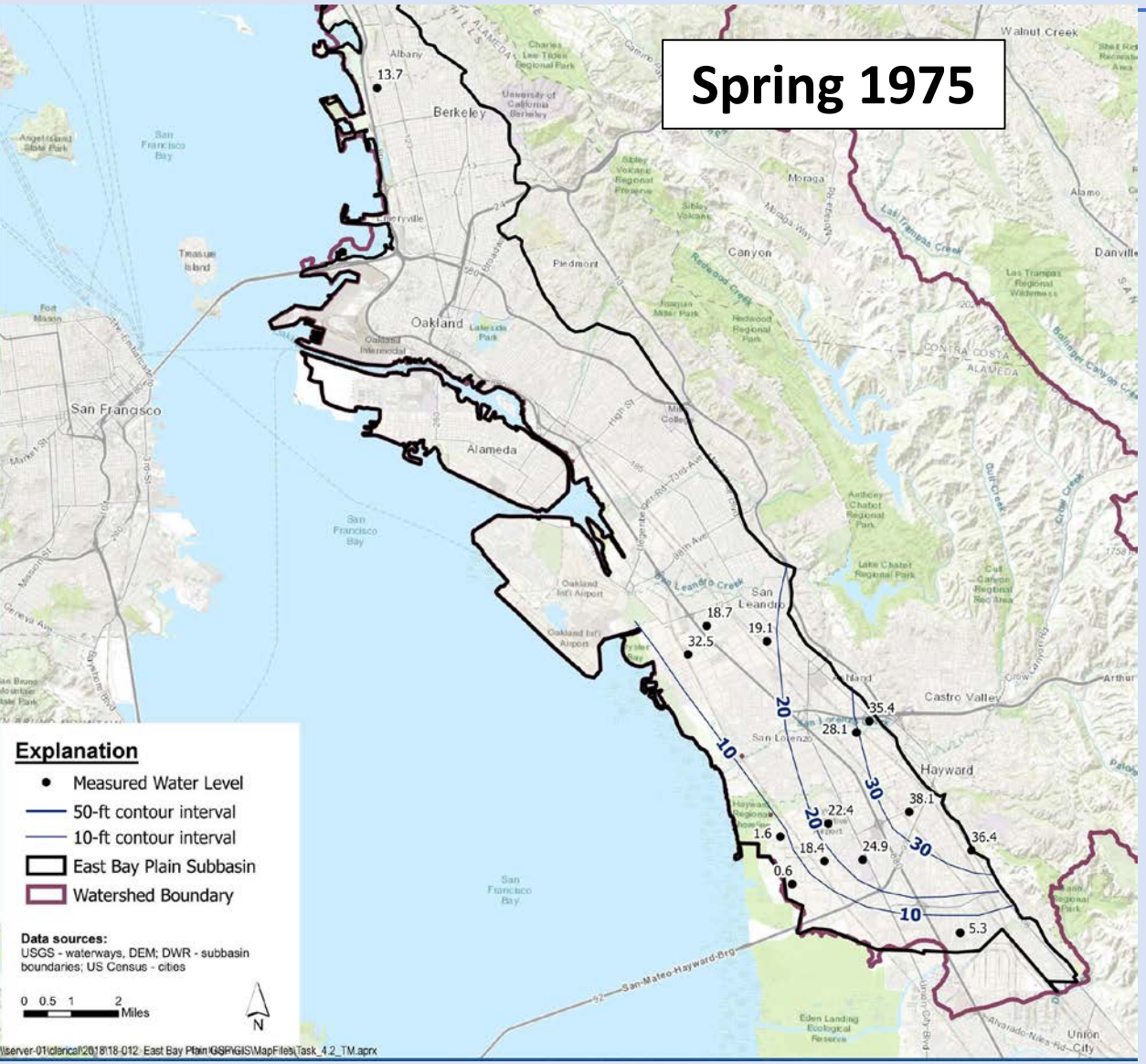
Subtask 4.2 Groundwater Conditions – Water Elevations – Water Table

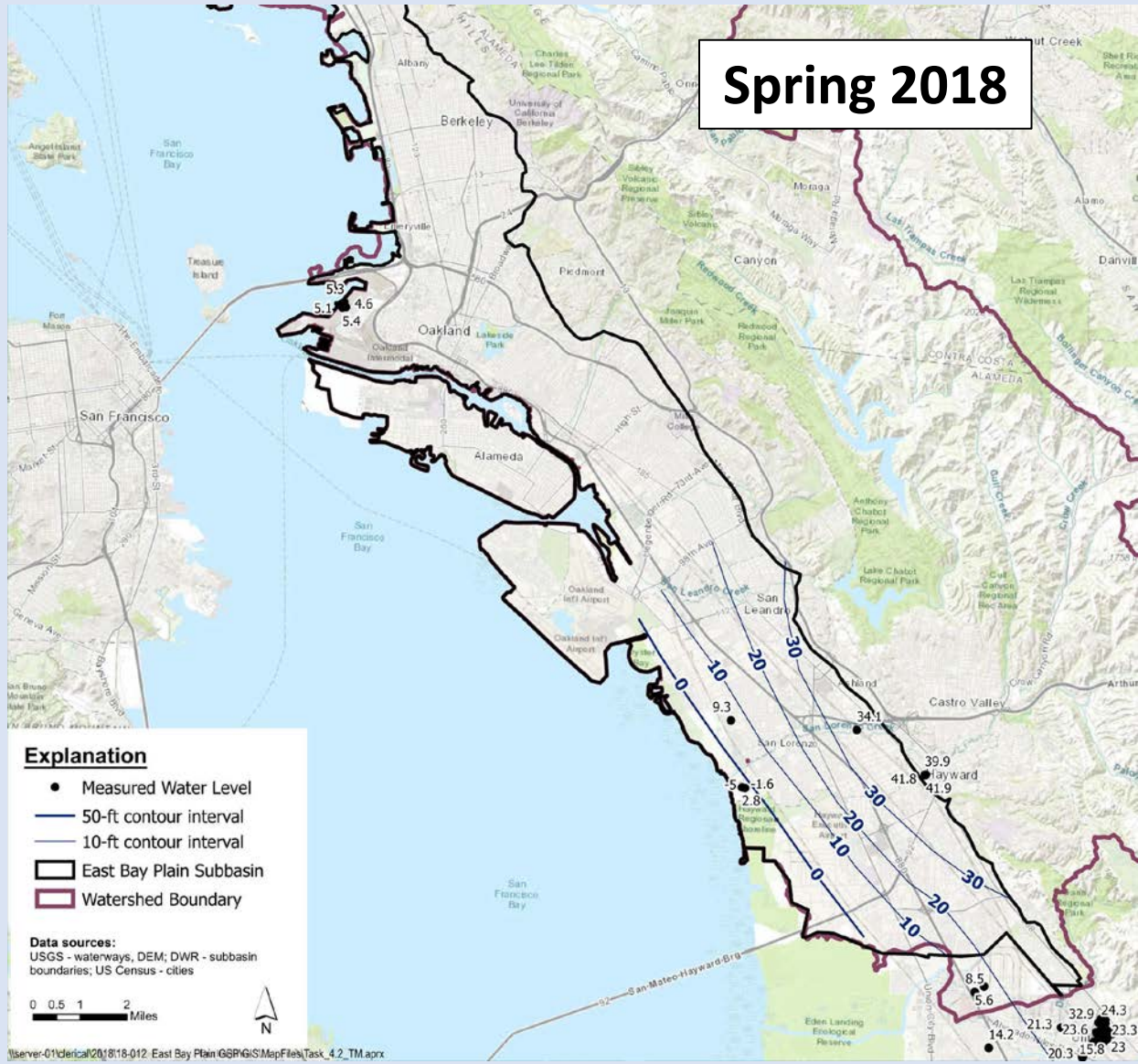
North Subbasin Spring 2008

South Subbasin Spring 2008

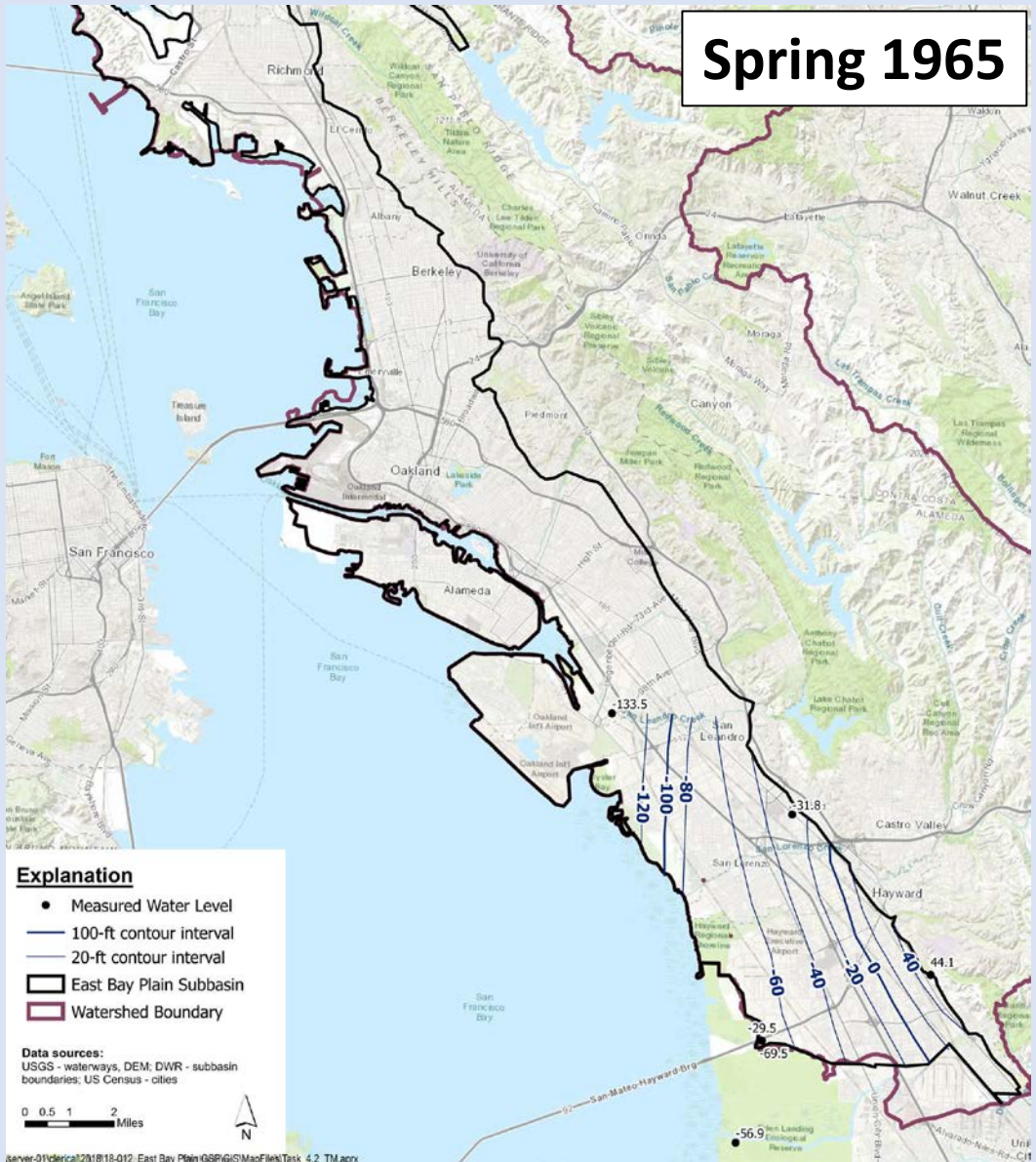


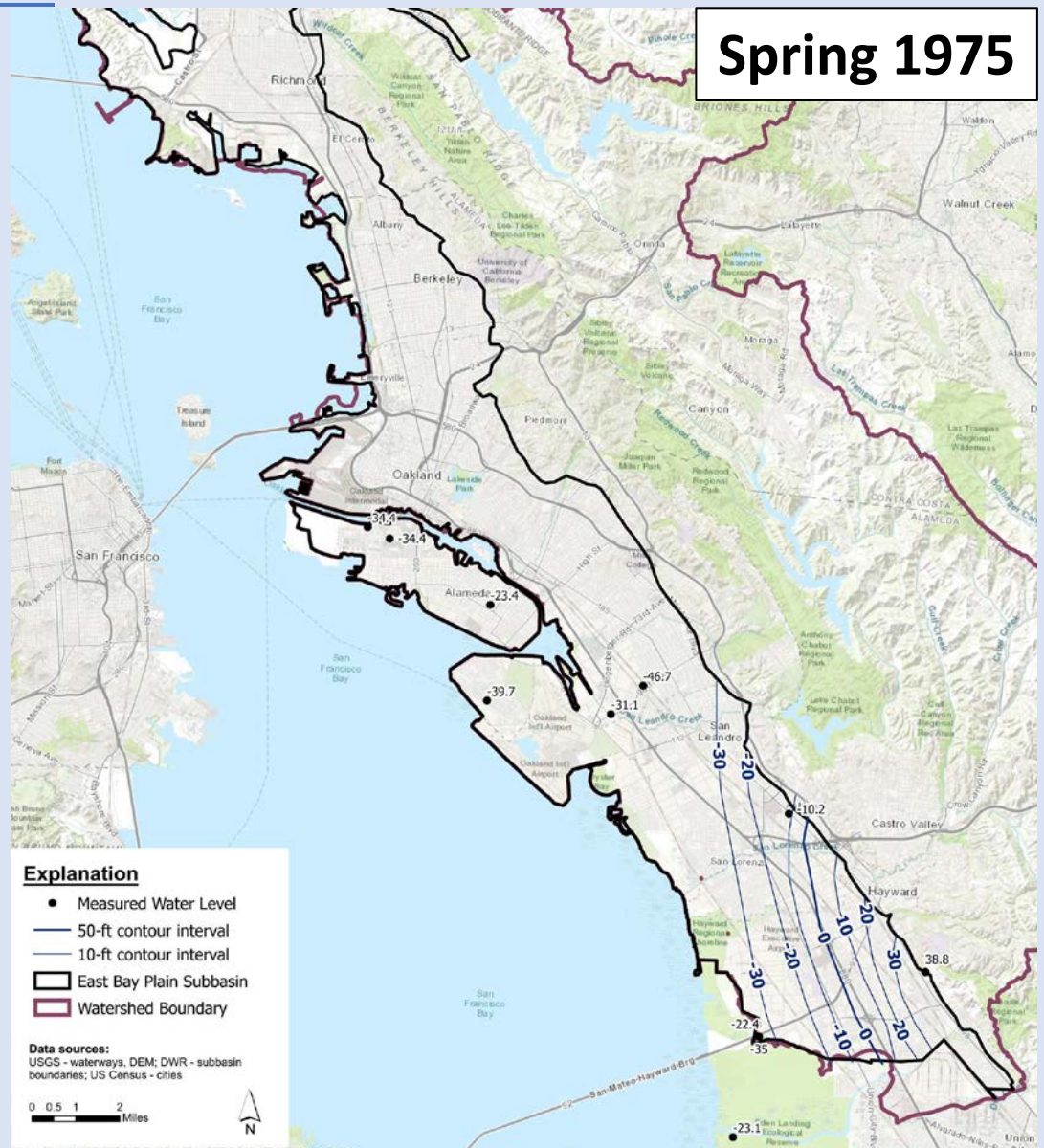
Subtask 4.2 Groundwater Conditions – Water Elevations - Shallow



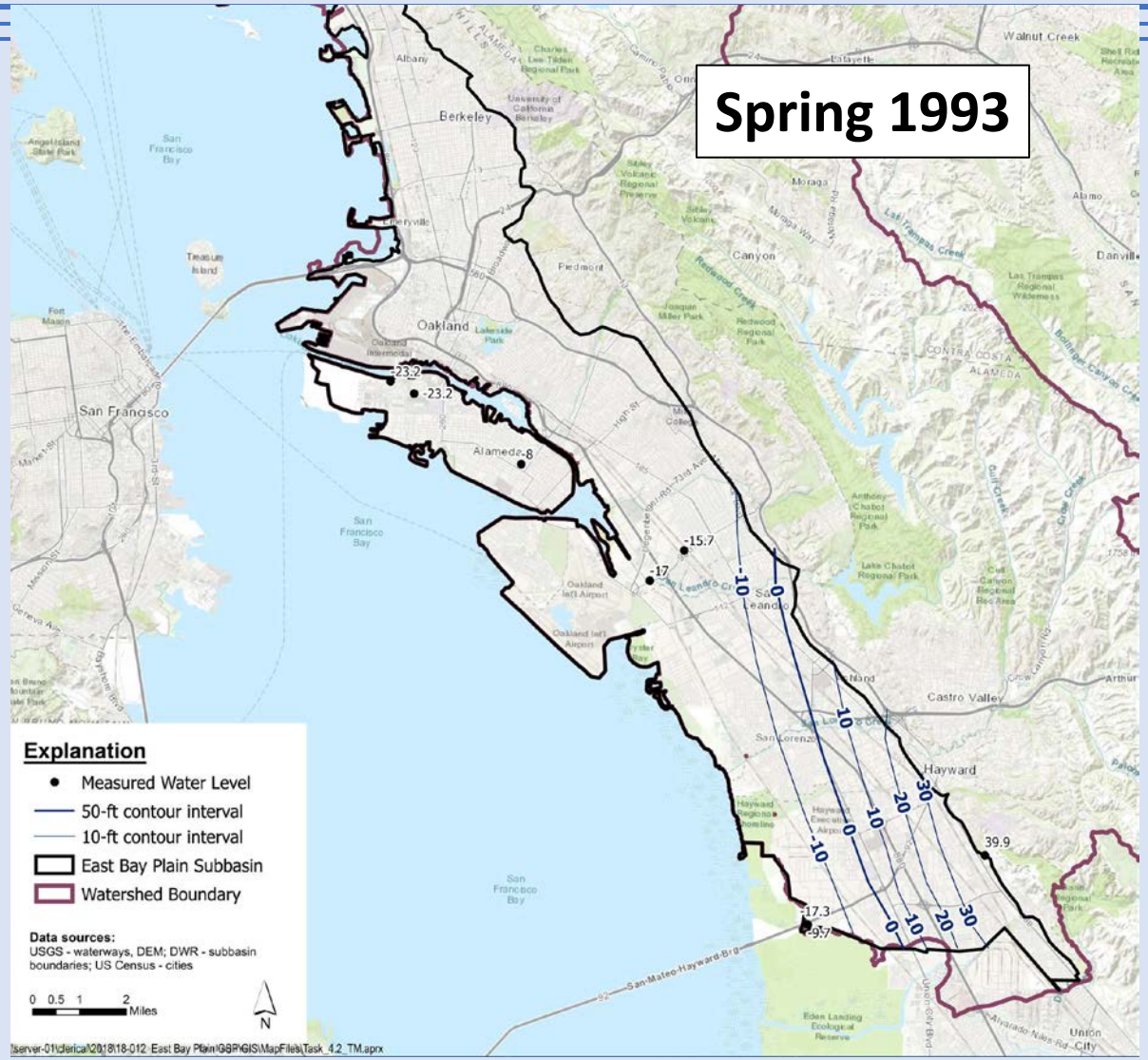


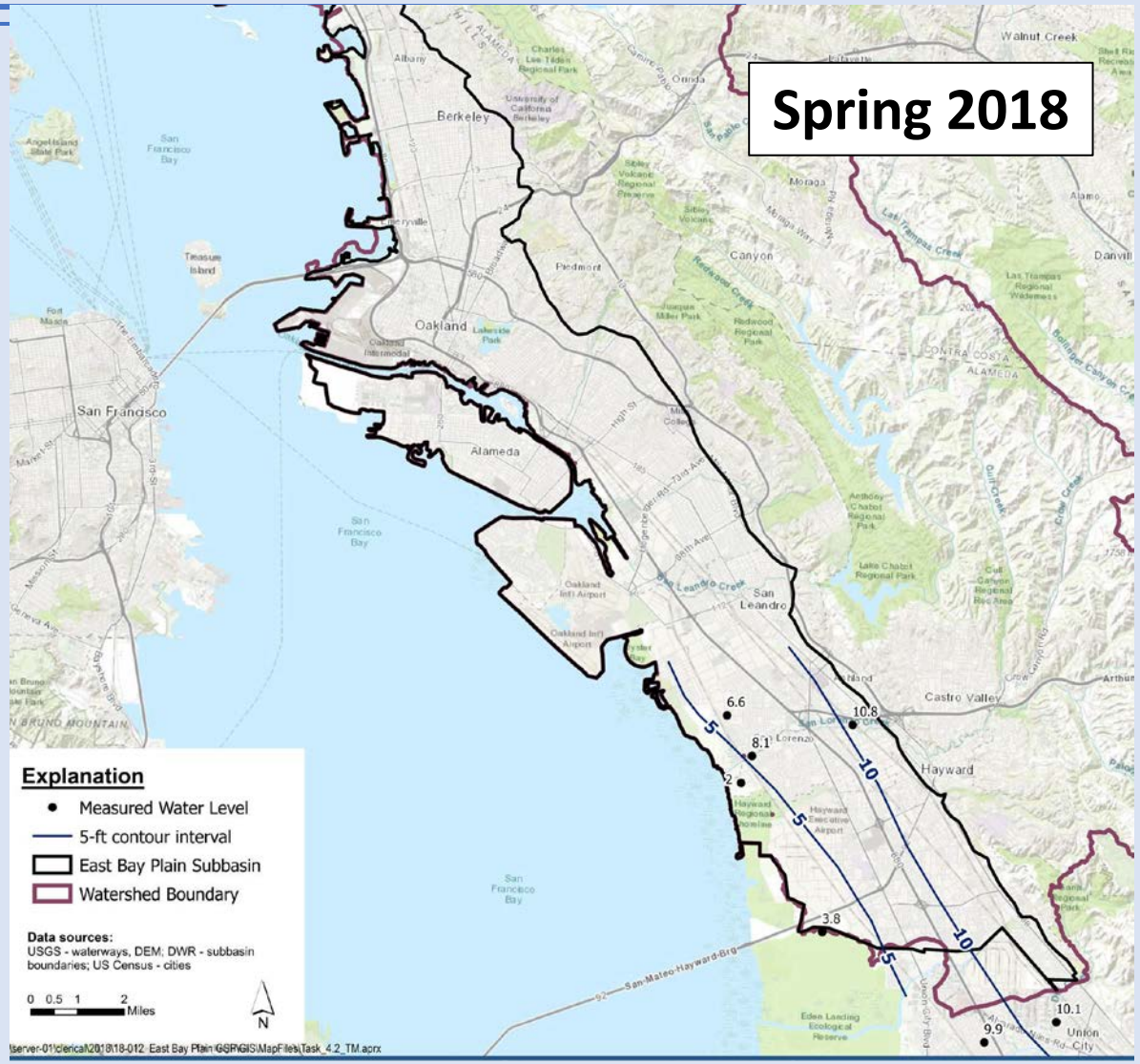
Subtask 4.2 Groundwater Conditions – Water Elevations - Intermediate



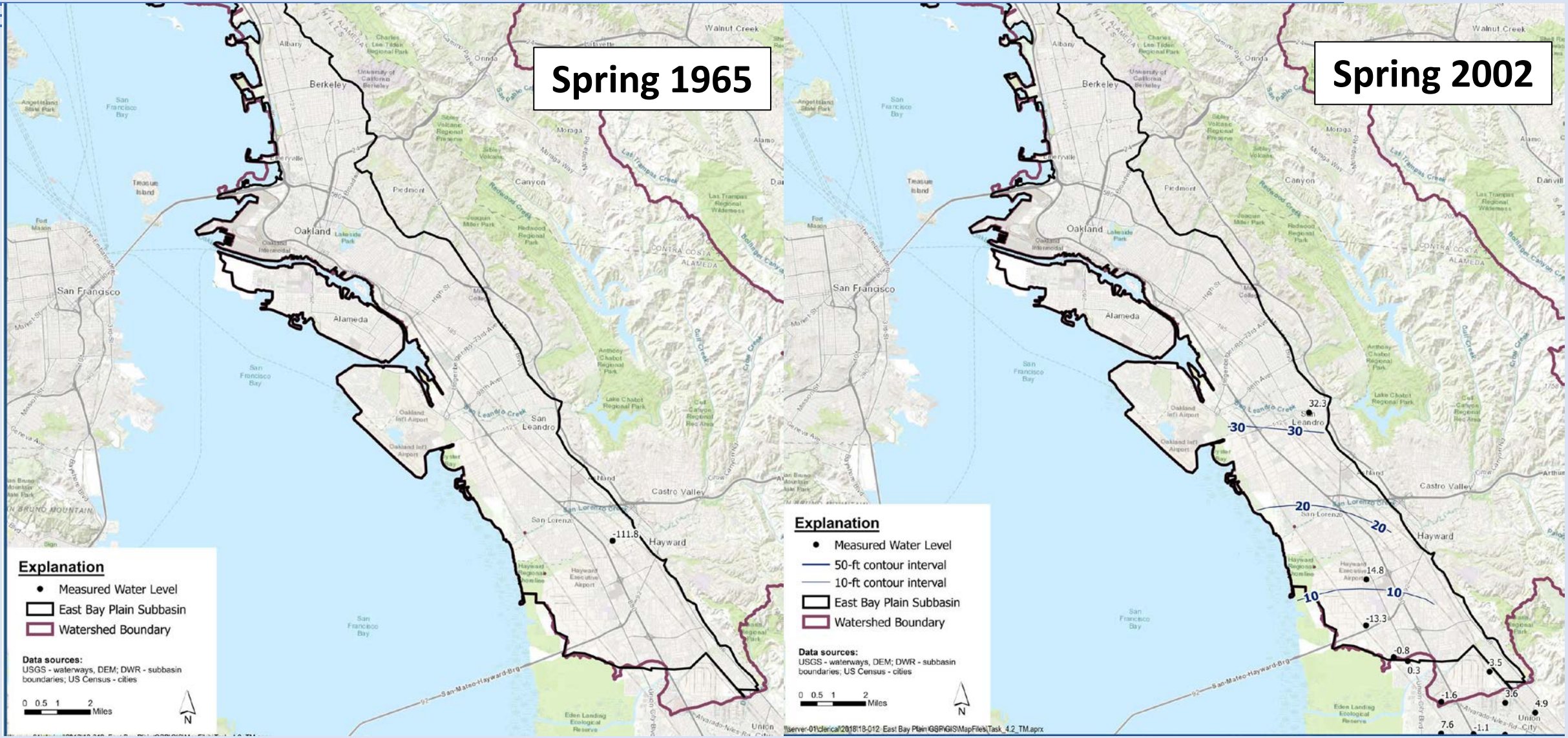


Subtask 4.2 Groundwater Conditions – Water Elevations - Intermediate

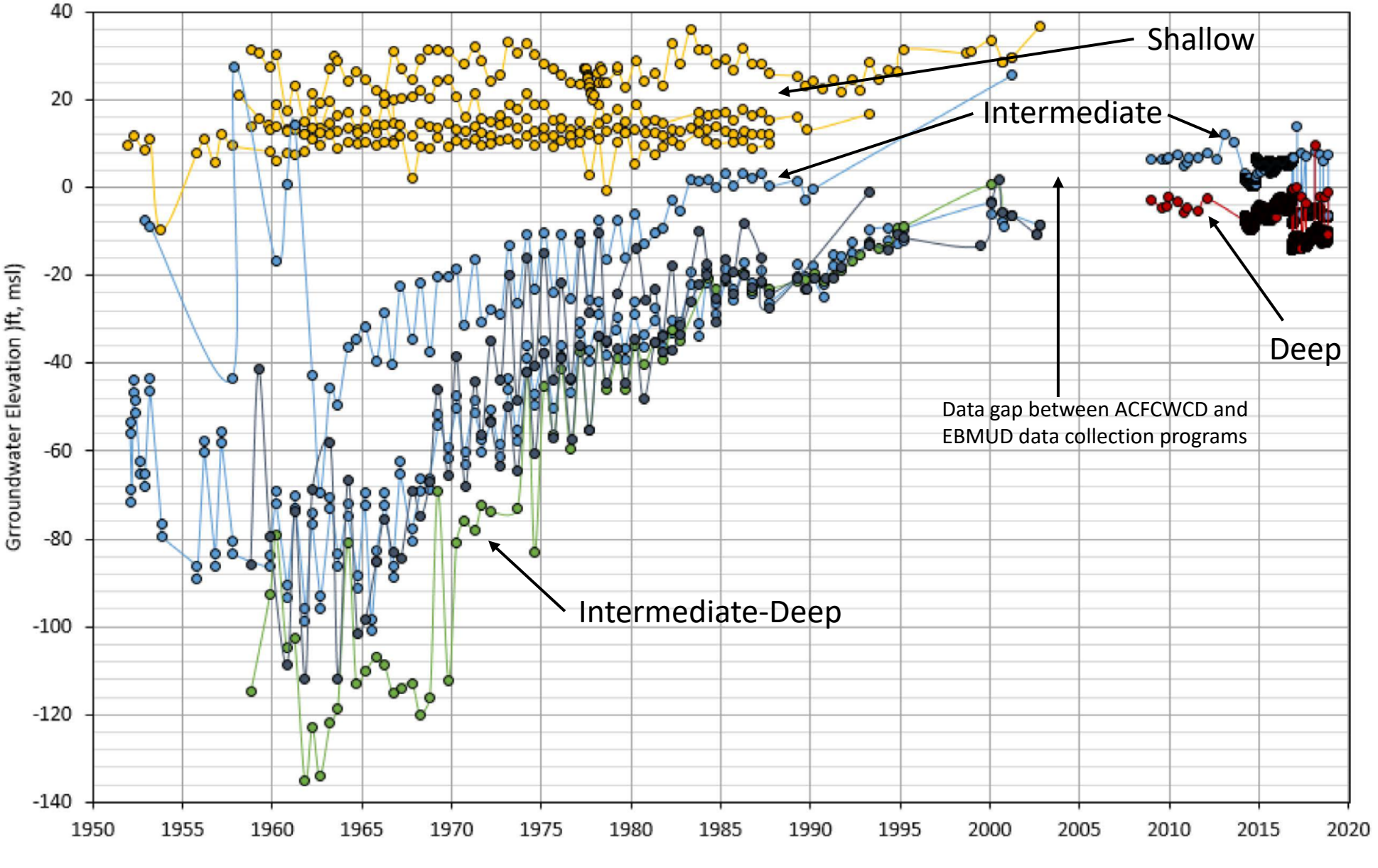




Subtask 4.2 Groundwater Conditions – Water Elevations - Deep



Subtask 4.2 Groundwater Conditions – Water Elevations - Hydrographs

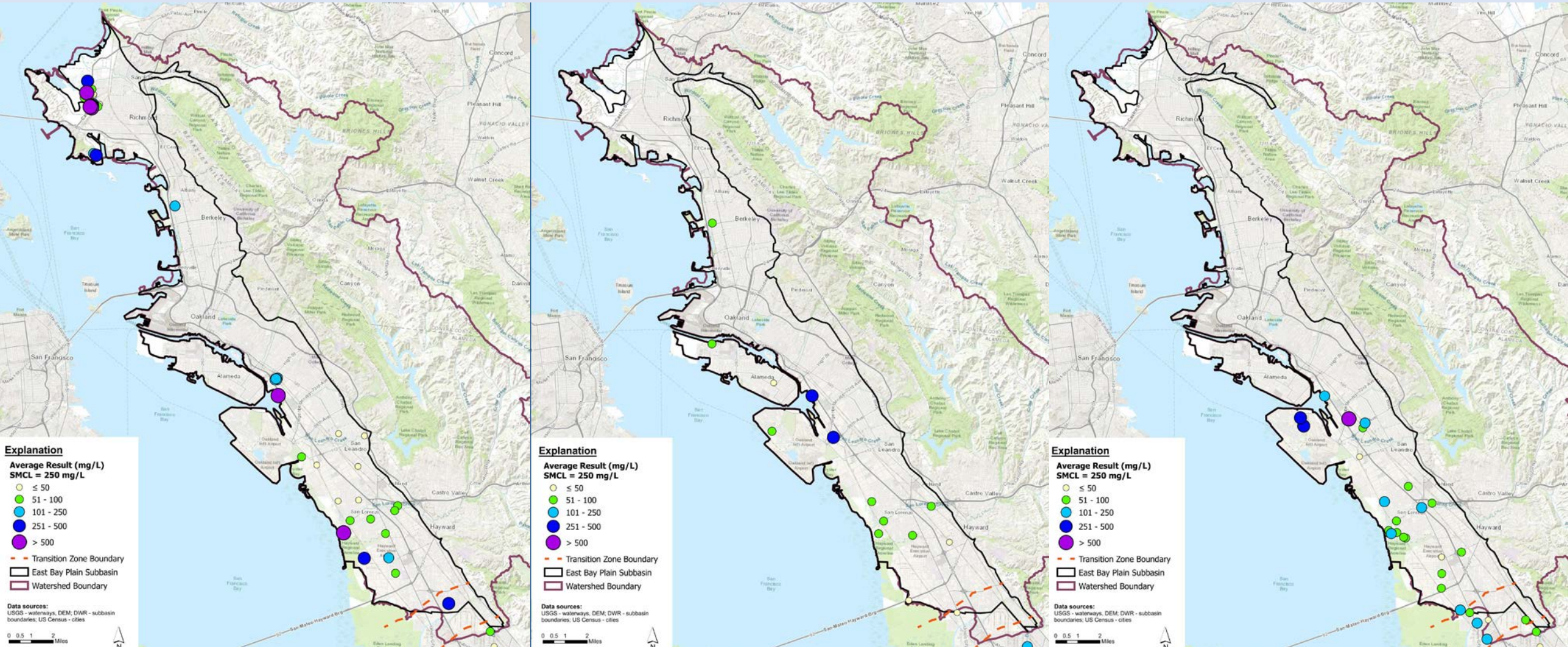


Subtask 4.2 Groundwater Conditions – Water Quality - Chlorides

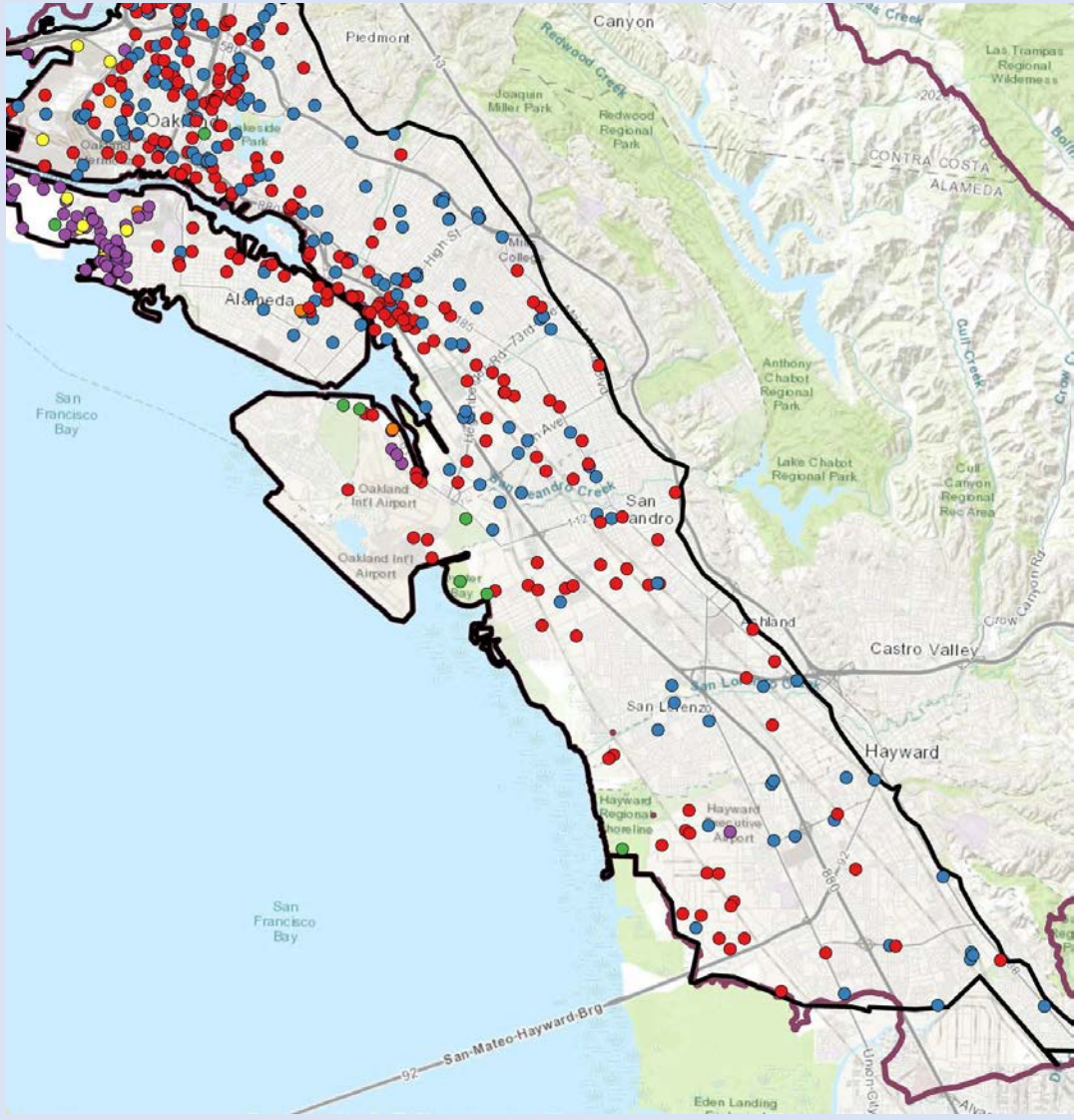
Shallow
50 to 200 ft bgs

Intermediate
200 to 400 ft bgs

Deep
> 400 ft bgs



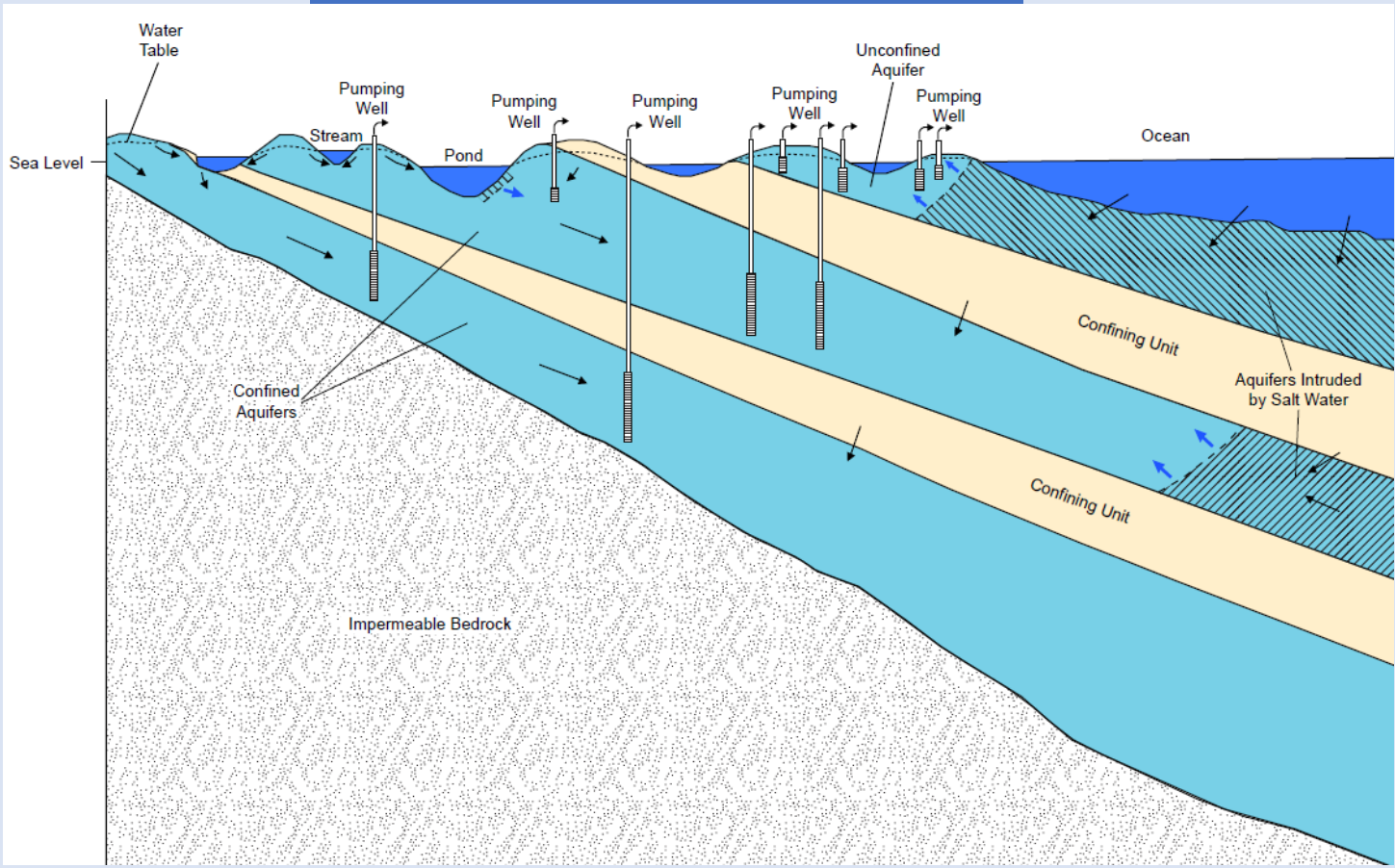
Subtask 4.2 Groundwater Conditions – Water Quality – Contaminant Sites



Subtask 4.2 Groundwater Conditions – Seawater Intrusion

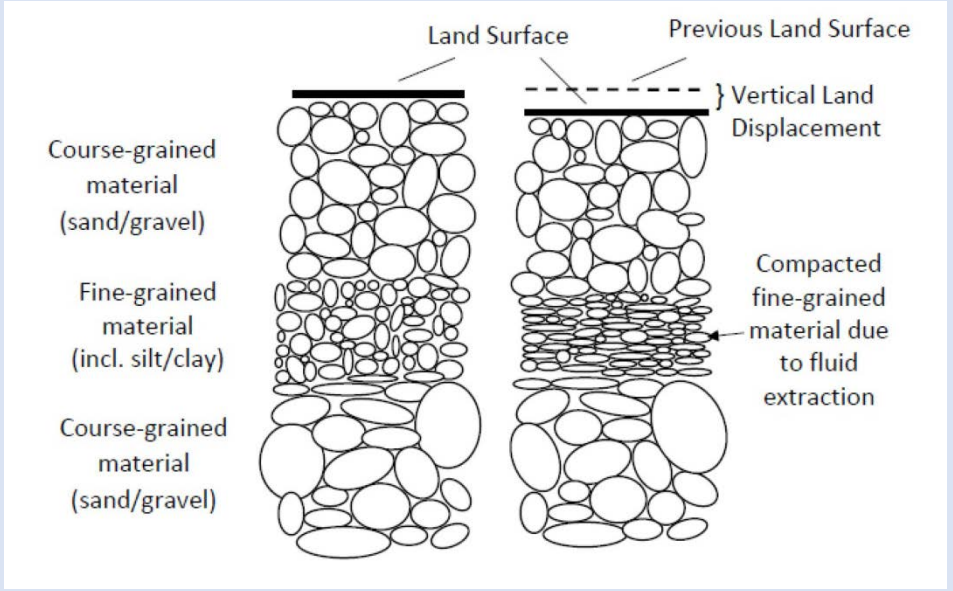
- Seawater Intrusion (SWI) – function of GW Levels & Geologic Conditions
- GW Levels – below sea level can be conducive to SWI
- Geologic Conditions – distribution of aquifers/aquitards
- Geologic Conditions – fine grained (e.g., clay) sediments can provide protection
- Unconfined vs. Confined Conditions

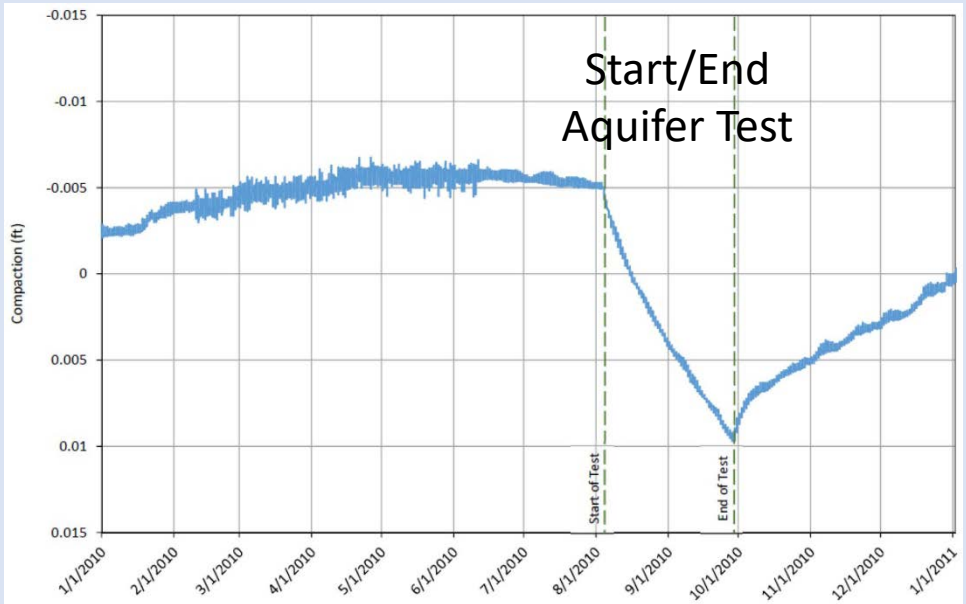
Schematic: Example of SWI



Subtask 4.2 Groundwater Conditions - Subsidence

- Subsidence – function of GW Levels & Geologic Conditions
- GW Levels – below historic lows can be conducive to subsidence
- Geologic Conditions – distribution/type of fine-grained sediments (i.e., clay)
- Difference between elastic (temporary) vs. inelastic (permanent) compaction





Subtask 4.2 Groundwater Conditions

- Groundwater – Surface Water (GW-SW) Interaction
  - Depth to Water (DTW) is generally less than 30 feet below ground surface
  - Few data points near EBP Subbasin eastern margin where DTW likely greater
  - GW-SW interaction likely increases to the west towards Bay

Subtask 4.2 Groundwater Conditions – Potential GDEs

Subtask 4.2 Hydrogeologic Conceptual Model (HCM)

California Code of Regulations

§ 354.14

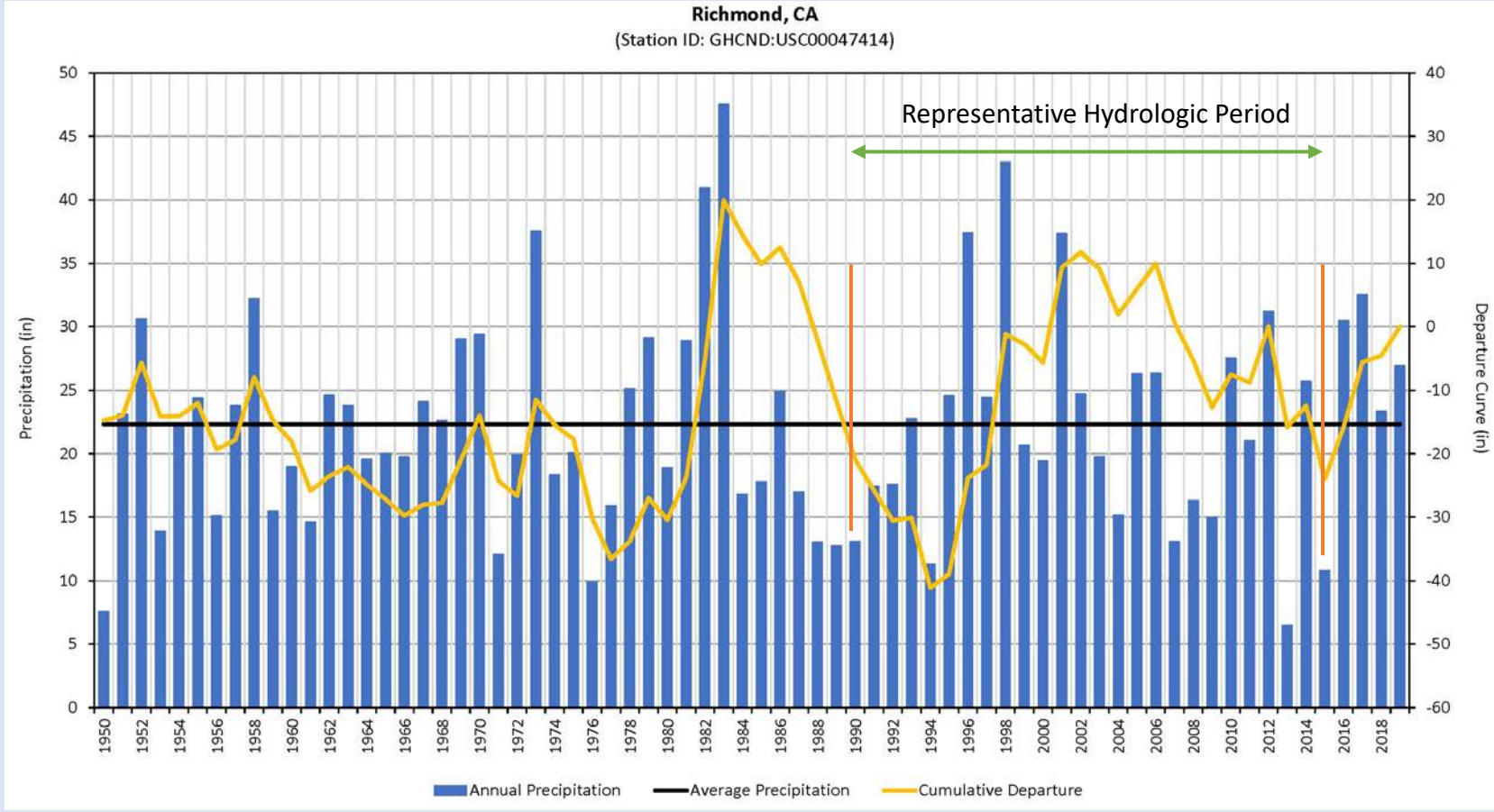
§ 354.16

§ 354.18

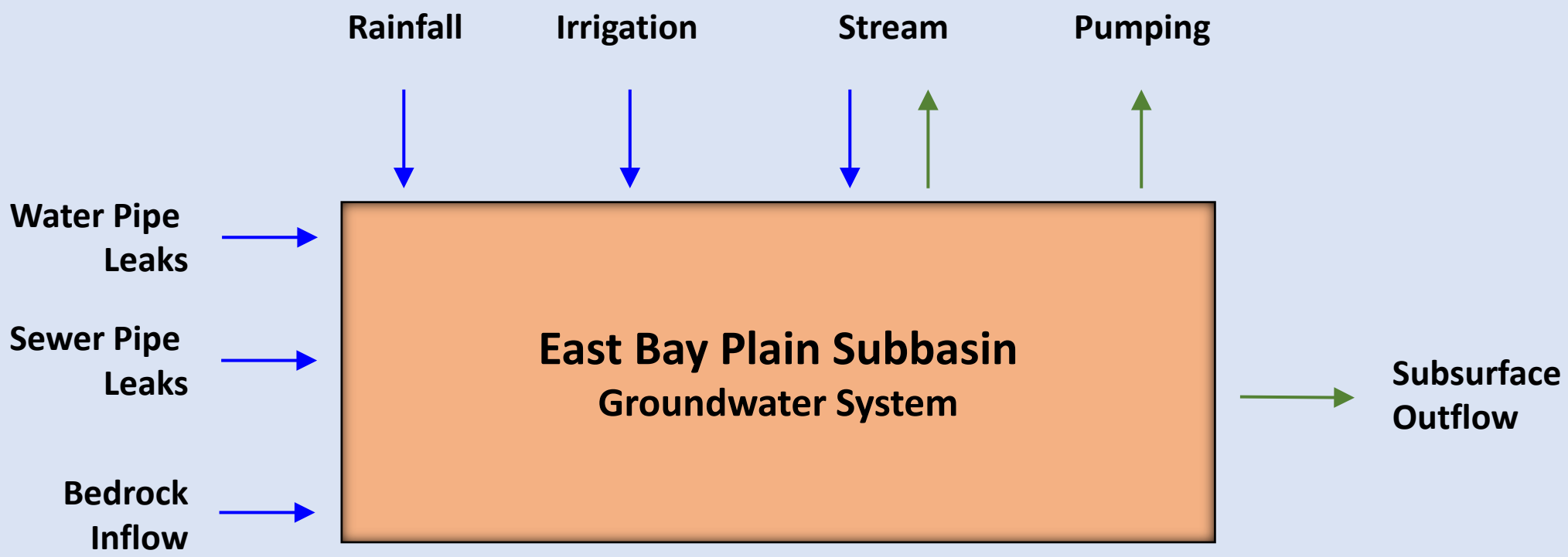
- Geologic Conditions
- Groundwater Conditions
- Water Balance

Subtask 4.2 Water Balance

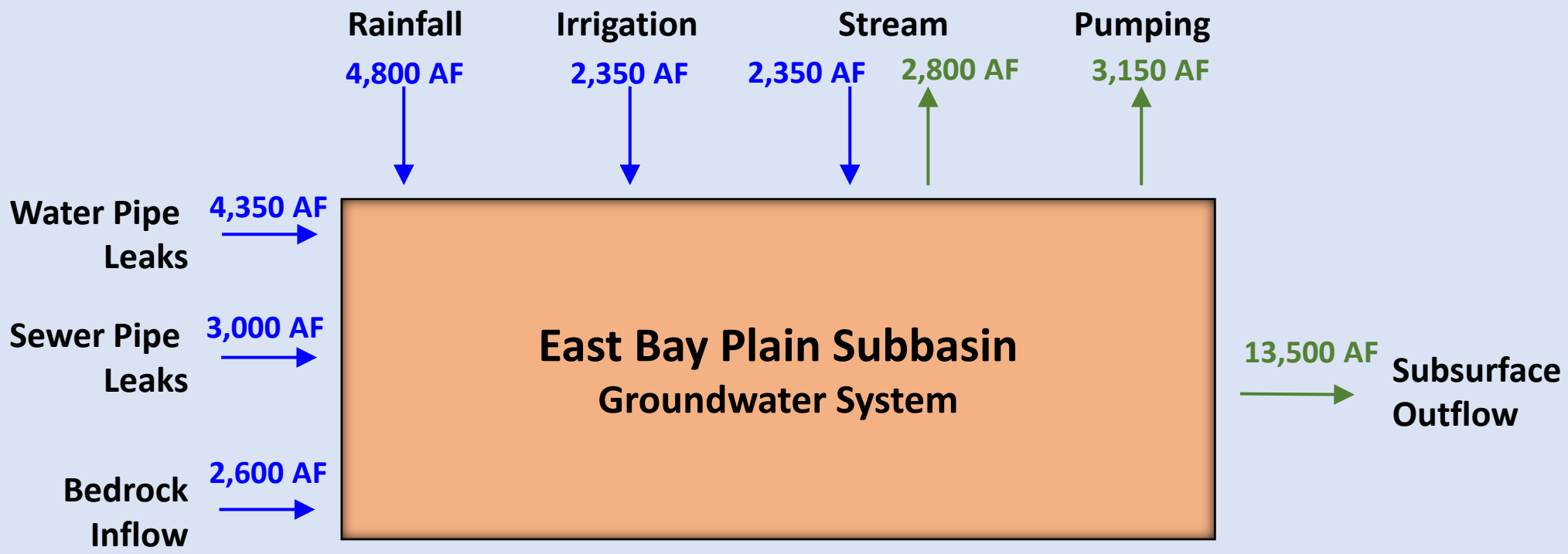
- Representative hydrologic period = 1990 to 2015
  - Begin/end in dry years
  - Average rainfall period
  - Covers range of dry, average, and wet years
  - Covers time period with adequate data available



Subtask 4.2 Water Balance



Subtask 4.2 Water Balance



Inflow = 19,450 **Outflow = 19,450**

Subtask 4.2 Water Balance – Initial Estimates

Recharge Component	Amount (AFY)	Comments
Precipitation	4,800	4% of total rainfall
Irrigation	2,350	Includes large parcels and residential
Water Pipe Leaks	4,350	
Sewer Pipe Leaks	3,000	
Stream Infiltration	2,350	12 streams evaluated
Bedrock Inflow	2,600	
Total	19,450	Annual Average for 1990 to 2015

Discharge Component	Amount (AFY)	Comments
Groundwater Pumping	3,150	Relatively consistent since 1990's
Subsurface Outflow	13,500	Flow towards SF Bay
Stream Discharge	2,800	
Total	19,450	Annual Average for 1990 to 2015

Subtask 4.2 Basin Setting Summary

- Geologic Conditions (Hydrogeologic Conceptual Model)
  - Regional geology/depositional environments
  - Geologic cross sections
  - Aquifer parameters
- Groundwater Conditions
  - Levels/storage, Quality
  - Seawater intrusion, subsidence
  - GW-SW interaction, GDEs
- Water Balance
  - Recharge from rainfall, irrigation return flow, streamflow, leaking pipes, bedrock inflow
  - Discharge from pumping, subsurface outflow, stream discharge

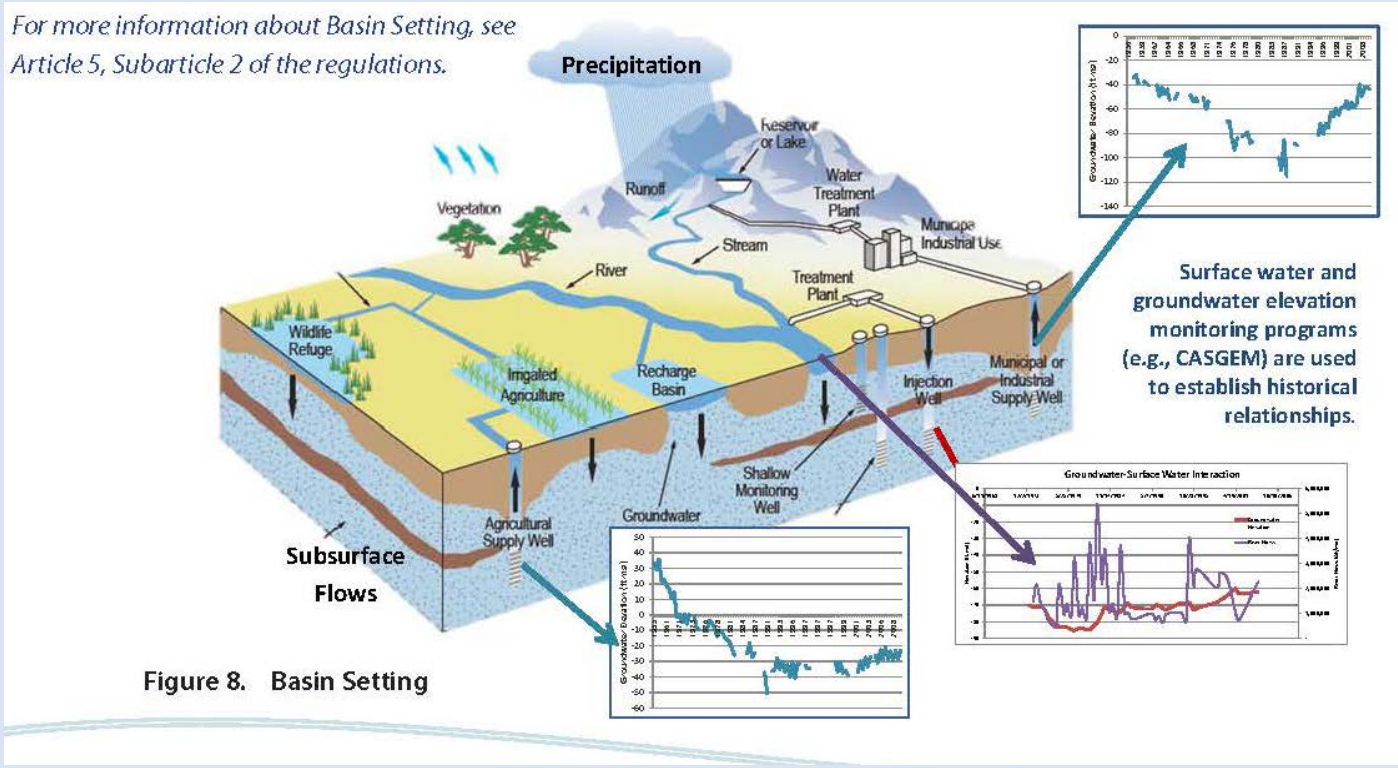


Figure 8. Basin Setting

Subtask 4.2 Basin Setting Summary

- Sustainable groundwater management has been occurring since the 1970s
- The EBP Subbasin is in balance with potential for additional development
- Need to determine additional groundwater development potential of EBP Subbasin (i.e., sustainable yield)

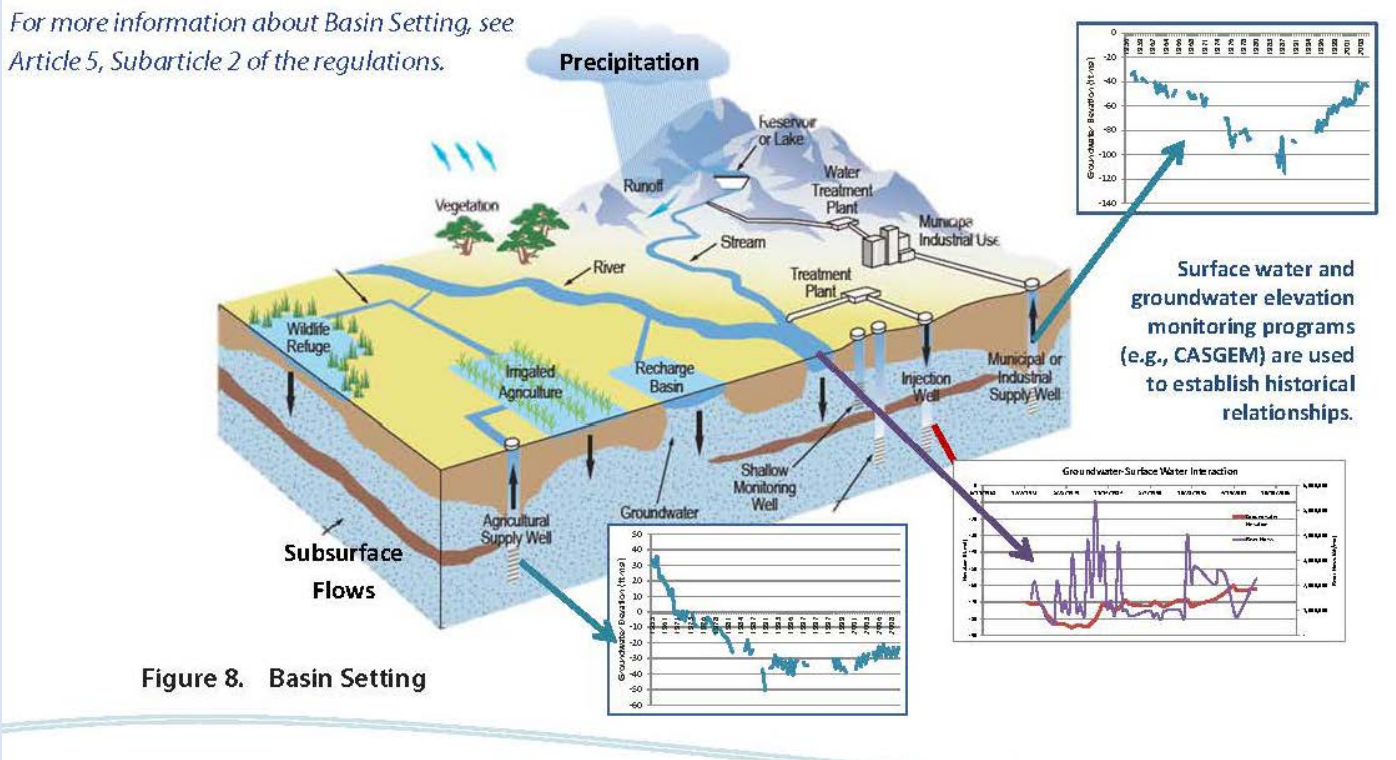
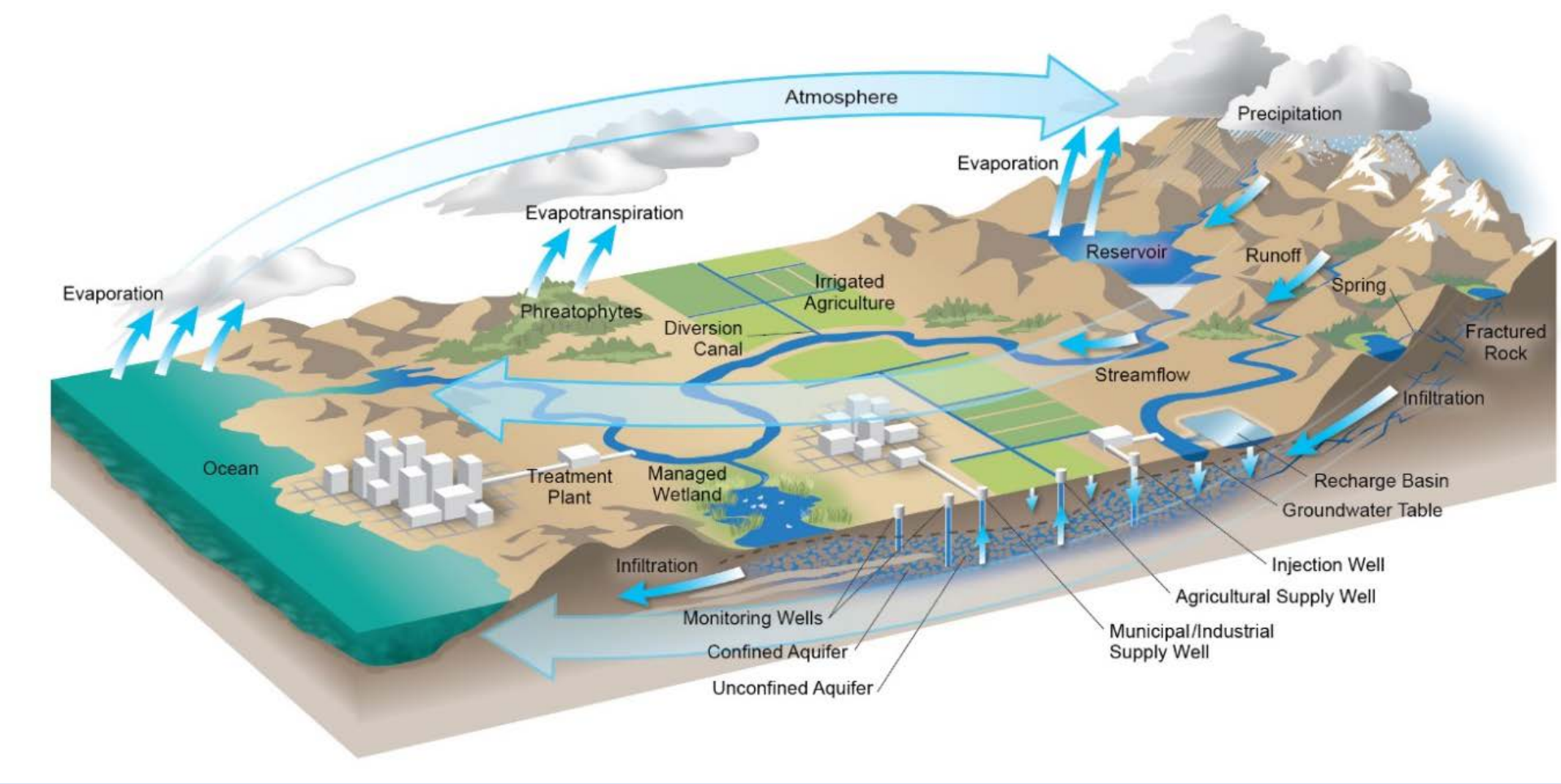


Figure 8. Basin Setting

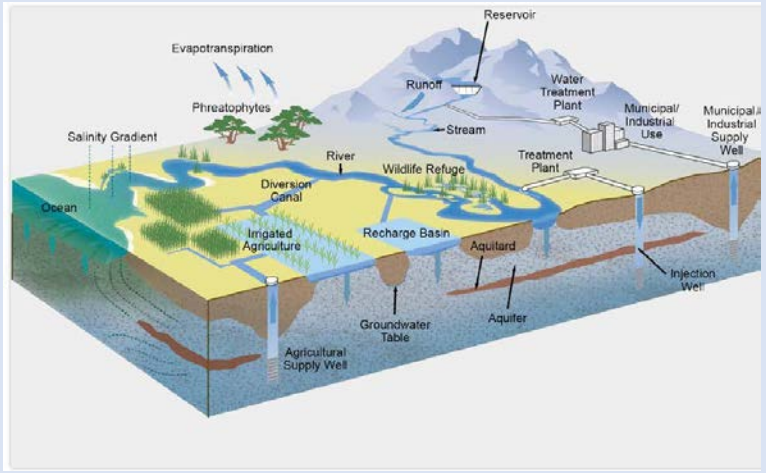
Questions: Subtask 4.2 HCM TM



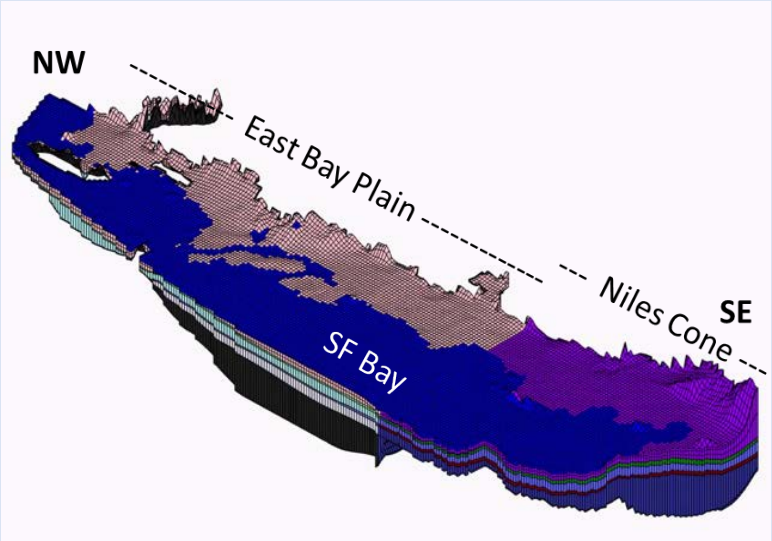
The Hydrologic Cycle, DWR Water Budget BMP, 2016

Tasks in Progress

- Subtask 4.2: Hydrogeologic Conceptual Model (HCM)



- Subtask 4.4: Model Development



Status Summary on Numerical Model Development

- Inputs/updates to the numerical model are based on HCM
- Progress on model development
- Planned work with the model

Purpose of the Numerical Model

- Quantify water budget
  - Analyze GW – SW interaction
- Develop monitoring criteria for sustainable management
  - Protect water quality (e.g., seawater intrusion)
  - Protect GDEs
- Estimate sustainable yield
- Evaluate potential projects and management actions

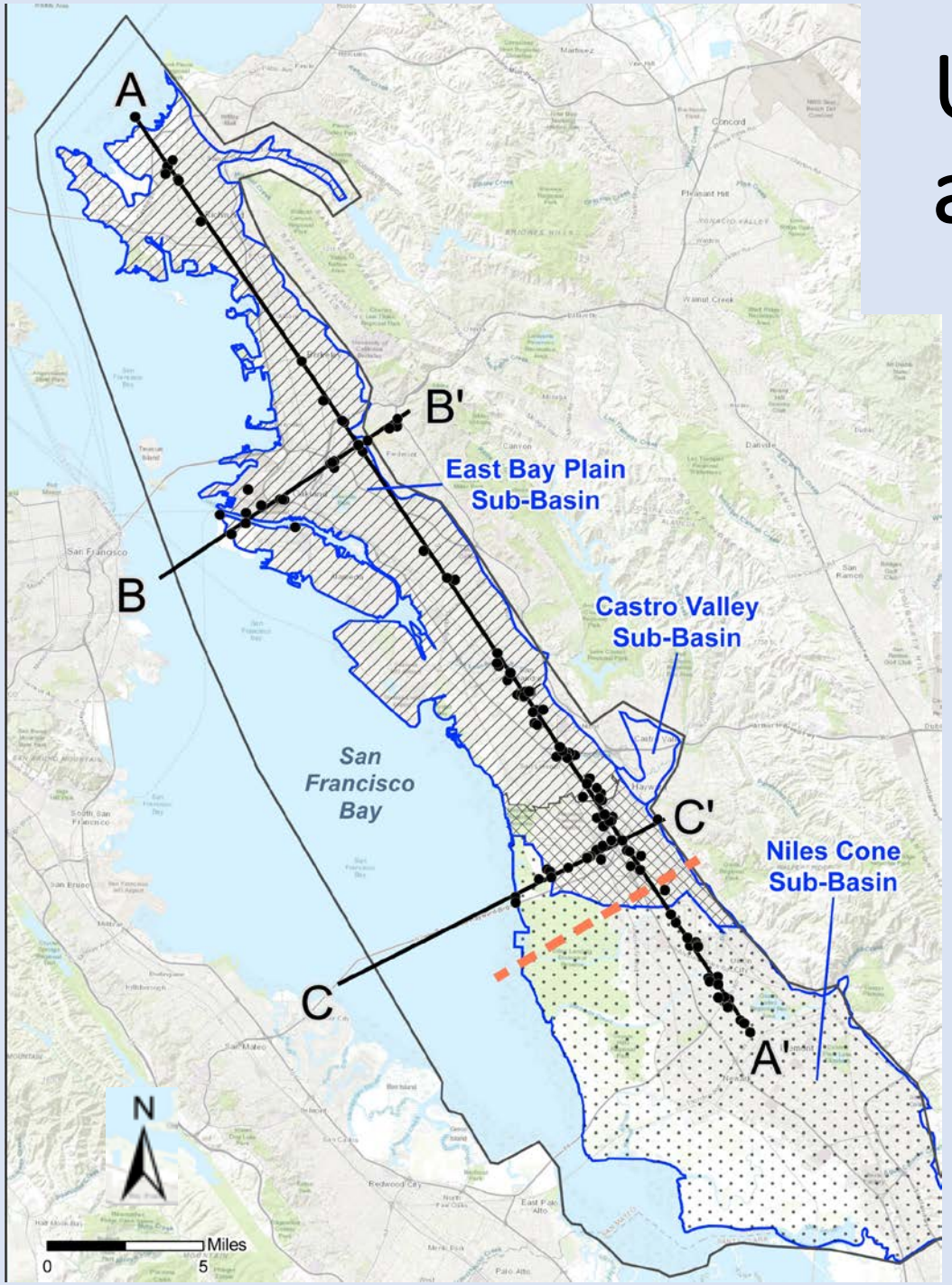
Model Updates Based on HCM

- Data compiled for HCM uploaded to the numerical model platform and GIS
- Expansion of model domain

  To the north and for consistency with DWR subbasin delineations.
- Updates to model grid and layers

  Consistency with the HCM and improved ability to accurately represent vertical flow of groundwater and SW-GW interaction
- Initial assignment of boundary conditions, hydraulic properties, parameter zonation subareas, and ranges of properties for calibration

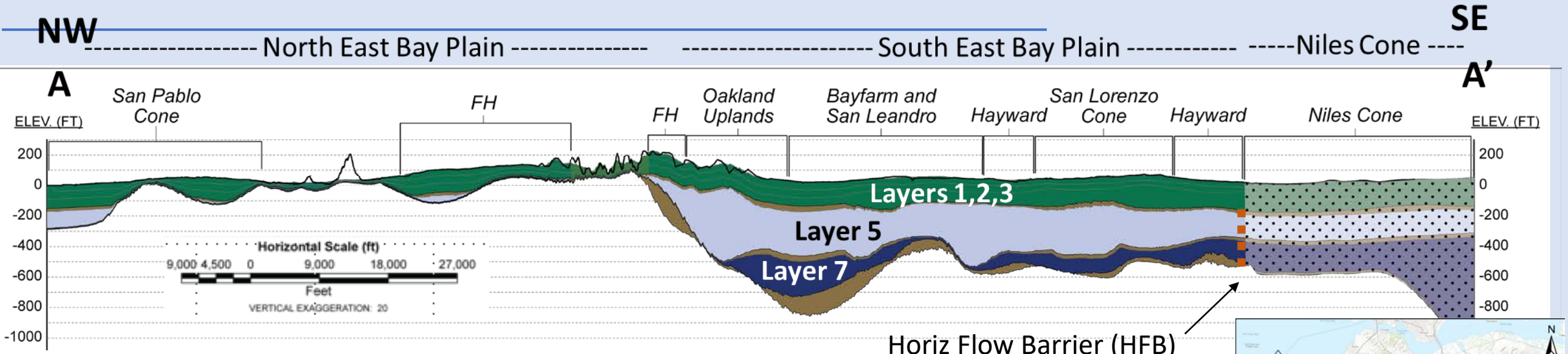
Updates to Model Domain and Layering



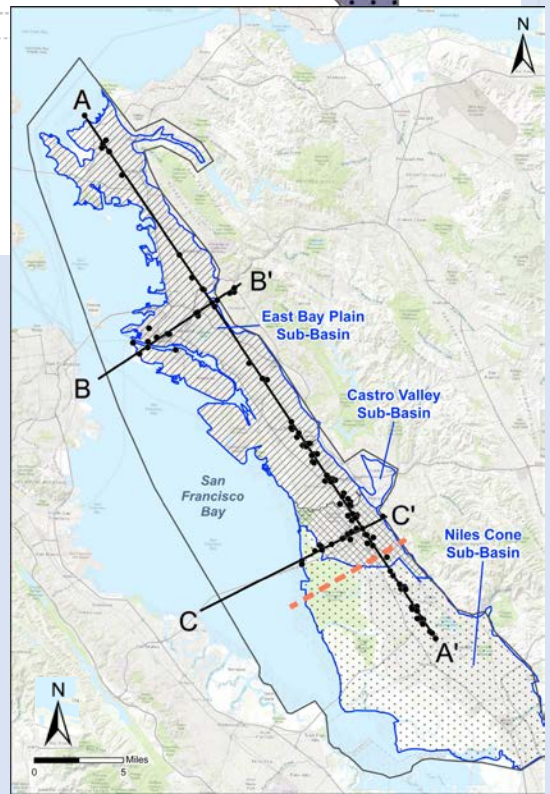
Legend

- Well Locations along Transects
- Cross-Section Location
- Horizontal Flow Barrier (simulates transition zone)
- DWR Groundwater Sub-Basins
- EBMUD GSA
- HAYWARD GSA
- ACWD GSA

Updates to Model Domain and Layering

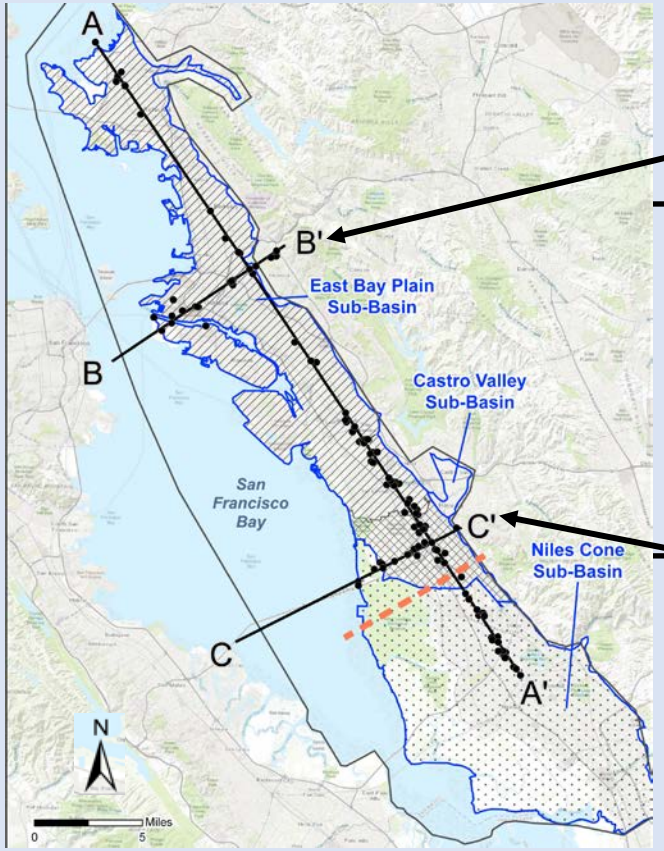


Horiz Flow Barrier (HFB) flexible representation of transition zone

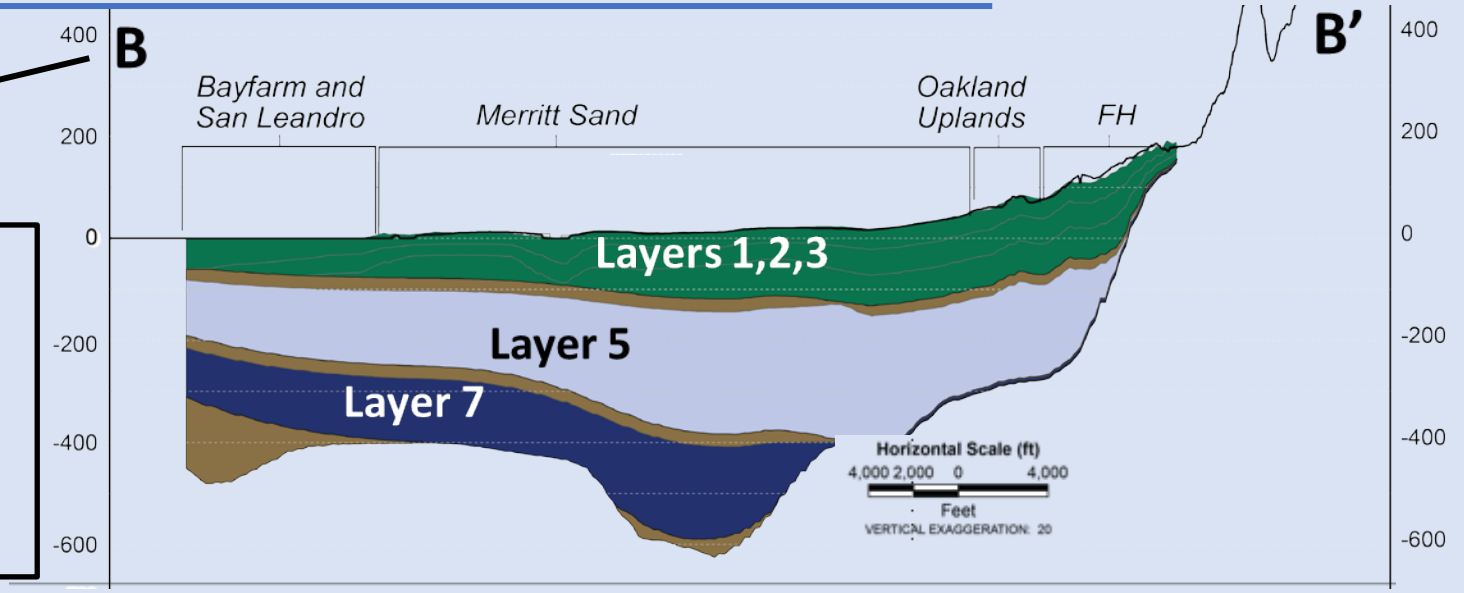


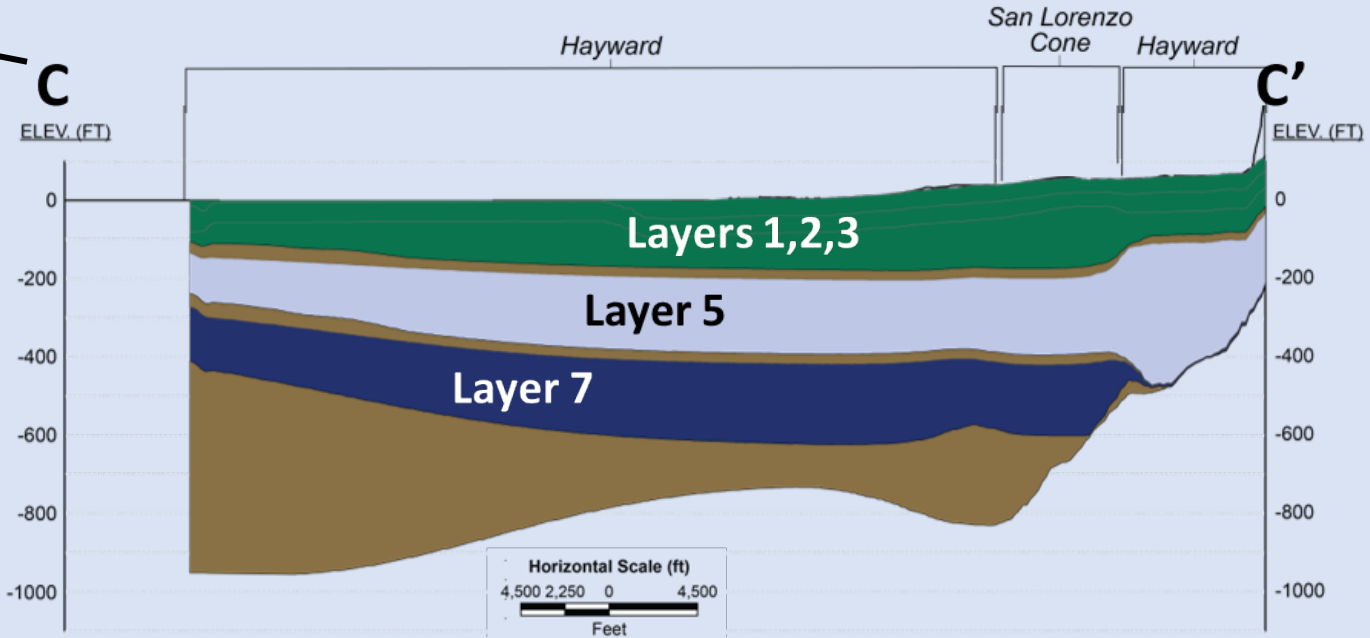
- Three zones (depth intervals) in which aquifers are present.
- Previous model was 7 layers. Updated EBP Model is 8 layers.
- Additional layer for the shallow aquifer zone more accurately represents vertical flow of groundwater and SW-GW interaction.
- Transition zone represented by horizontal flow barrier, for which the conductance can be varied, which depends on hydraulic conductivity and thickness.

Updates to Model Domain and Layering

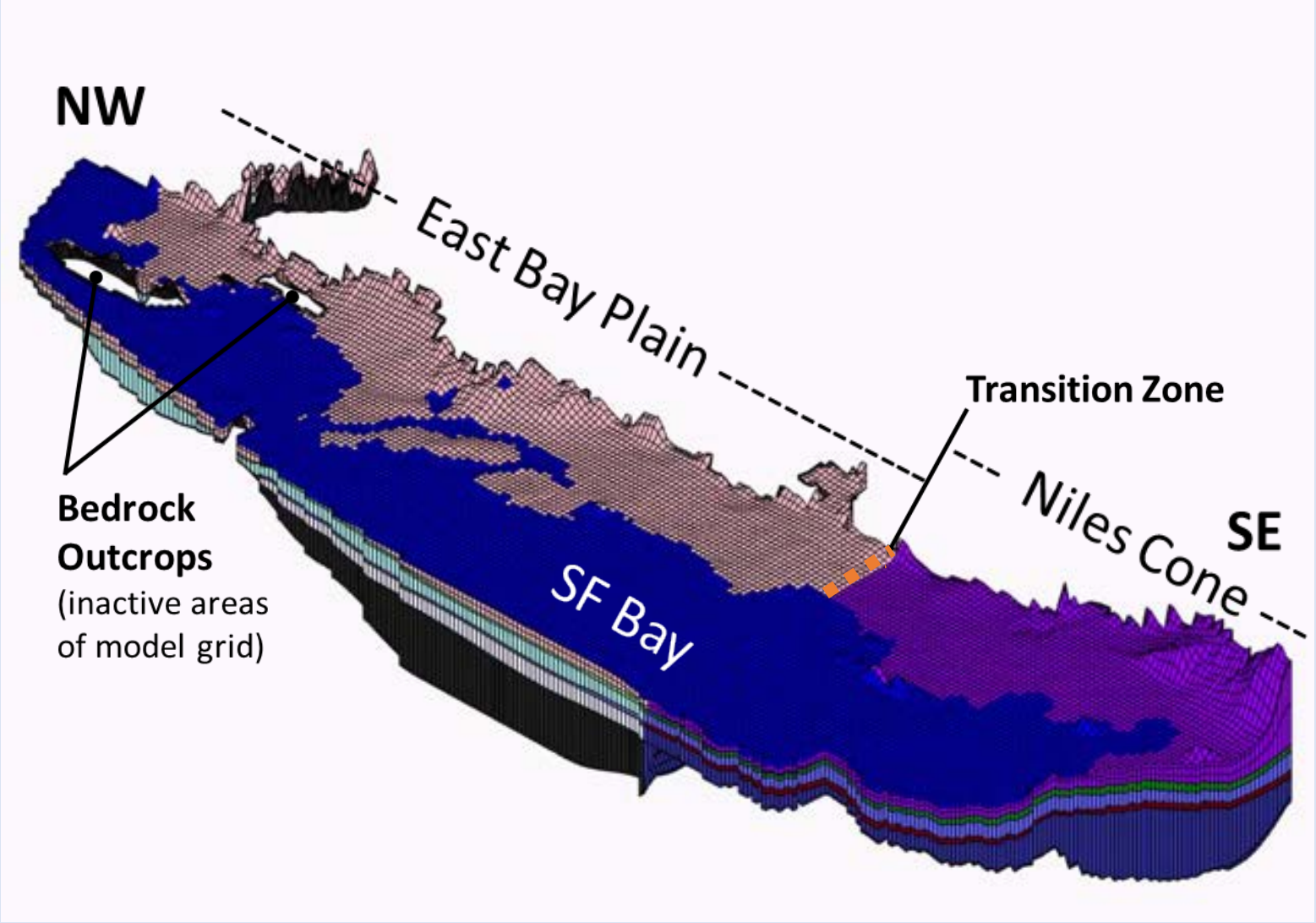


Horizontal Flow Barrier (simulates transition zone)
DWR Groundwater Sub-Basins
EBMUD GSA
HAYWARD GSA
ACWD GSA

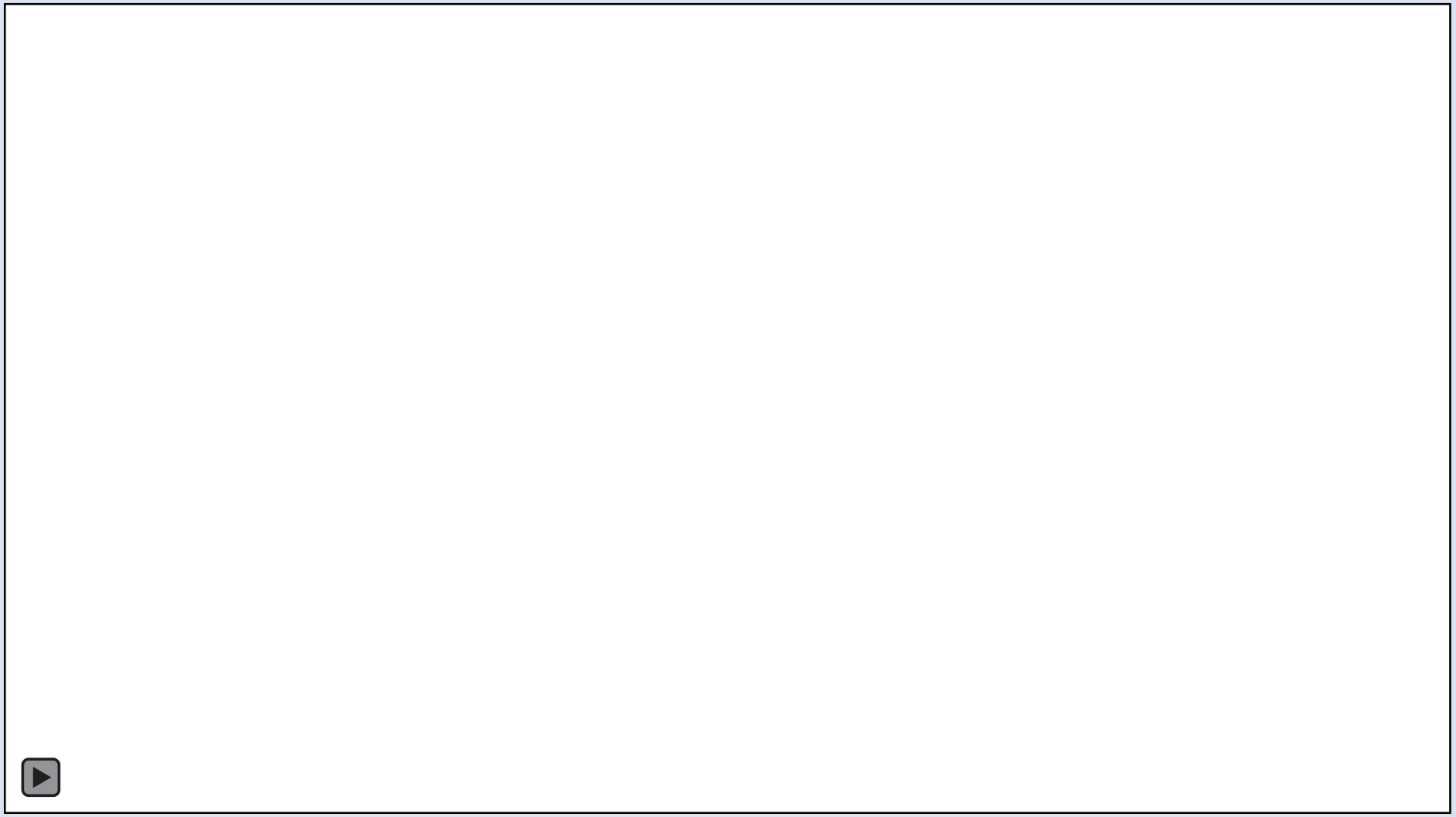




3-D View of Updated Model Domain and Layering

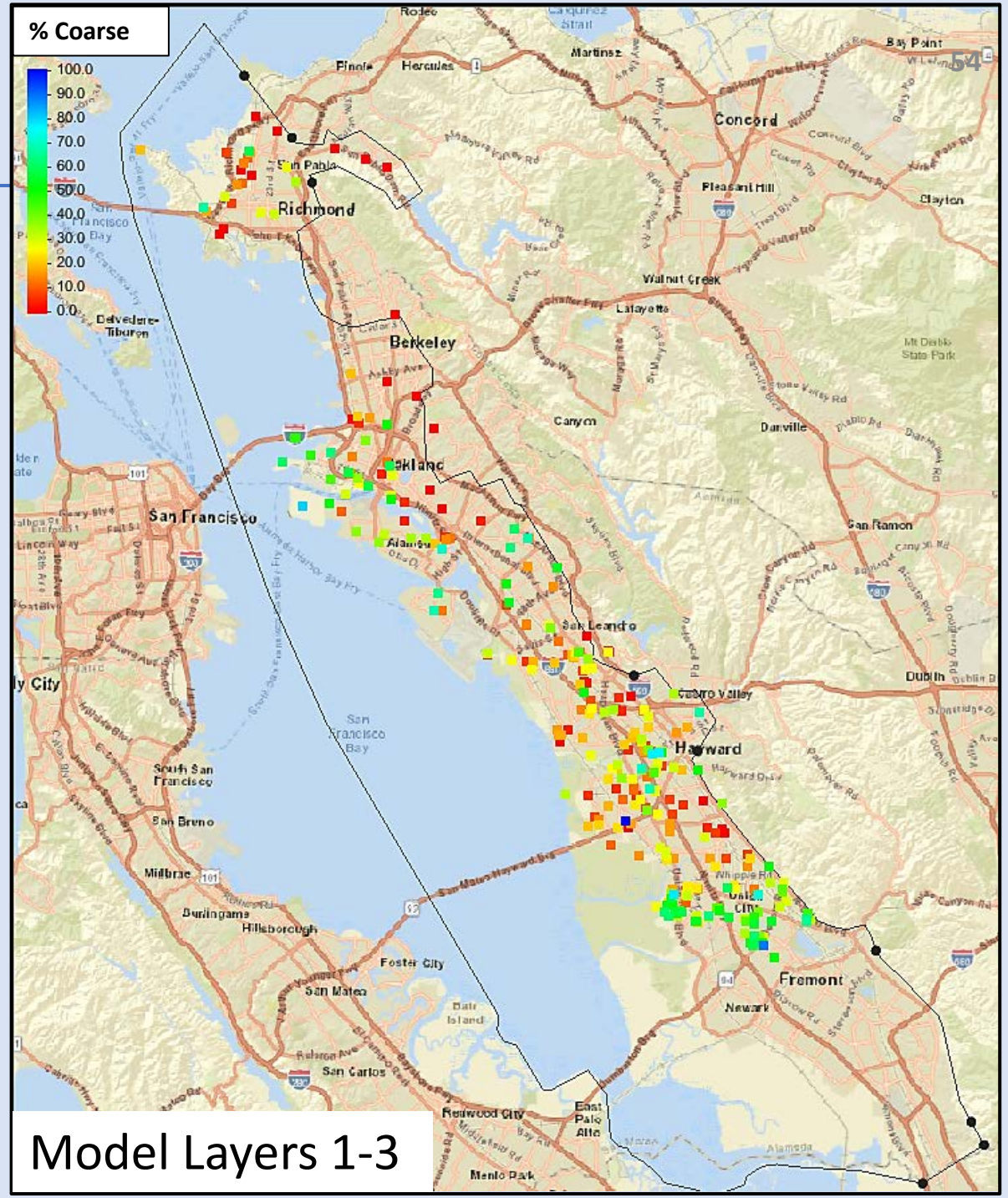


3-D View of Updated Model Domain and Layering



Initial Values of Hydraulic Conductivity (K)

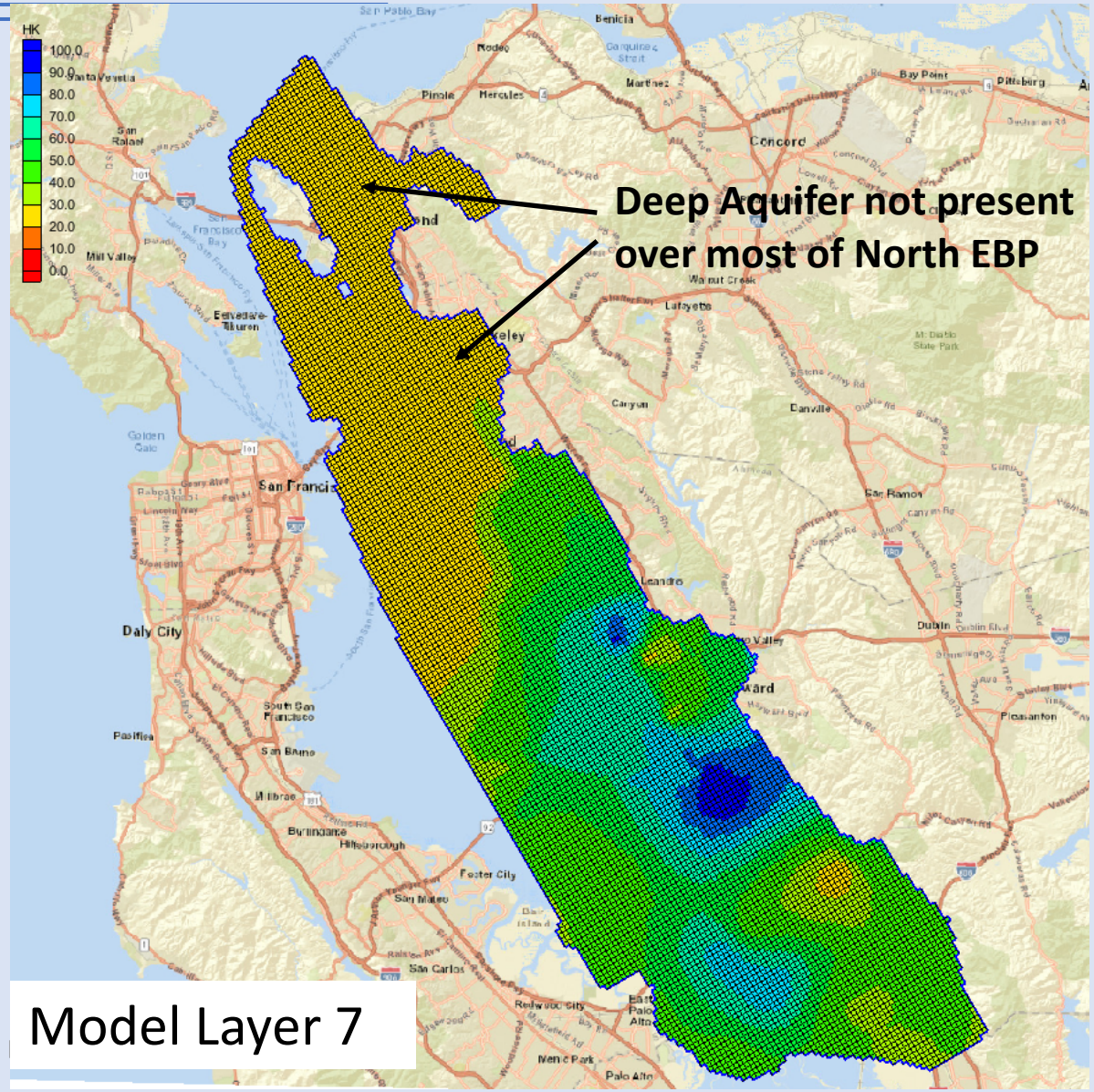
- Based on percent coarse-grained material in each layer at each borehole from lithologic logs
- Average boring log lithologies compiled for 5-ft intervals



Distribution of Hydraulic Parameters Based on HCM

Example of initial hydraulic conductivity (K) distribution (Deep Aquifer)

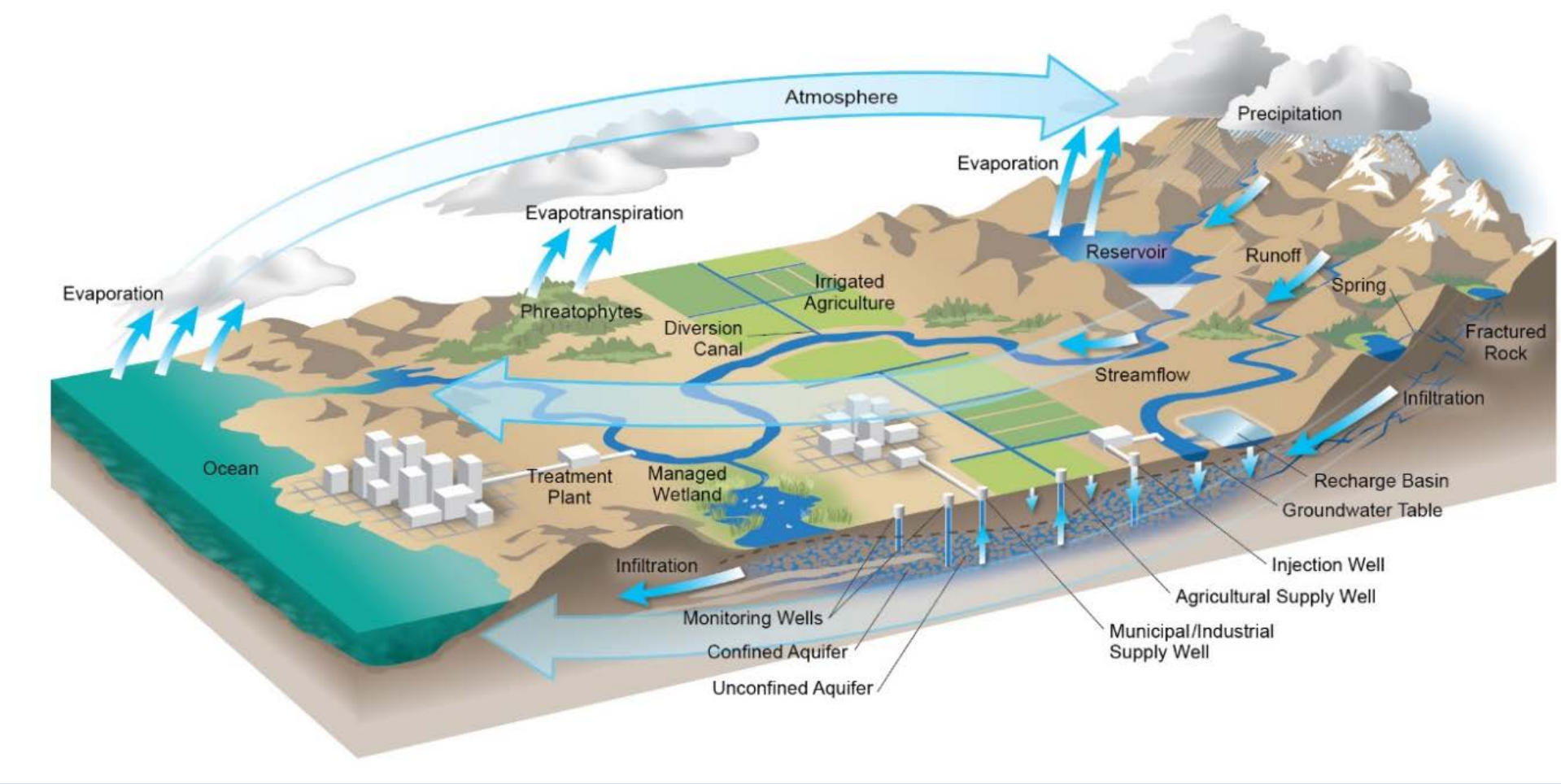
- Distribution of K in each aquifer layer is interpolated between values at each boring log
- Each grid cell is assigned an initial K value
- K values are refined during the calibration process



Next Steps for Model Development and Application

- Addition of minor streams
- Refinement of recharge
- Check of water balance
- Calibration
- Sensitivity Analyses
- Finalize Baseline Model
- Sustainable Yield Estimates
- Evaluate Potential for Groundwater Resources Development

Questions: Groundwater Model Development



The Hydrologic Cycle, DWR Water Budget BMP, 2016

Next Steps

EAST BAY PLAIN SUBBASIN GSP DEVELOPMENT SCHEDULE
(Updated 11/16/20)

No	TASKS	2020			2021												2022
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1	**TAC meetings**		11/18			12/22											
2	**General Stakeholders meetings**																
3	Complete TM 4.2																
4	GW Model Development and Calibration																
5	Planned GW Use/Projects (GW Management Scenarios Development)																
6	Model Runs																
7	**Sustainable Management Criteria and Management Actions**																
8	GSP Preparation																
9	DMS																
10	Public review of draft GSP													Public review			1/14
11	**DWR submittal**																

Acronyms:

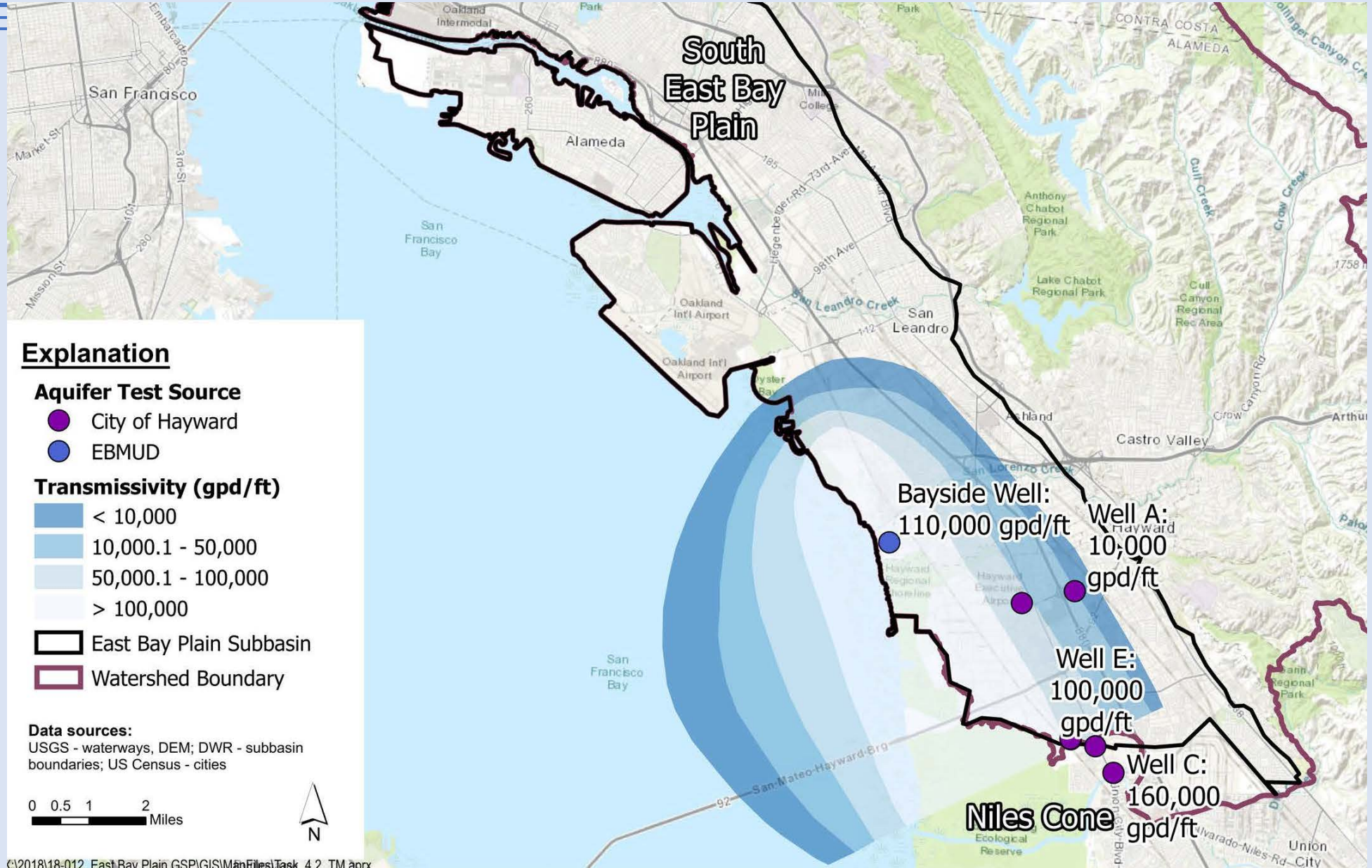
BOD - EBMUD Board of Directors

TAC - Techinical Advisory Committee

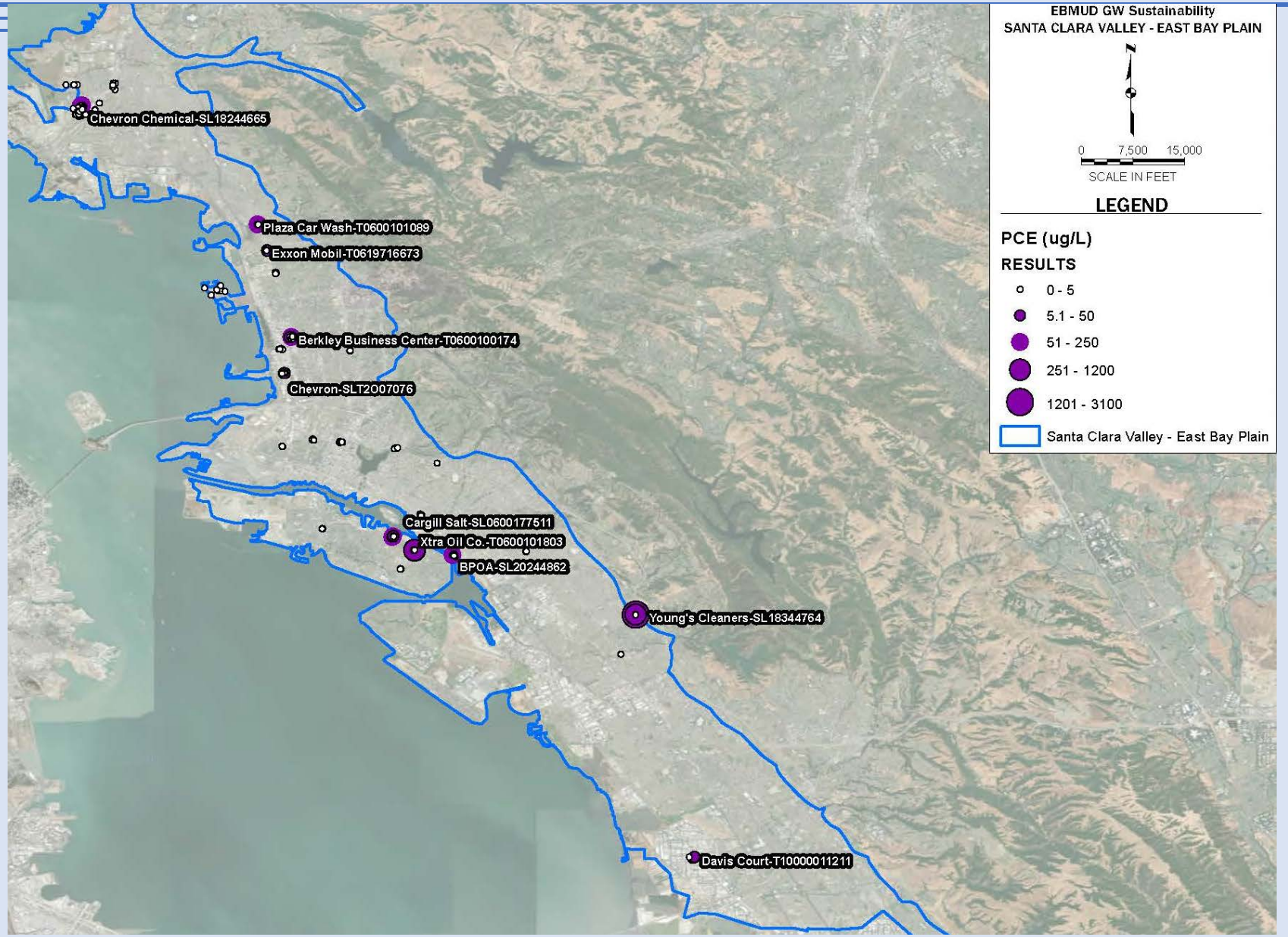
IWG - Interbasin Working Group

Potential Extra Slides

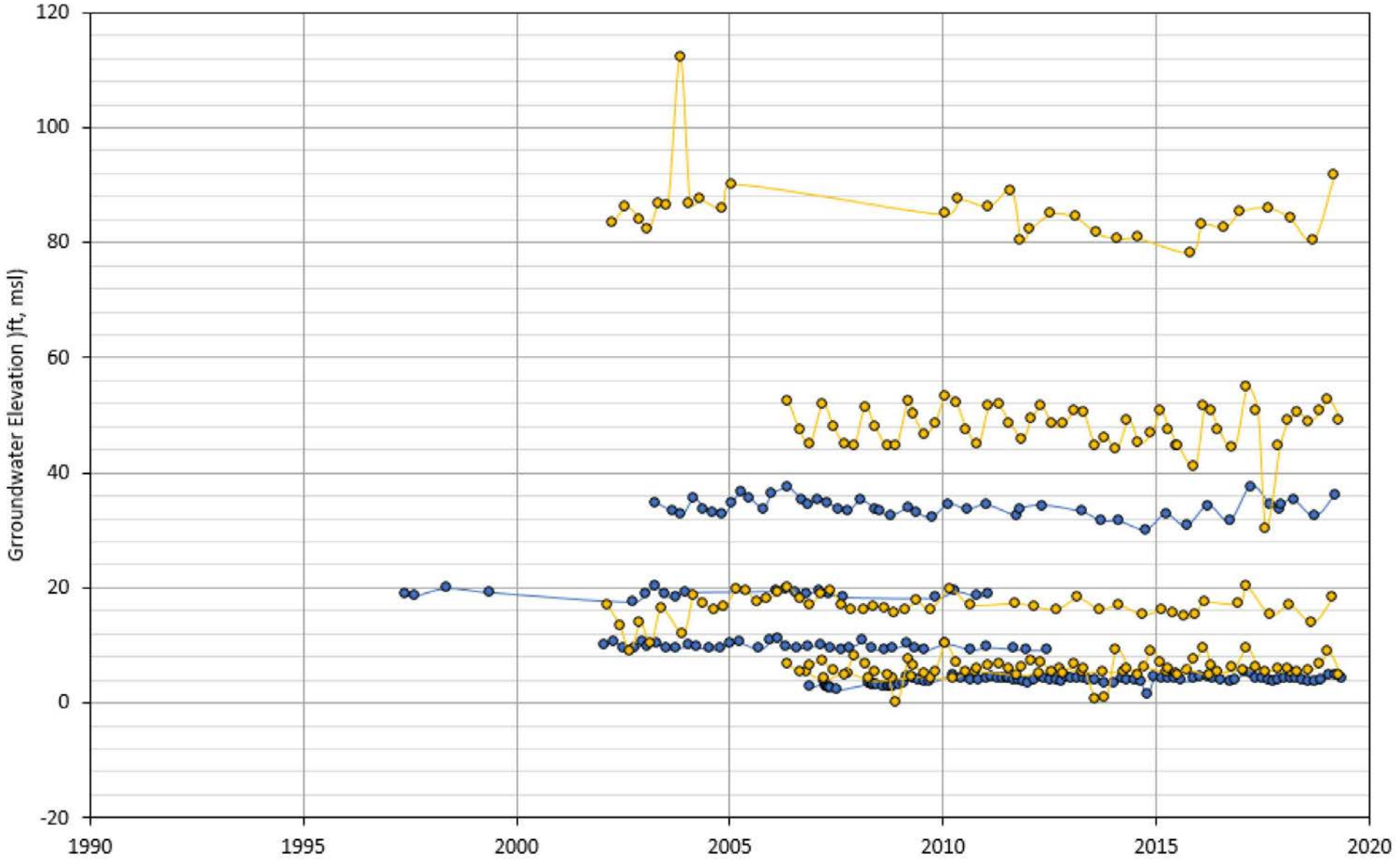
Subtask 4.2 Geologic Conditions – Extent of Aquifers - Deep



Subtask 4.2 Groundwater Conditions – Water Quality - PCE



Subtask 4.2 Groundwater Conditions – Water Elevations - Hydrographs



Shallow Wells

Subtask 4.2 Water Balance

- Review of Previous Water Balance Studies for SF Bay Area Groundwater Basins
  - Overall total recharge rates ranging from 0.18 to 0.61 ft/yr (2.2 – 7.3 in/yr)
  - Previous estimate for EBP Subbasin areas ranged from 0.18 to 0.28 ft/yr (2.2 – 3.4 in/yr)
  - Previous water balance analysis for EBP Subbasin by Muir in 1990s (from Berkeley in north to Hayward in south)
  - Used Muir work as starting point and refined components; added bedrock inflow component

Table 6-4: Comparison of Recharge Estimates for San Francisco Bay Area Groundwater Basins

Groundwater Subbasin; Study Period; Report Date	Net Deep Perc (AFY)	Stream Seepage (AFY)	Bedrock Inflow (AFY)	Net Lateral Subsurface Inflow (AFY)	Pipe Leakage (AFY)	Basin Area (acres)	Total Recharge (AFY)	Total Average Recharge (feet/ year)
Westside; 1959-2005; 2007						26,080	16,010	0.61
San Mateo; 1984-2015; 2018	3,600	1,300	600	1,200	1,200	37,708	7,900	0.21
City of San Francisco; 1987-1988; USGS, 1993						29,496	16,489	0.56
Palo Alto Area of Santa Clara Plain; 2018	9,600	4,700	900	0	2,200	47,486	17,400	0.37
South East Bay Plain; San Lorenzo and Hayward; DWR, 1963						18,141	5,000 (Safe Yield)	0.28
East Bay Plain – Berkeley to Hayward; 1990's, 1993; Muir	3,900	6,200	0	200	9,900	72,960	20,200	0.28
East Bay Plain; 1965-2000; 2005; NEBIGSM	6,350	139	0	299	0	38,400	6,788	0.18

Subtask 4.2 Water Balance

- Evaluation of rainfall recharge
  - Soil zones with lowest permeability not included
  - Subtract ET and runoff from total rainfall to estimate rainfall recharge
  - Average of 6.4 percent of total rainfall estimated to be recharge
  - Consistent (low end) of estimate in other SF Bay Area Basins

Table 6-6: Updated Soil Moisture Balance Evaluation for Rainfall Recharge

GW Subarea	Subarea Recharge Area (acres)	Average Annual Rainfall (inches)	Average Annual Rainfall Volume (ac-ft)	Runoff Percent	Runoff Volume (ac-ft)	ET Percent	ET Volume (ac-ft)	Recharge (ac-ft)	Recharge Percent
San Lorenzo Cone – Niles Cone	4,294	19	6,799					370	5.4
San Lorenzo Cone - EBP	5,434	19	8,604					465	5.4
San Leandro Cone - Bayfarm / Airport	3,200	18	4,800	51	2,448	44.7	2,144	200	4.2
San Leandro Cone – Plain Area	5,504	21	9,907					535	5.4
Merritt Sand Outcrop	4,352	20	7,398	55	4,069	39.4	2,916	400	5.4
Oakland Upland /Plain	10,816	24	21,632	58	12,547	33.5	7,247	1,800	8.3
Berkeley Plain	4,864	23	9,242	57	5,268	35.3	3,259	700	7.6
Richmond	6,400	24	12,800					700	5.4
Updated Muir Totals /Averages	38,464	21.4	68,382	57.0	39,049	37.6	25,772	4,470	6.5
Totals/ Averages for EBP	**44,864**		**81,182**					**5,170**	**6.4**

Subtask 4.2 Water Balance

- Evaluation of Irrigation Return Flows
  - Separate calculations for large irrigated parcels and residential parcels
  - Applied water estimated to be 2.0 (residential) to 2.5 (large parcels) ft/year
  - Portion of applied water becoming recharge assumed to be 10 (residential) to 15 (large parcels) percent
  - Totals for EBP Subbasin of 750 (large parcels) and 1,600 (residential) AFY

Table 6-7: Summary of Irrigation Return Flows for Large Irrigated Parcels

GW Subarea	Irrigated Area (acres)	Applied Water (ft)	Average Annual Irrigation Volume (ac-ft)	Return Flow Percent	Recharge (ac-ft)
San Lorenzo Cone	537	2.5	1,343	15	201
San Leandro Cone	739	2.5	1,848	15	277
Merritt Sand Outcrop	140	2.5	350	15	53
Oakland Upland /Plain	309	2.5	773	15	116
Berkeley Plain	120	2.5	300	15	45
Richmond	152	2.5	380	15	57
Totals/ Averages	**1,997**	**2.5**	**4,994**	**15**	**749**

Table 6-8: Summary of Irrigation Return Flows for Residential Parcels

Muir Groundwater Subarea	Pervious Residential Area (acres)	Irrigated Area (acres)	Applied Water (ft)	Average Annual Irrigation Volume (ac-ft)	Return Flow Percent	Recharge (ac-ft)
San Lorenzo Cone	5,999	2,000	2.0	4,000	10	400
San Leandro Cone	3,606	1,202	2.0	2,404	10	240
Merritt Sand Outcrop	1,580	527	2.0	1,054	10	105
Oakland Upland /Plain	5,567	1,855	2.0	3,710	10	371
Berkeley Plain	3,134	1,045	2.0	2,090	10	209
Richmond	4,005	1,335	2.0	2,670	10	267
Totals/ Averages	**23,891**	**7,964**	**2.0**	**15,928**	**10**	**1,592**

Subtask 4.2 Water Balance

- Evaluation of Streamflow Infiltration
  - Apply methodology outlined by Muir
  - Based on unlined stream length, infiltration rate, number of days with streamflow
  - Revised estimates about 40% of Muir total
  - Final values subject to model calibration

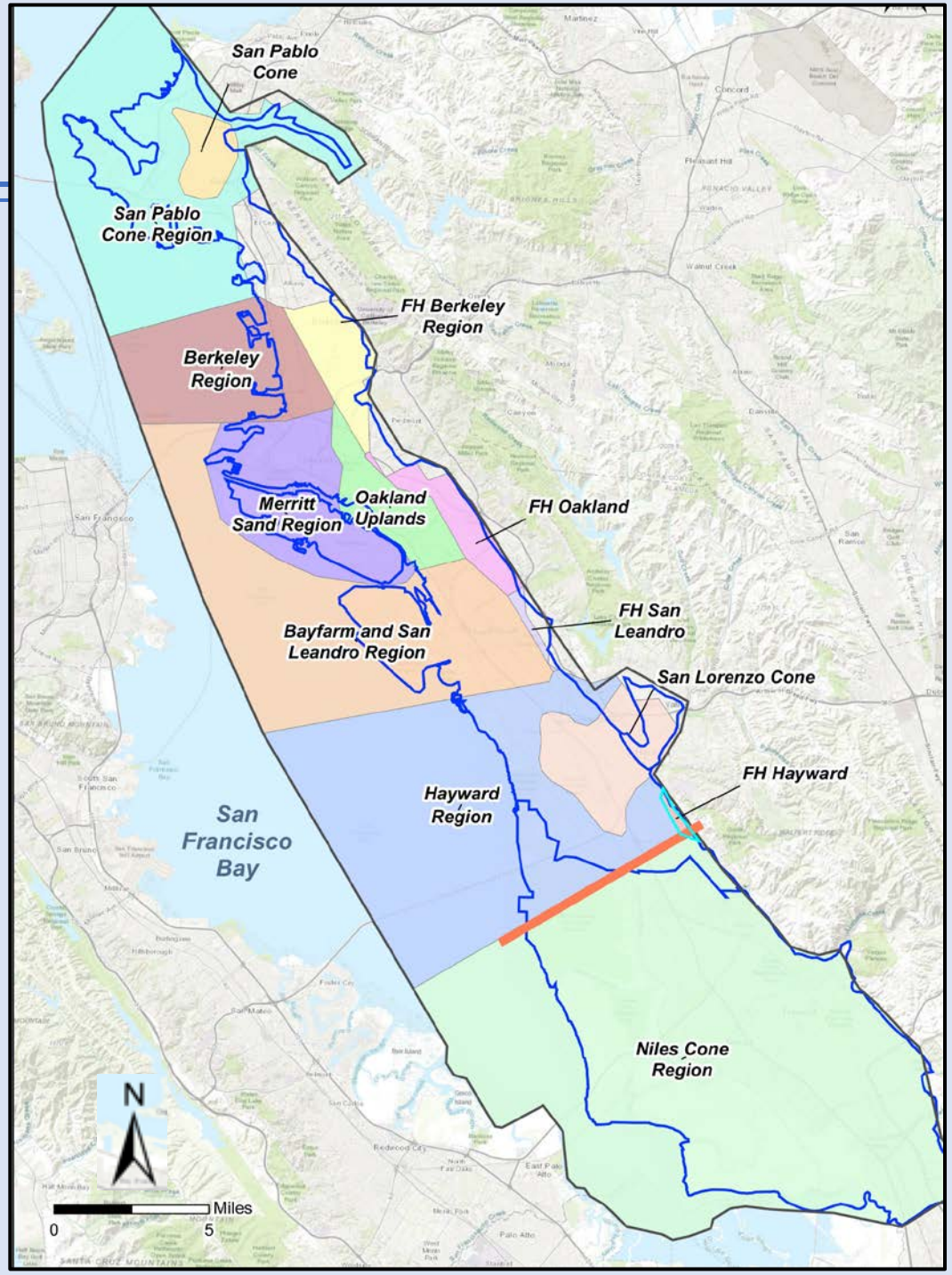
Table 6-9: Streamflow Infiltration Evaluation

Stream	Muir GW Subarea	Muir Unlined Stream Length (Miles)	Muir Infiltration Rate (cfs/mi)	Muir Stream Recharge (AFY)	Updated Unlined Stream Length (Miles)	Updated Infiltration Rate (cfs/mi)	Updated Stream Recharge (AFY)	Total by GW Subarea (AFY)
Old Alameda	San Lorenzo	1.89	0.99	448	1.89	0.99	448	Outside EBP
Ward-Steile	San Lorenzo	0.47	1.28	145	0.47	0.5	56	
Zone 4, Line A	San Lorenzo	0.13	0.77	24	0.13	0.77	24	
San Lorenzo	San Lorenzo	2.31	1.83	1,016	0	0.8	0	80
San Leandro	San Leandro	2.08	1.89	944	2.97	0.8	570	
Elmhurst	San Leandro	1.14	1.90	520	1.14	0.5	137	
Arroyo Viejo	San Leandro	0.98	1.90	448	0.98	0.5	118	825
Peralta	Oakland	1.06	2.33	592	1.06	0.5	127	
Sausal	Oakland	1.33	2.24	714	1.33	0.5	160	287
Codornices	Berkeley	1.02	1.73	424	1.02	0.5	122	
Cerrito	Berkeley	1.33	1.52	484	1.33	0.5	160	
Strawberry	Berkeley	1.33	1.63	520	1.33	0.5	160	442
Wildcat	Richmond	NA	NA	NA	2.0	0.8	384	
San Pablo	Richmond	NA	NA	NA	1.8	0.8	346	730
Totals				6,200			2,812	2,364
Totals (within EBP)				**5,752**			**2,364**	

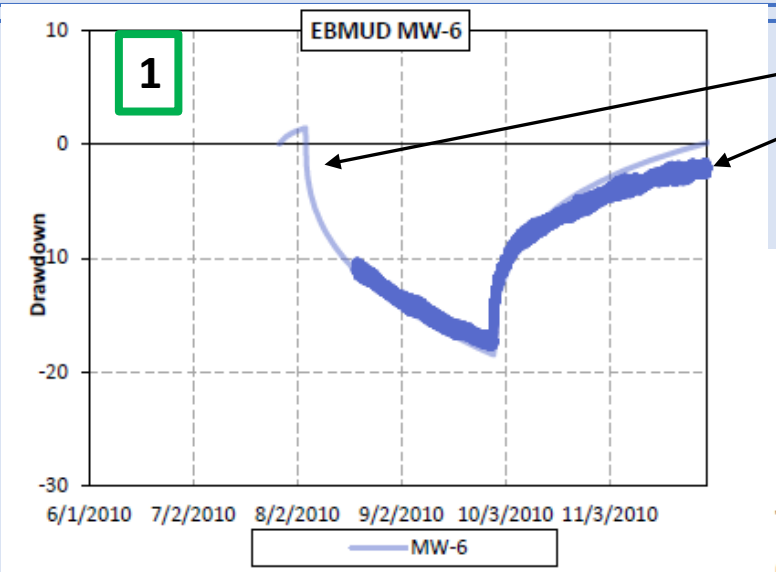
Note: Calculations based on Muir estimate of 121 days/year with streamflow available for infiltration.

Geographic Areas

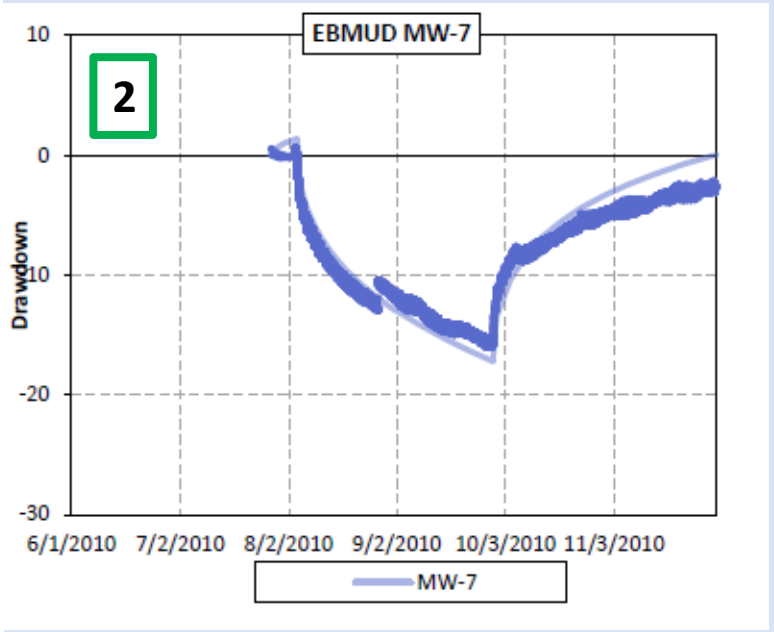
- Defined regional zones based on geography and hydrogeology
- Ranges of aquifer properties assigned for each zone

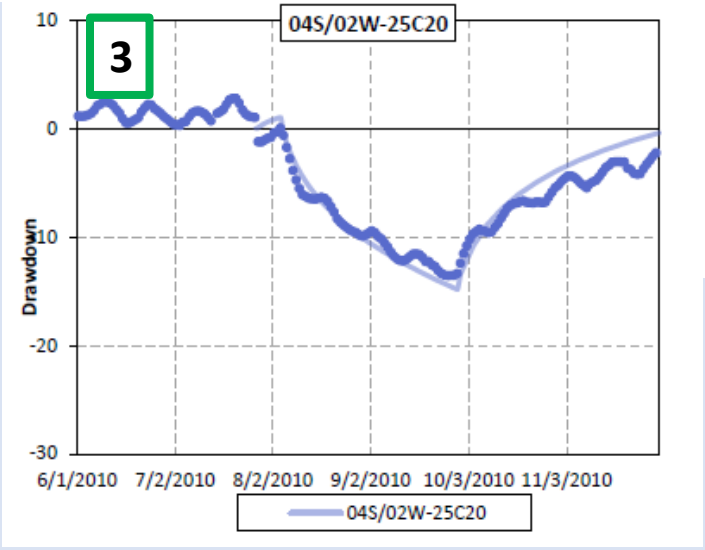


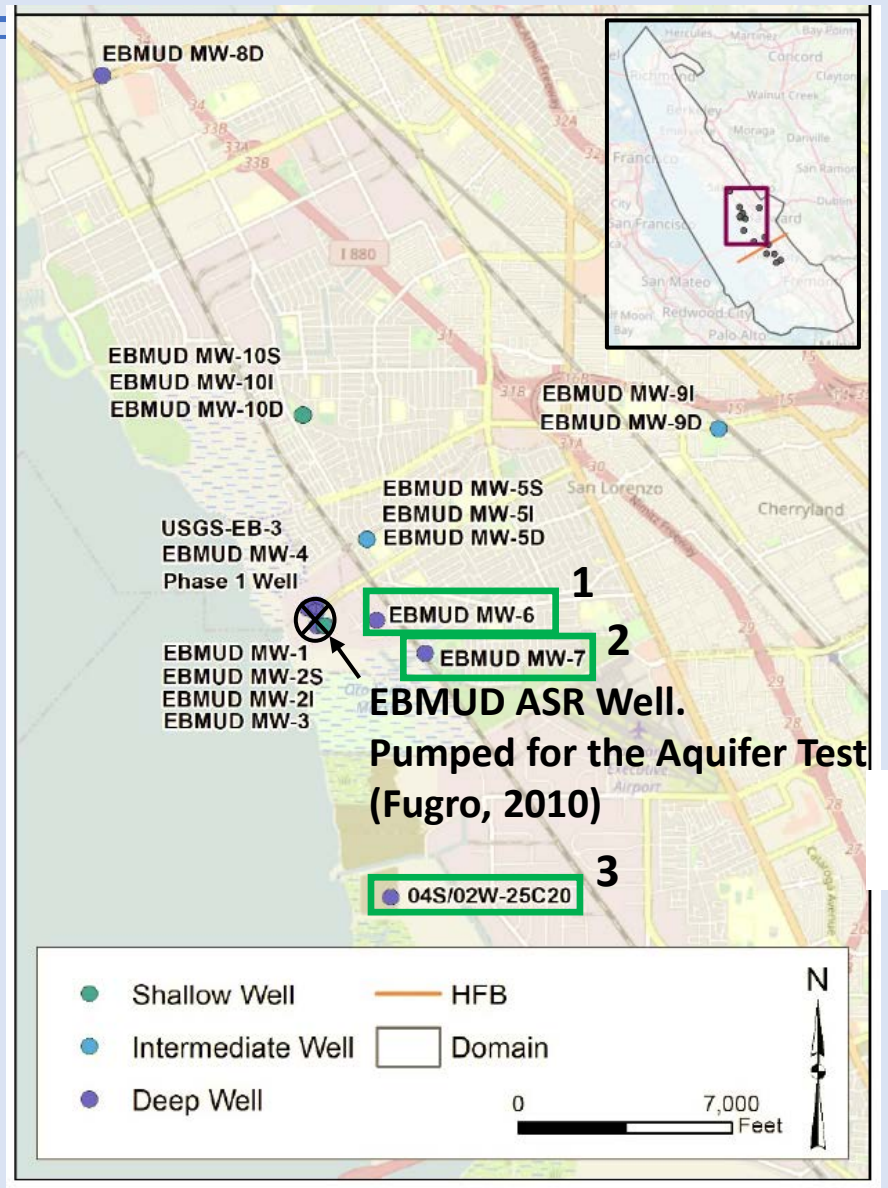
Preliminary Calibration to Aquifer Test (North of Transition Zone)



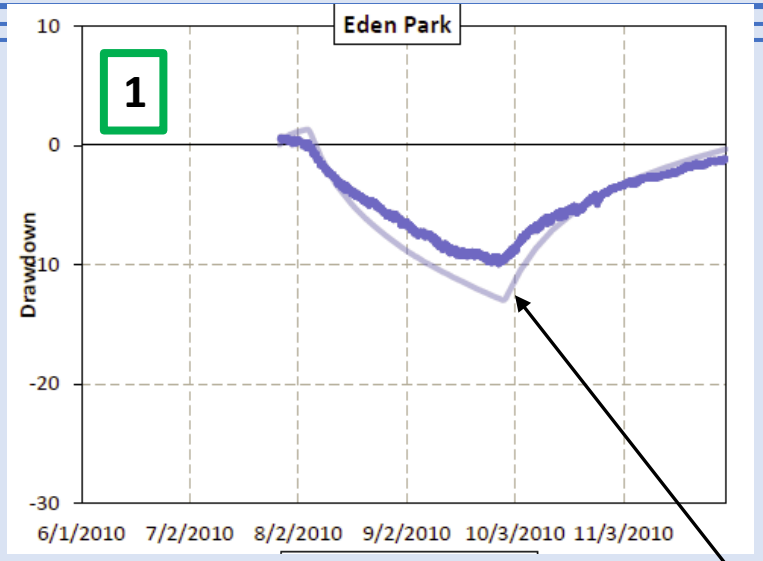
Narrow pale lines are model results and heavier points are the drawdown data recorded during the aquifer test.

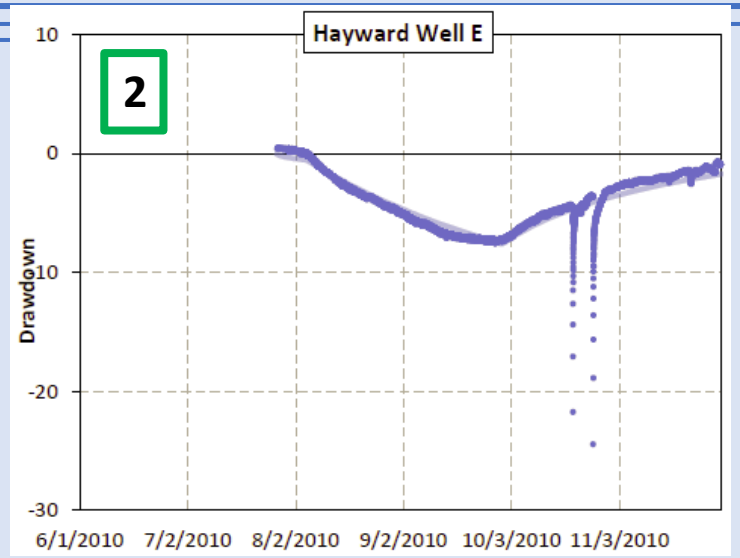






Preliminary Calibration to Aquifer Test (Near Transition Zone)





Narrow pale lines are model results and heavier points are the drawdown data recorded during the aquifer test.