Salinas Valley Seawater Intrusion Model

MONTGOMERY & ASSOCIATES
Water Resource Consultants

February 28, 2022

SVIHM Disclaimer

This data (model and/or model results) are preliminary or provisional and are subject to revision. This model and model results are being provided to meet the need for timely best science. The model has not received final approval by the U.S. Geological Survey (USGS). No warranty, expressed or implied, is made by the USGS or the U.S. Government as to the functionality of the model and related material nor shall the fact of release constitute any such warranty. The model is provided on the condition that neither the USGS nor the U.S. Government shall be held liable for any damages resulting from the authorized or unauthorized use of the model.

SVIHM Compared to SWI

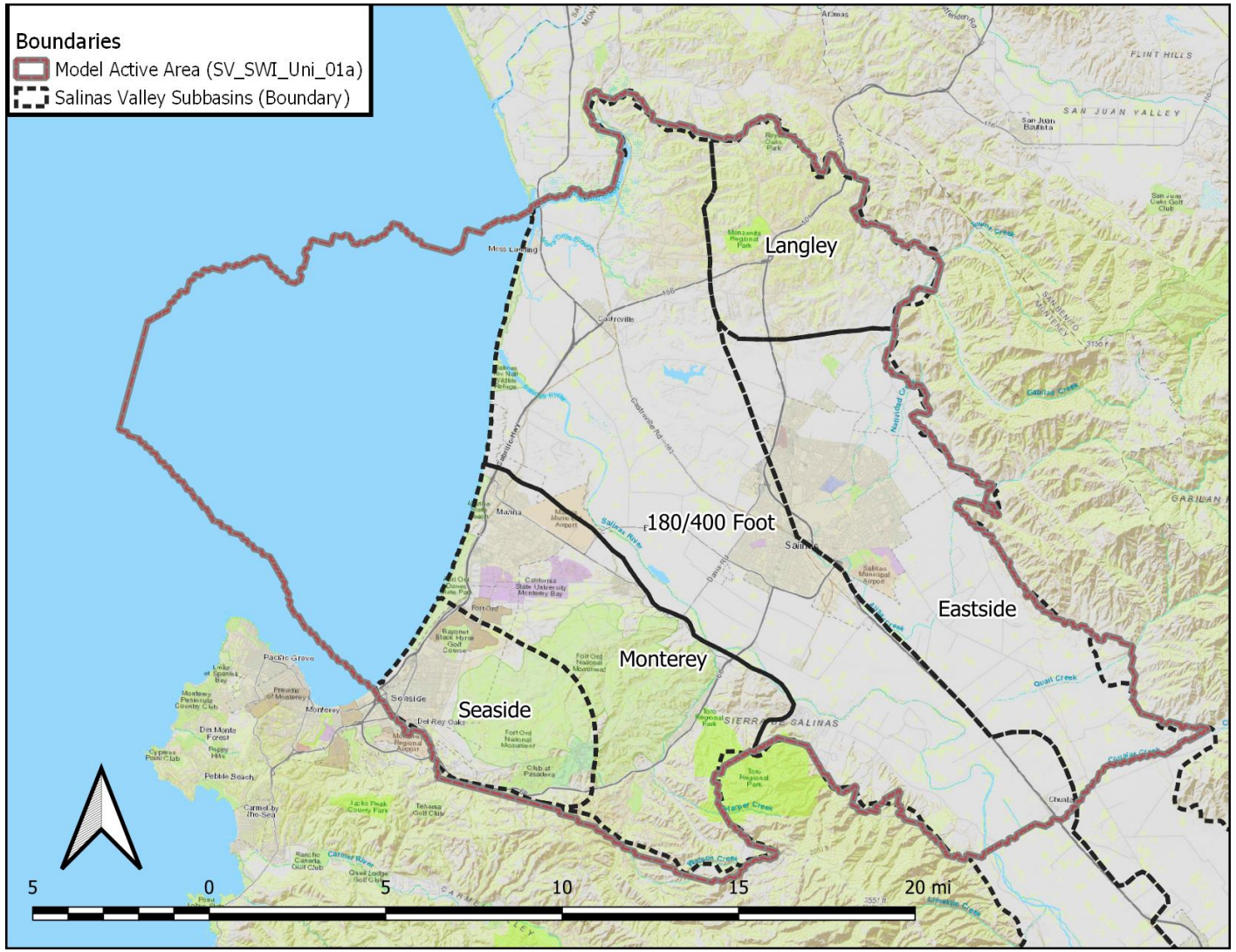
SVIHM / SVOM

- Model extent through Upper Valley
- Farm Process
  - Recharge and ET are implicit
- SWO – reservoir releases rules
- No transport
- SWI package

SWI

- Model extent to Chualar Creek
- Agriculture is explicit
  - Recharge and ET are explicitly defined
- Reservoir releases explicitly applied
- Transport
- Variable density flow

Model Location



Model Development

- Model Code
- Temporal Discretization
- Model Grid
- Model Layering
- Model Zonation
- Recharge and ET
- Pumping
- Boundary Conditions

- Streams
- Elkhorn Slough
- Salinas Valley Inflow
- Ocean Boundary
- Starting Heads
- Initial Concentrations (Chloride)
- Variable Density Flow
- Dispersivity

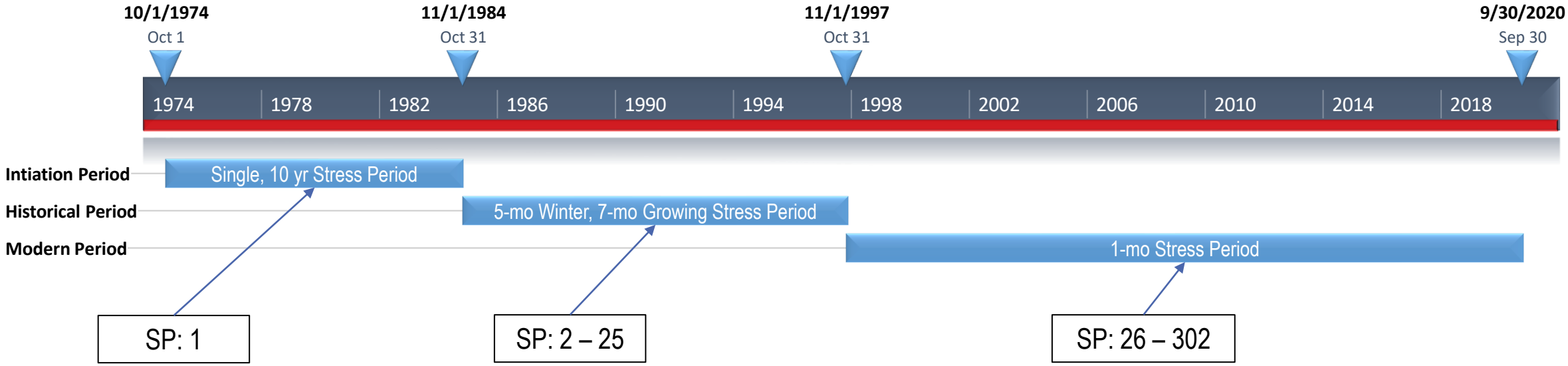
Model Code: USG-Transport

- Built from MODFLOW-NWT
  - Newton-Raphson formulation
- Control volume finite difference
- Unstructured grid
  - Grid resembles a finite element mesh
- Model layer pinch-outs

- Transport
- Variable Density Flow
  - Similar to SEAWAT
- Adaptive time stepping
  - Helps with model convergence
- Tools available for use with PEST and Python (flopy)

https://www.gsienv.com/product/modflow-usg/

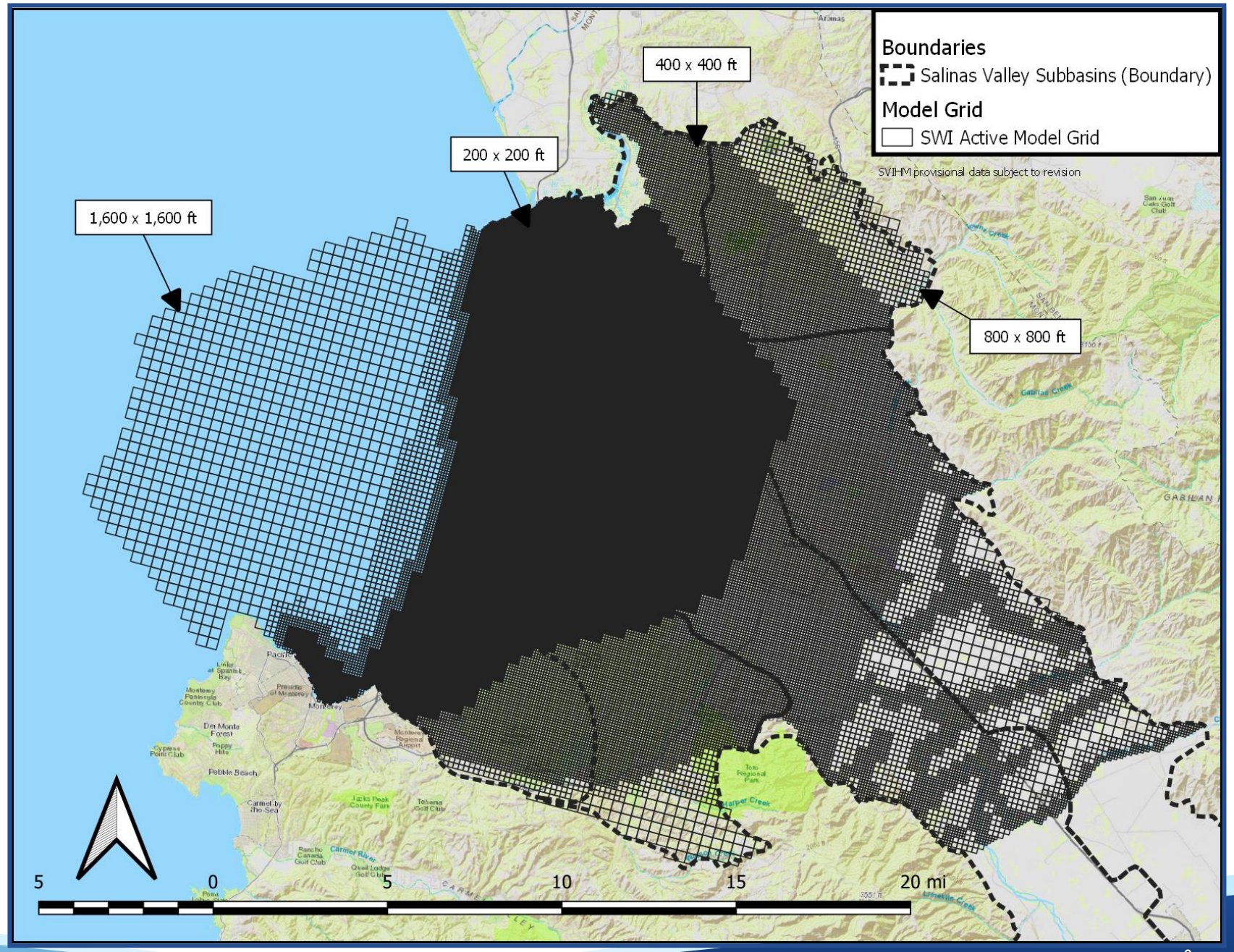
Temporal Discretization



- All stress periods are transient
- Boundary conditions generally vary from one stress period to another but remain constant throughout a stress period

Model Grid

- 11 Layers
- 1,300,838 nodes (cells)
- 118,258 nodes / layer
- Largest cell size: 1,600 ft
- Smallest cell size: 200 ft
- Active nodes: ~1,000,000



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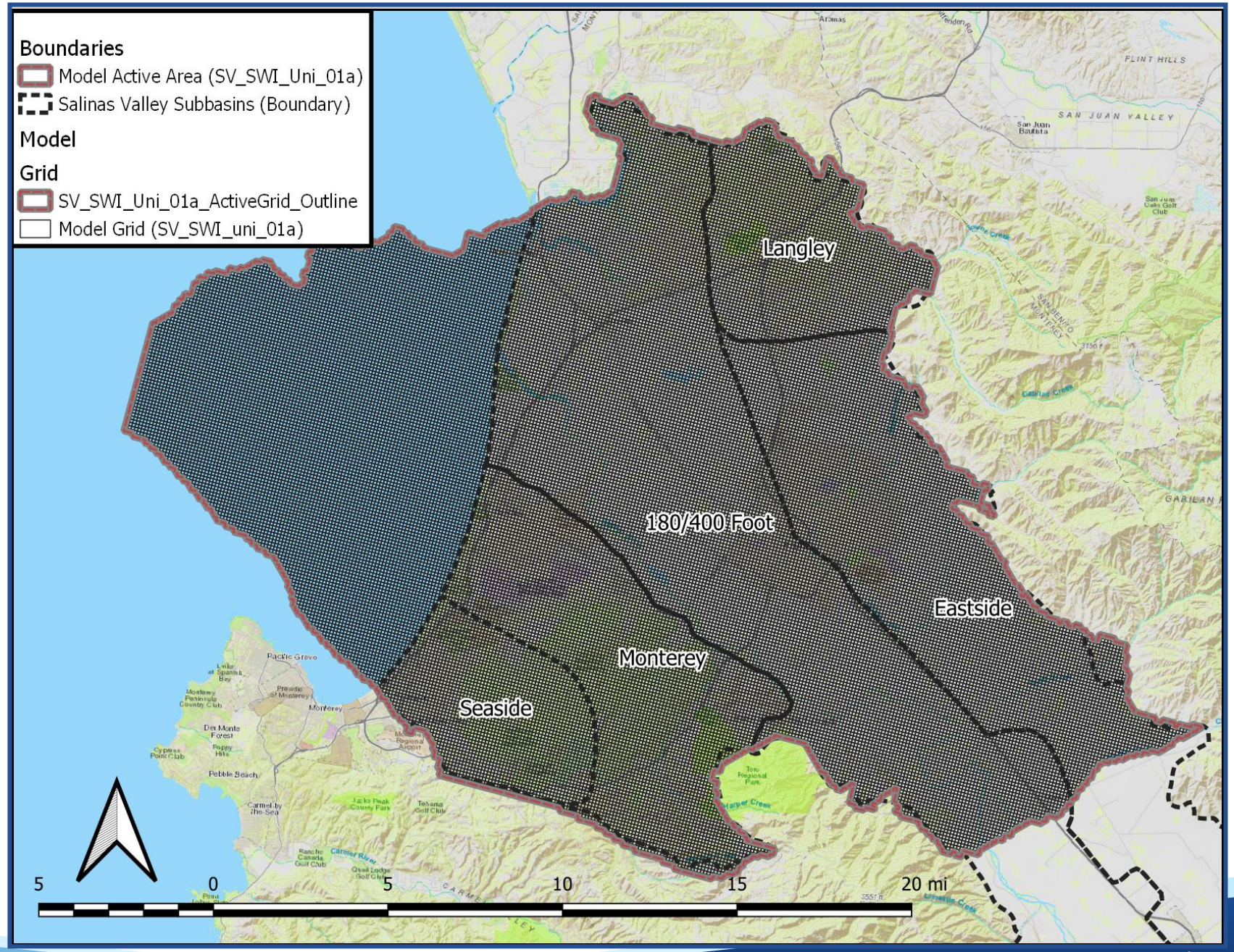
Model Grid

- 11 Layers
- 1,152,250 nodes (cells)
- 104,750 nodes / layer
- Cell size: 500 x 500 ft
- Active nodes: ~350,000

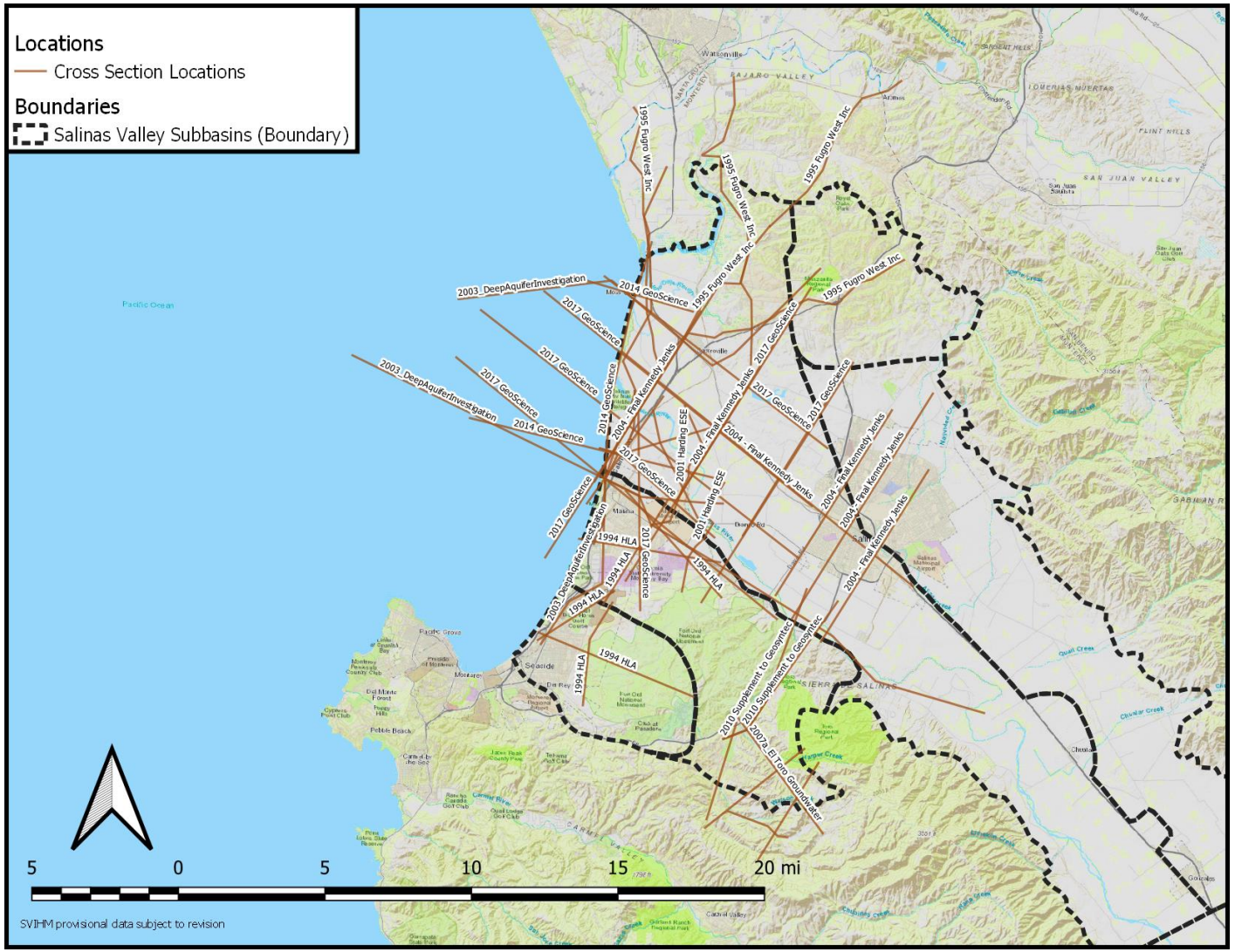


General Model Layering

1. Shallow Sediments
2. Salinas Valley Aquitard
3. 180 FT Aquifer (Layers 3.a, 3.b, and 3.c)
4. Middle Aquitard
5. 400 FT Aquifer
6. Deep Aquitard
7. Paso Robles Fmt
8. Purisima Fmt
9. Monterey Fmt (Bedrock

Model Zonation

- Cross sections
- Other model zonation:
  - SVIHM
  - Monterey Subbasin (EKI)
  - Seaside Watermaster Model



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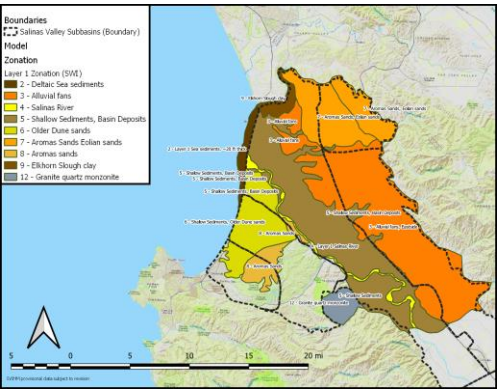
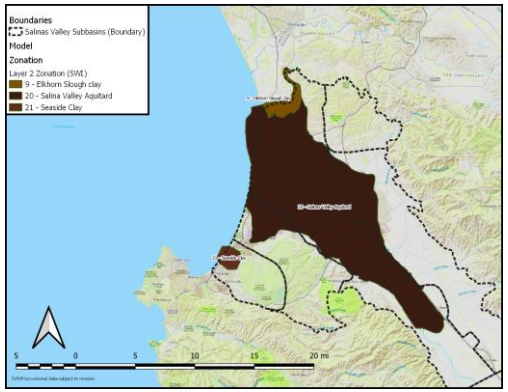
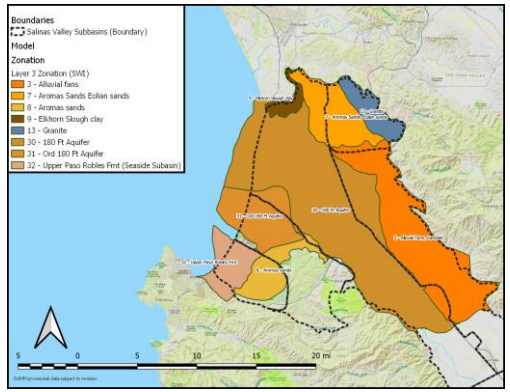
Model Zonation



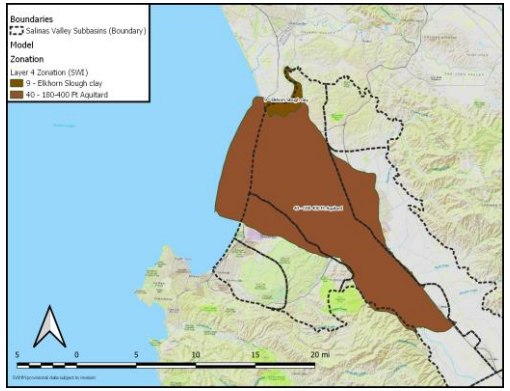
Layer 1



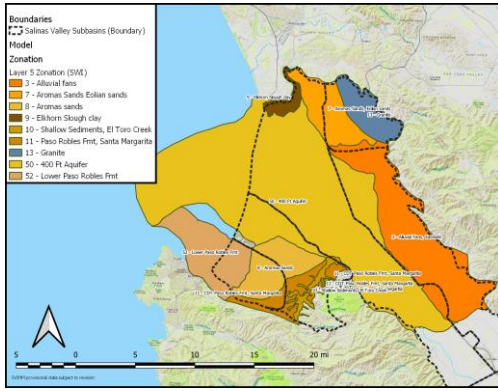
Layer 2



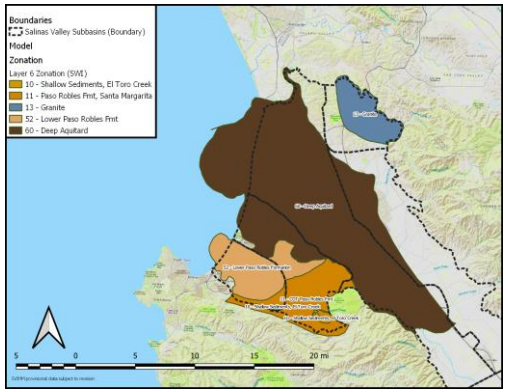
Layer 3 (3.1-3.3)



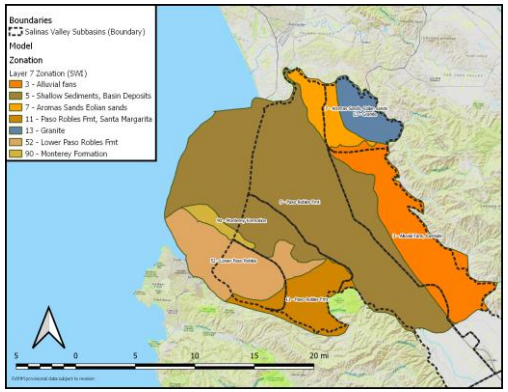
Layer 4



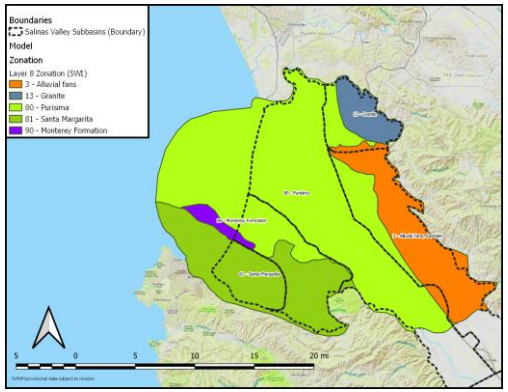
Layer 5



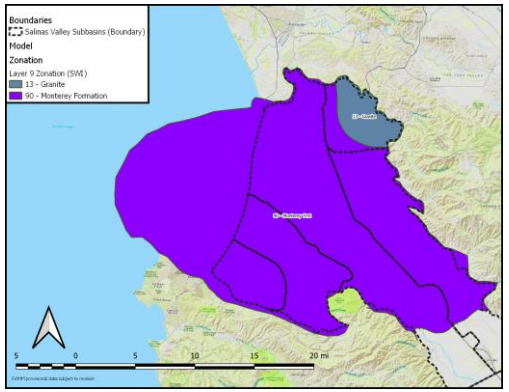
Layer 6



Layer 7



Layer 8



Layer 9

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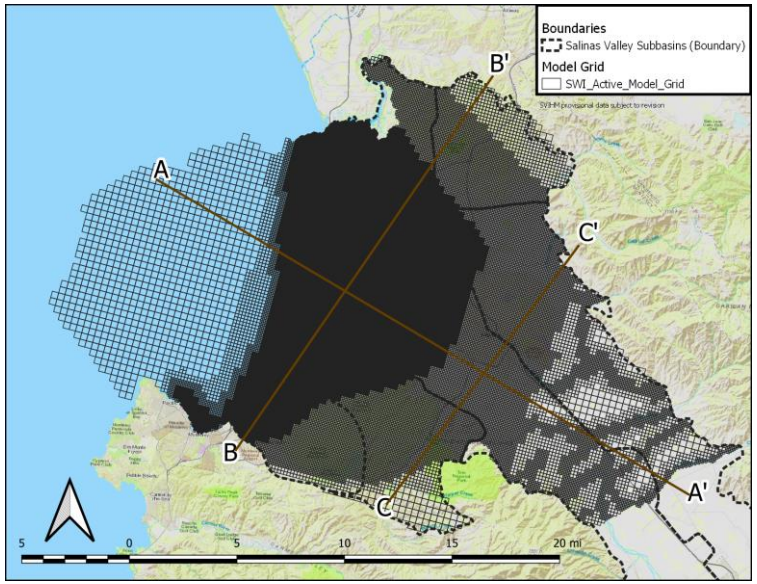
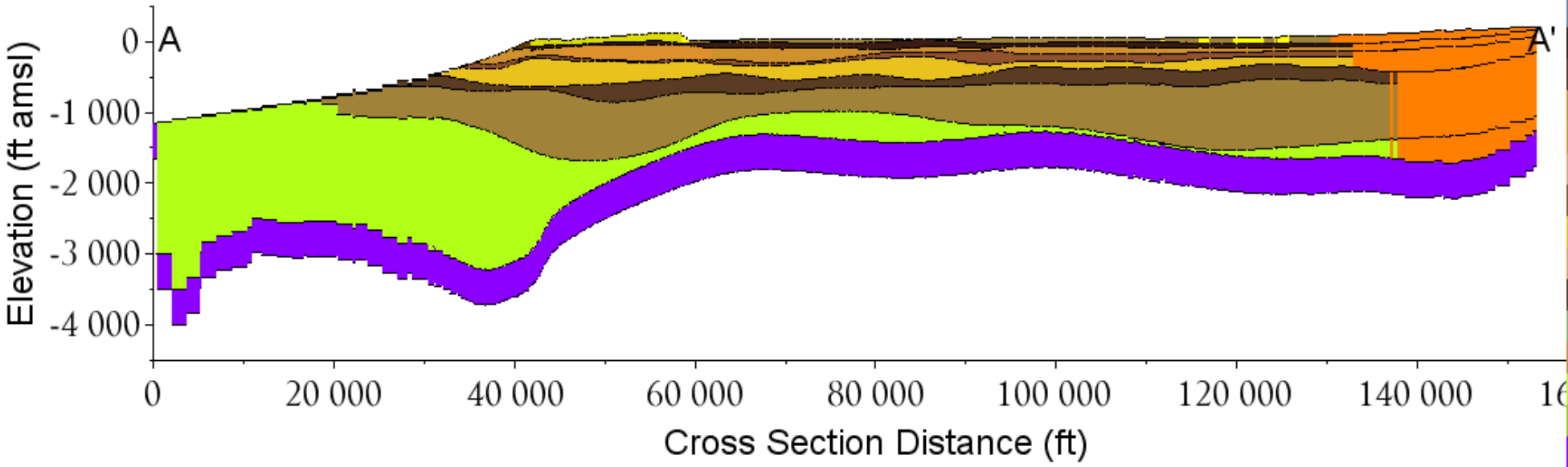
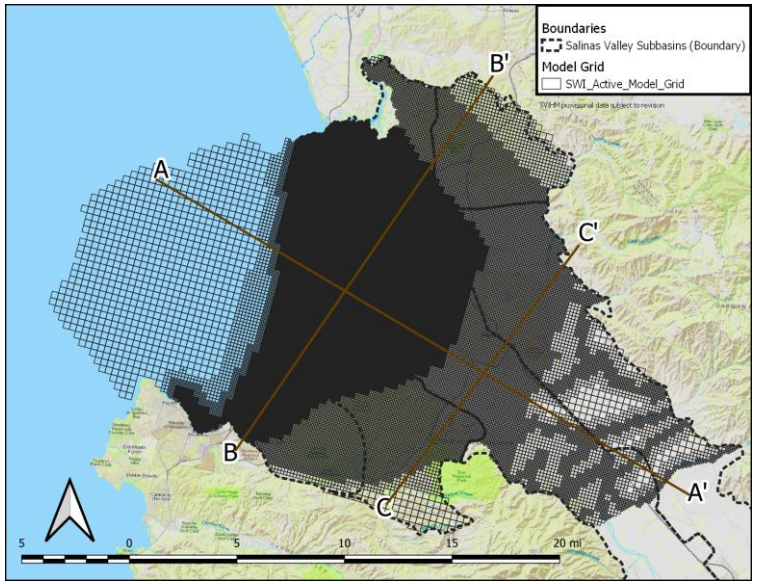
Model Zonation

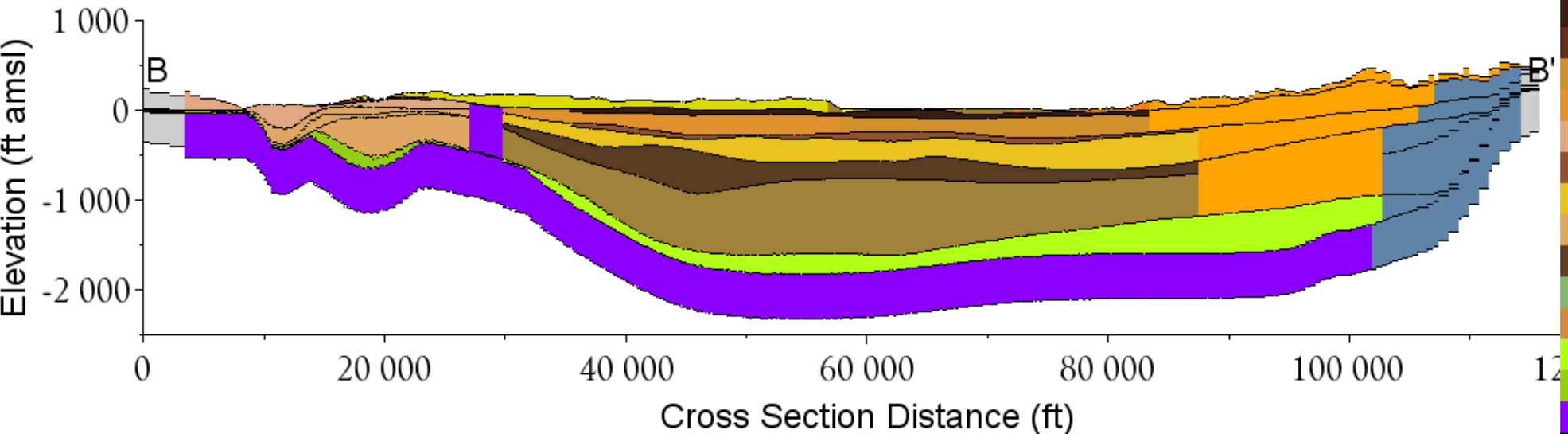




1	Outside the Model Domain
2	Deltaic Sea Sediments
3	Alluvial fans
4	Layer 1 Salinas River
5	Shallow Sediments, Basin Deposits
6	Shallow Sediments, Older Dune sands
7	Aromas Sands, Eolian sands
8	Aromas Sands
9	Elkhorn Slough clay
10	Shallow Sediments, El Toro Creek
11	CDT Paso Robles Fmt, Santa Margarita
12	Granite quartz monzonite
13	Granite
20	Salinas Valley Aquitard (Blue Clay)
21	Seaside Clay
30	180 FT Aquifer
31	Ord 180 FT Aquifer
32	Upper Paso Robles Fmt (Seaside Subasin)
40	180-400 Ft Aquitard
50	400 Ft Aquifer
52	Lower Paso Robles Fmt
60	Deep Aquitard
70	Paso Robles Fmt
71	Paso Robles Fmt (Pinched out)
80	Purisima
81	Santa Margarita
90	Monterey Fmt

Model Zonation





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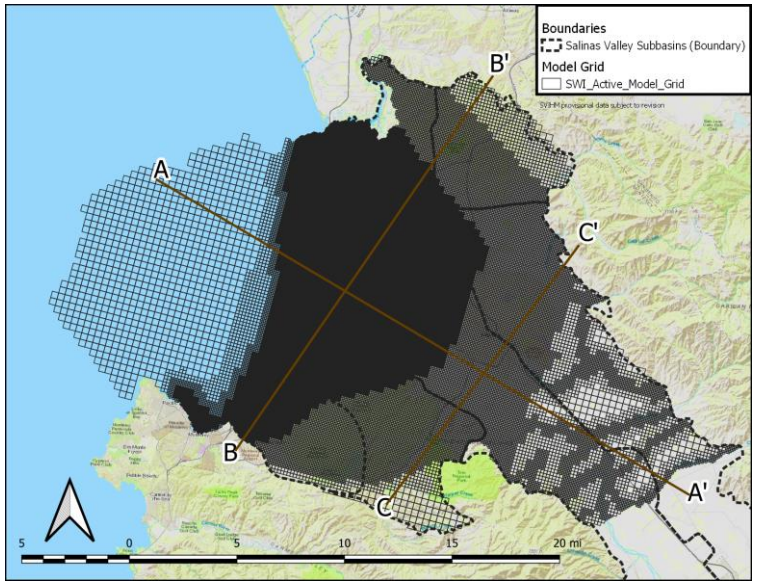

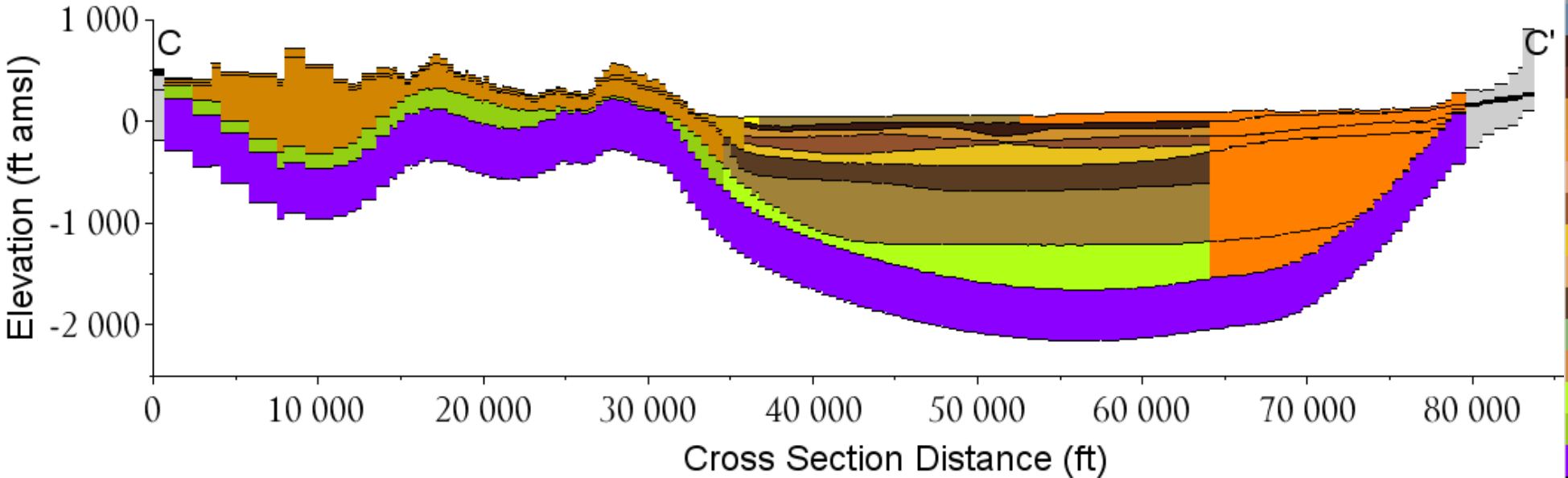

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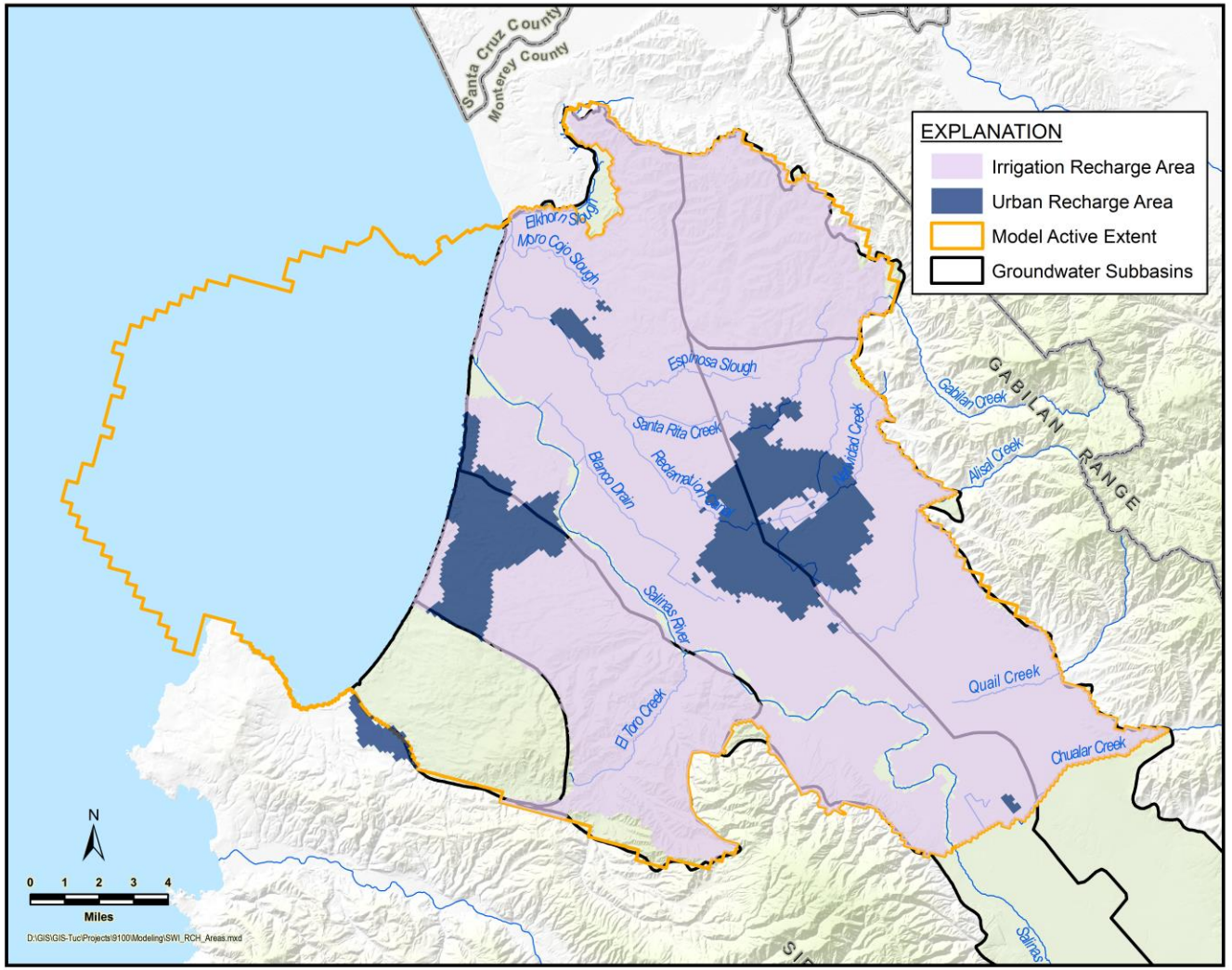
Recharge (RCH package)

- Urban
- Natural
- Irrigation Return Flows



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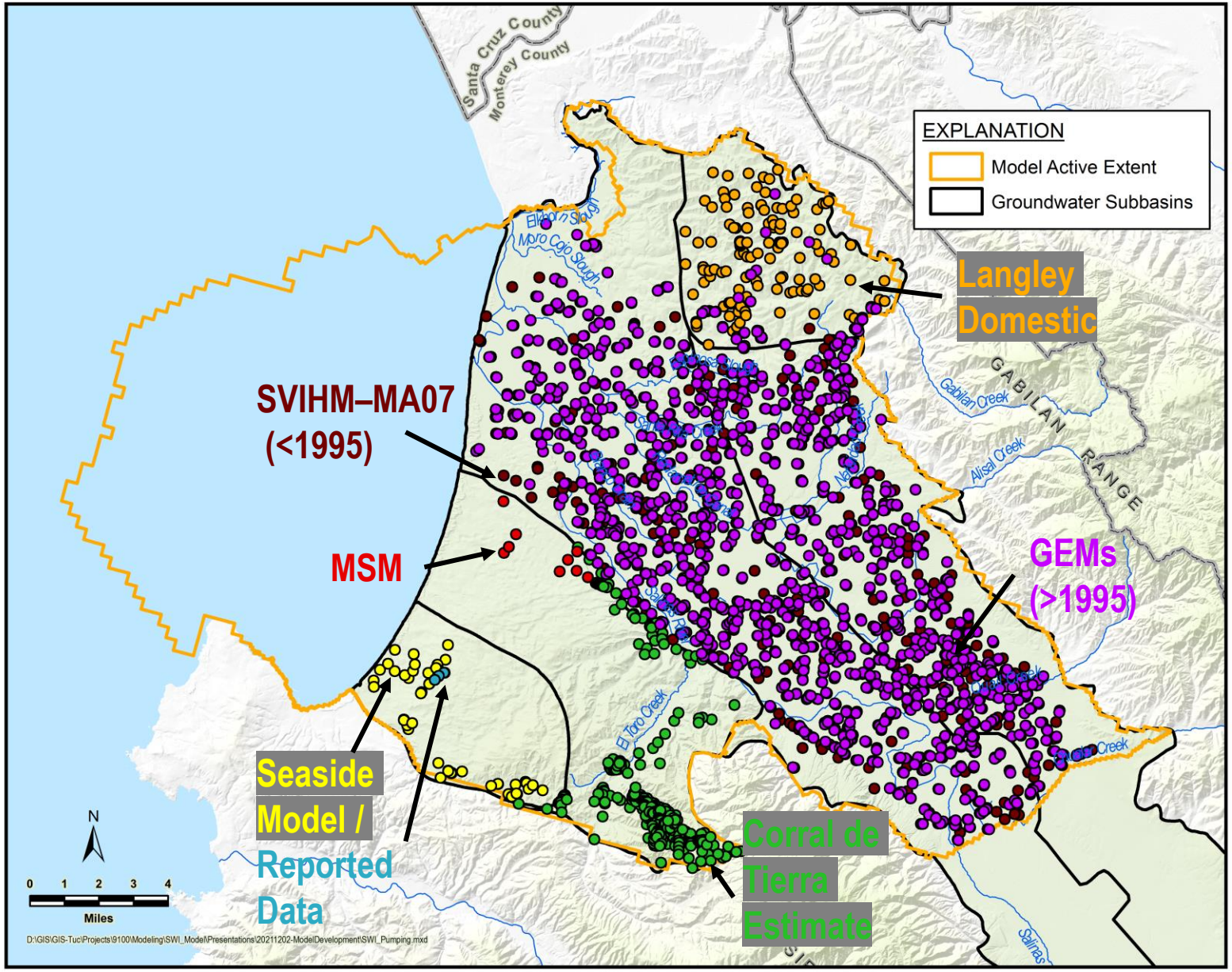
Pumping

- Compiled from reported and modeled sources
- Applied as CLN



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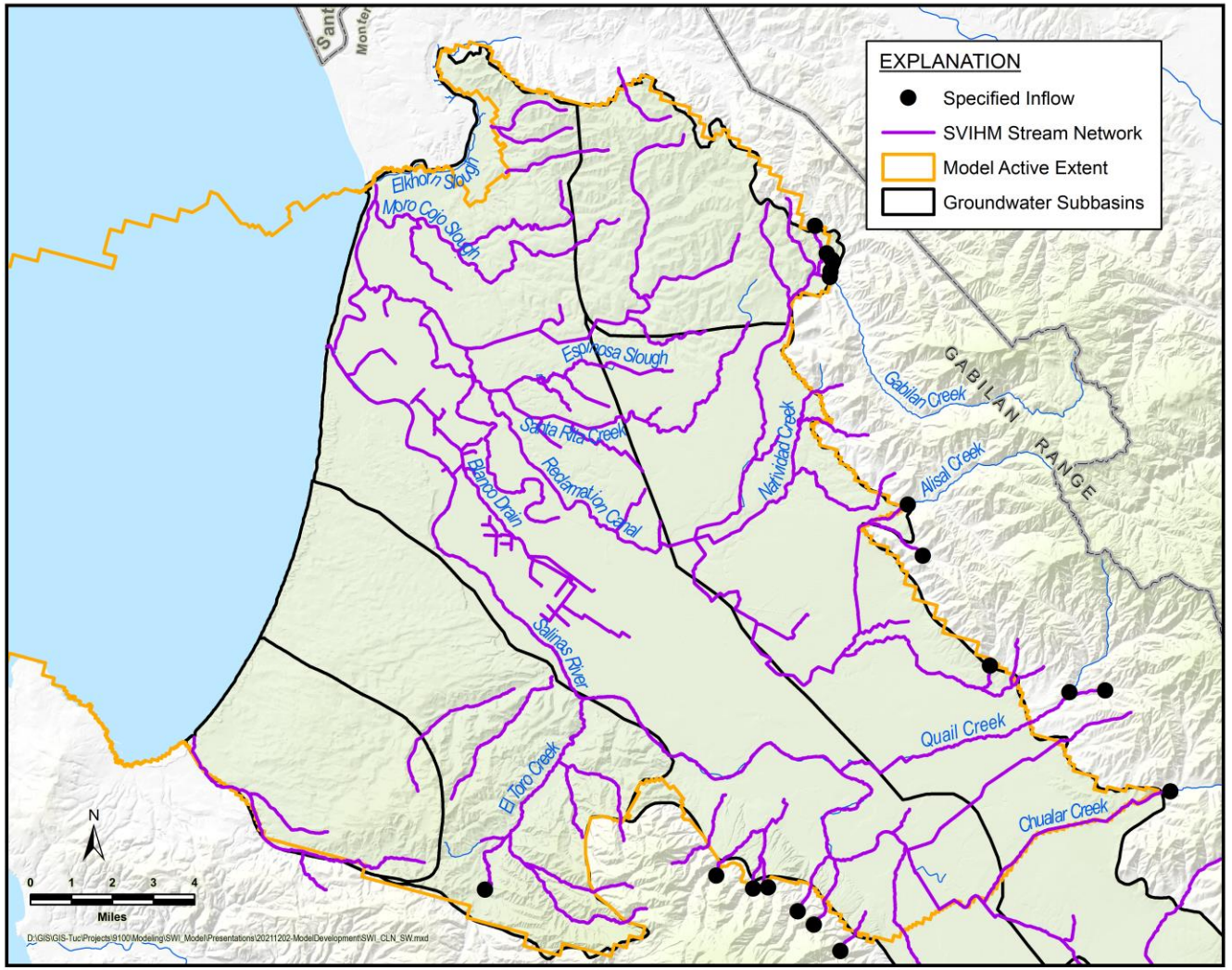
Streams

Stream Network

- Hydrologic flow modeling for the SVIHM
  - Calibrated to existing stream gauges
  - Specified inflow based upon this modeling (estimated to be perennial)
- Constant Concentration 74 mg/L Cl^-
  - Salinas River near Spreckels



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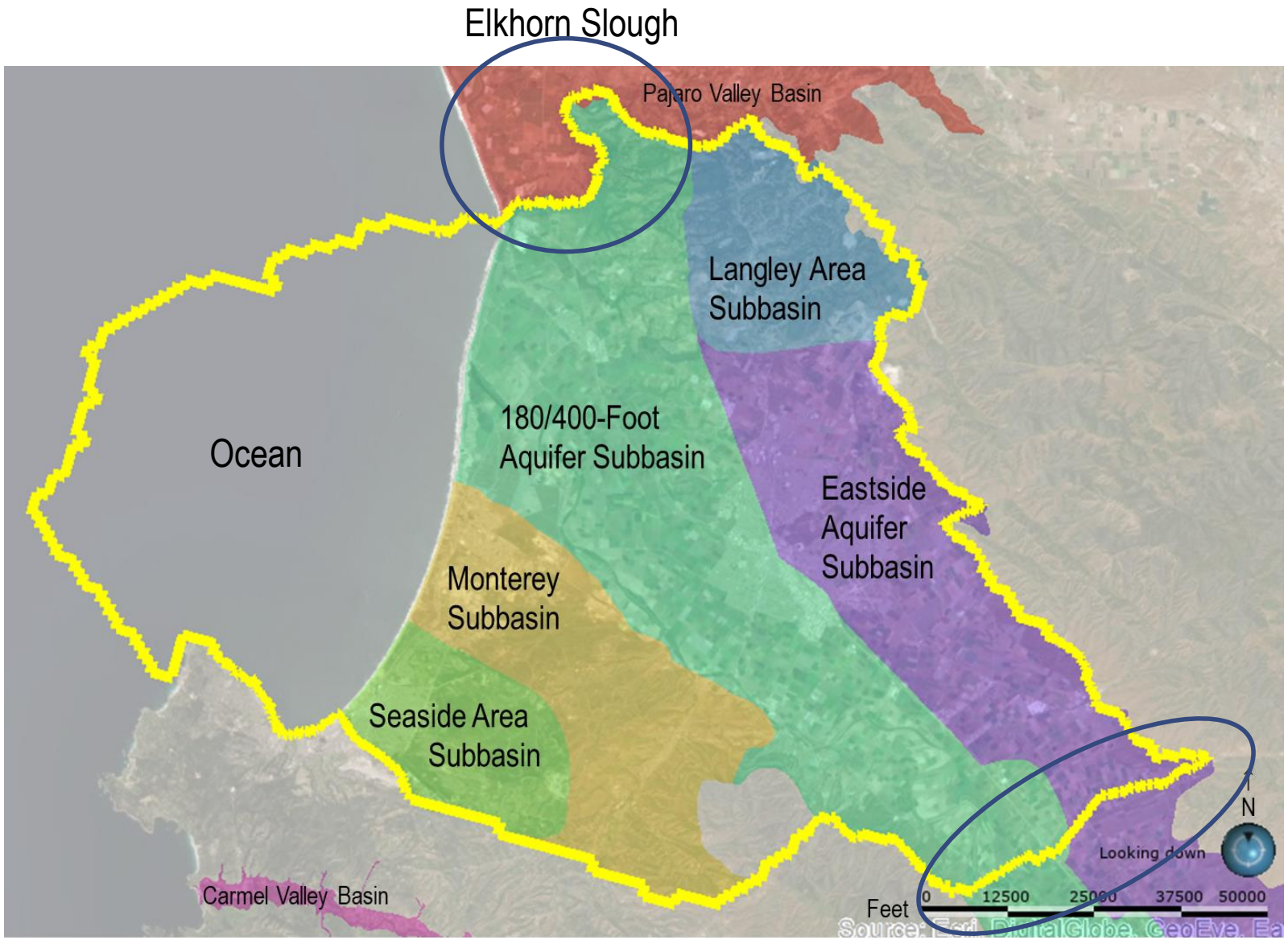
Boundary Conditions

- Elkhorn Slough
- Upgradient (from up the Salinas Valley)
- Ocean
- No-Flow (with surface water inflows – as defined in the SVIHM)



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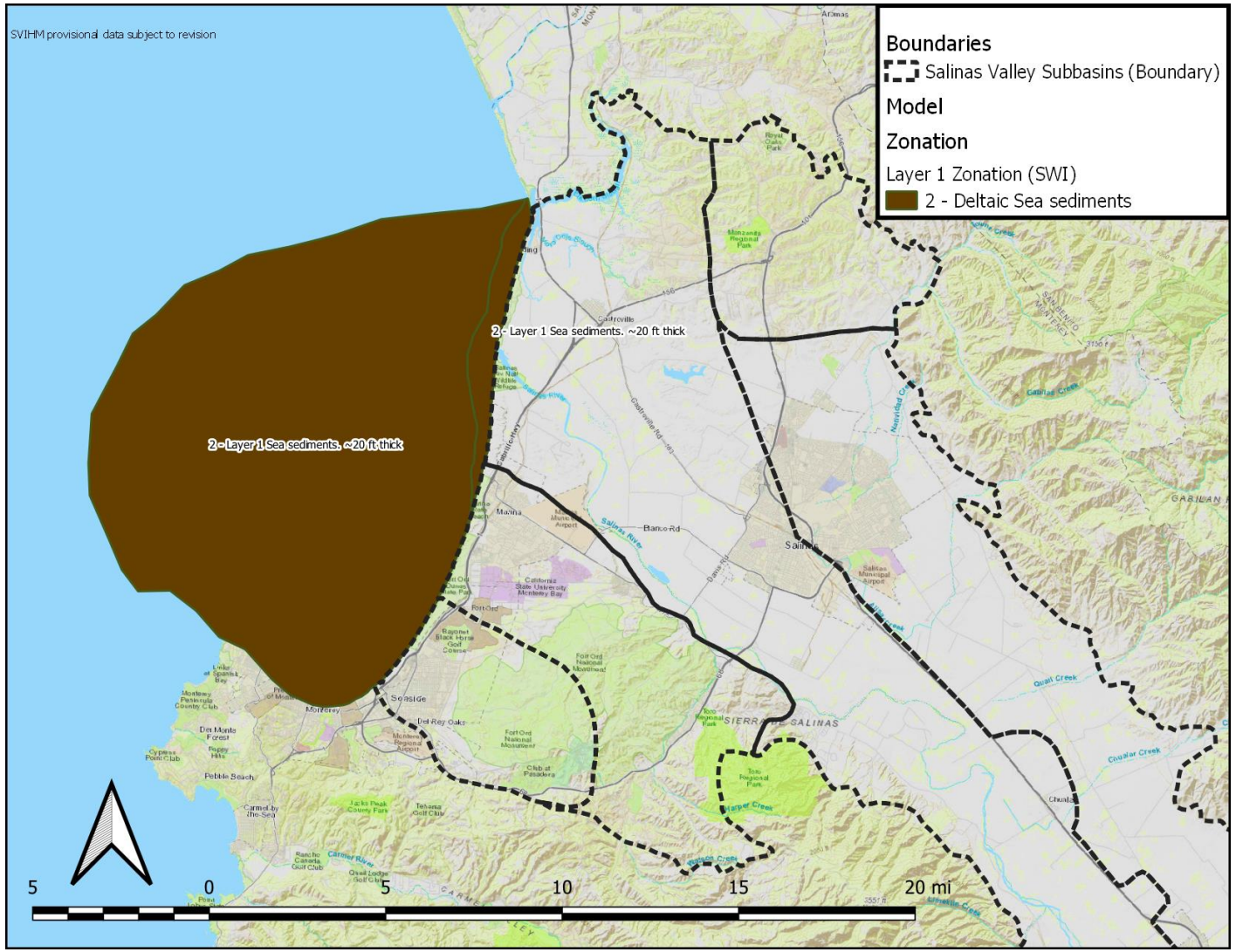
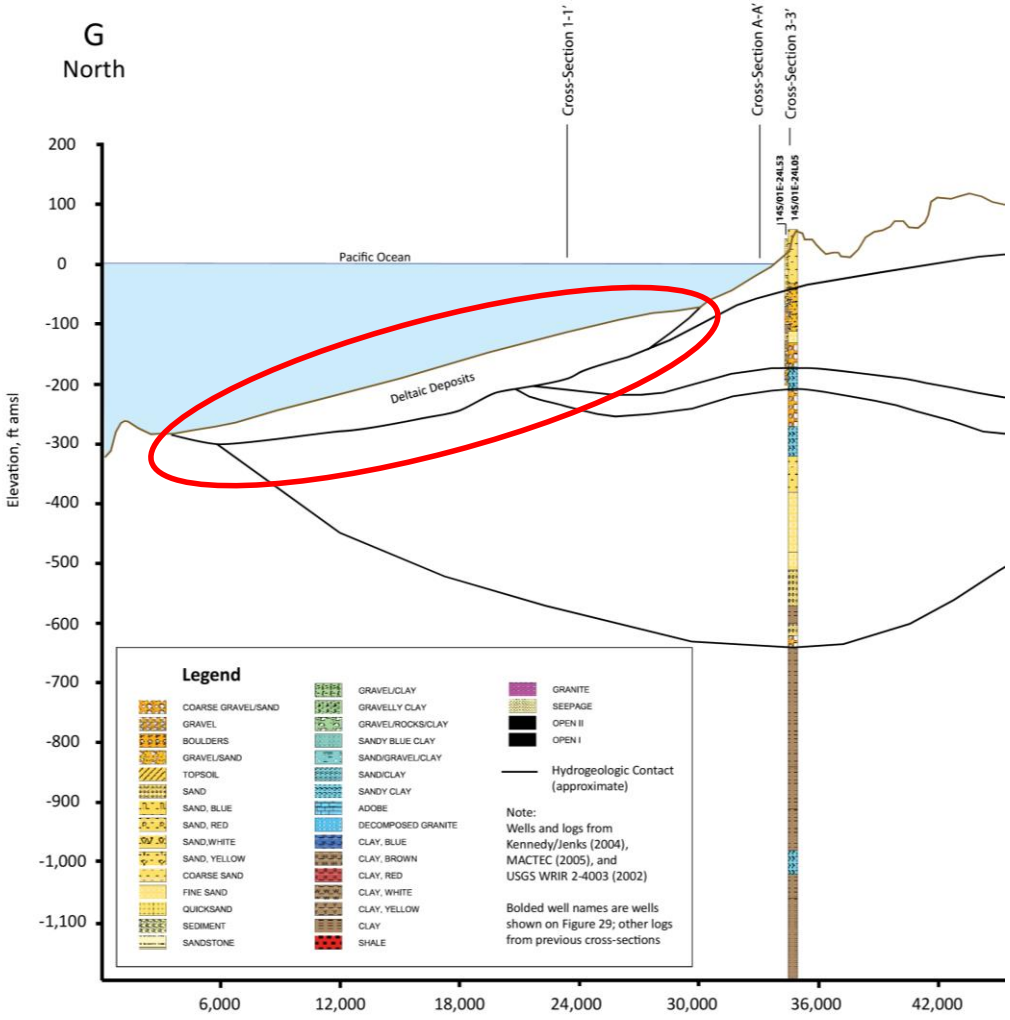
Ocean Boundary

- Deltaic Sediments
- Active in the model

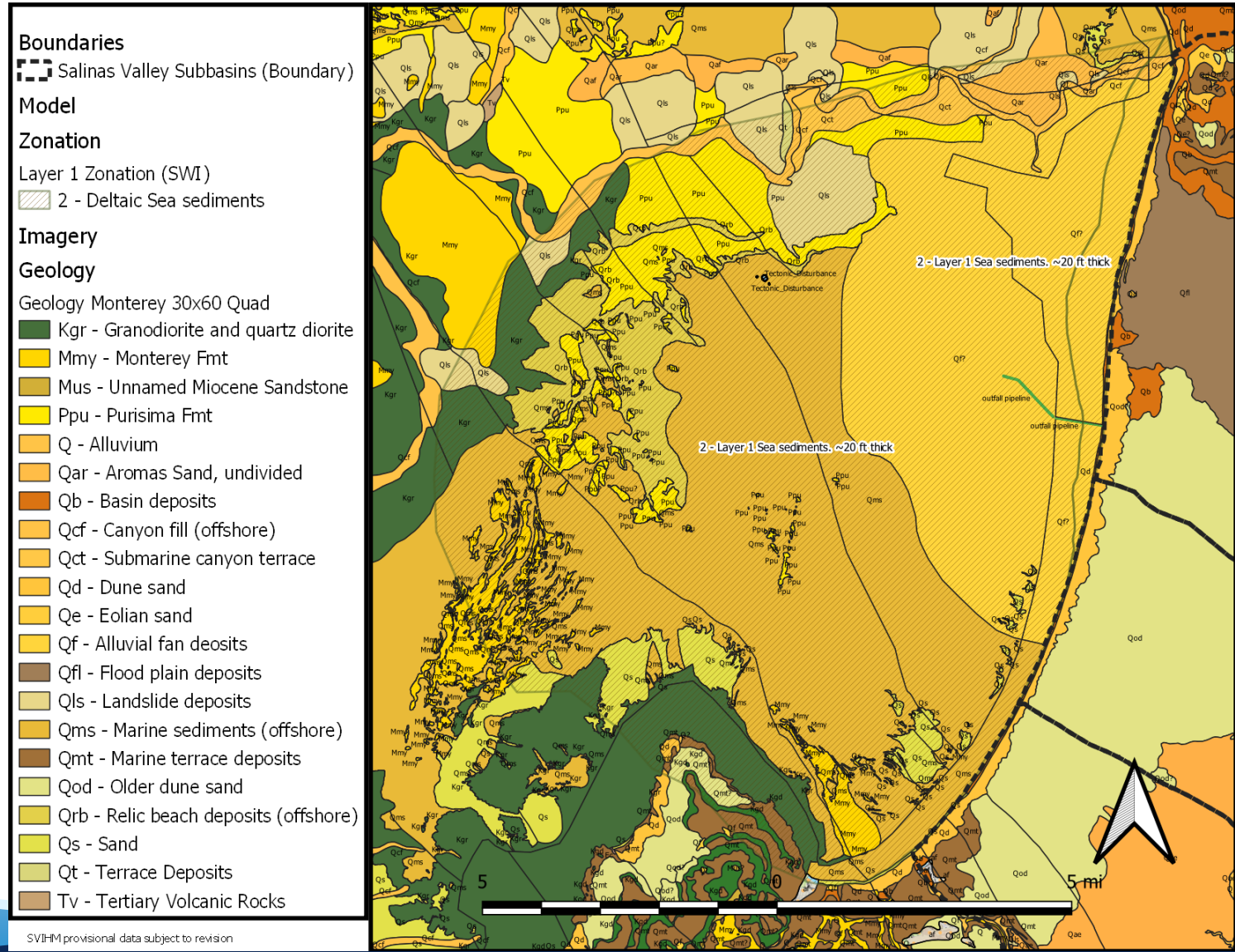


Ocean Boundary

Cross Section

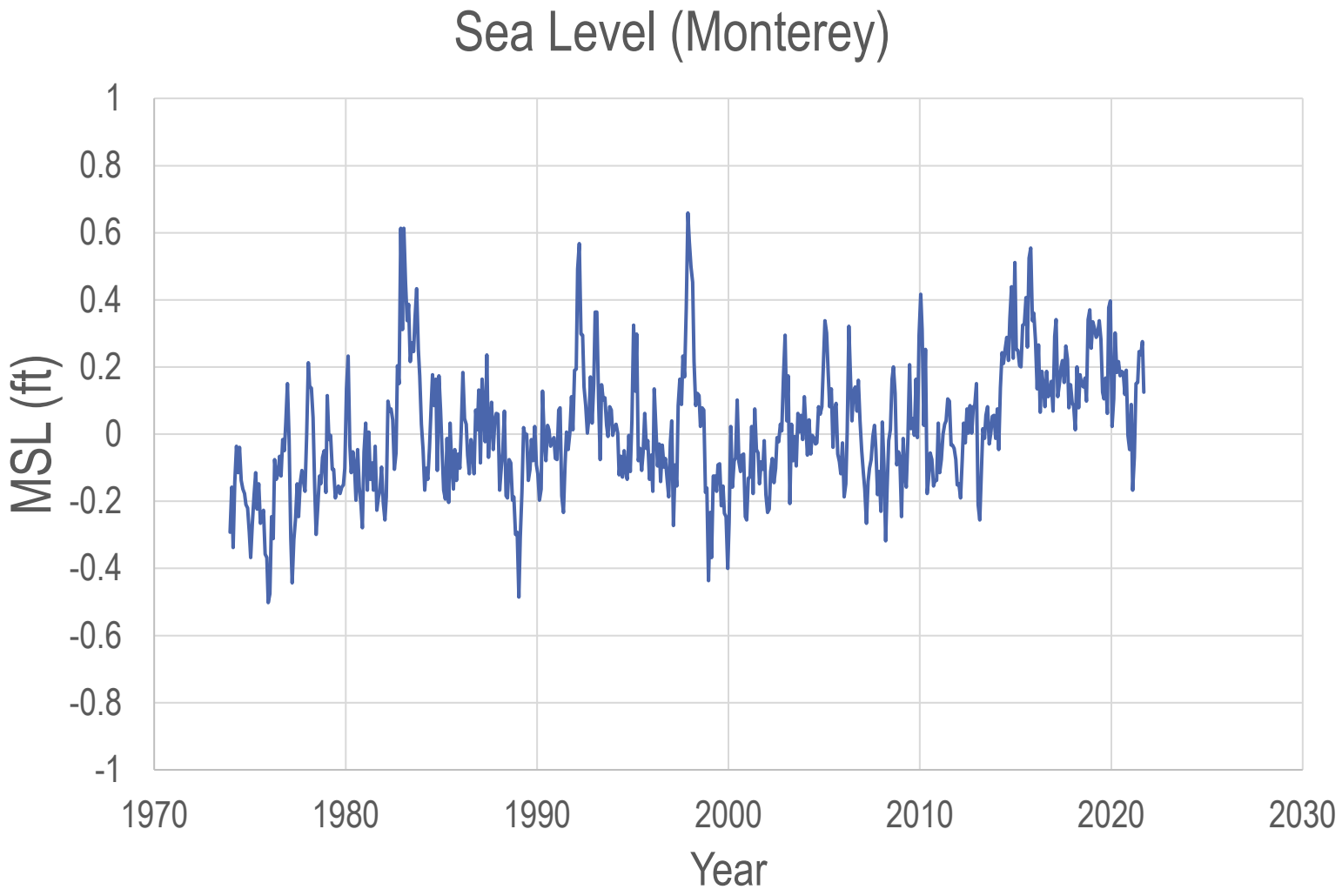


Ocean Sediments



Ocean Boundary

- Sea level has varied over the past 50 years



Ocean Salinity

- The Granite Canyon Monitoring Station
- TDS was measured at 33,694 mg/L compared to mean seawater of 35,176 mg/L
  - ~96% of Seawater

Estimates from: Geoscience 2014. Monterey Peninsula Water Supply Project Hydrogeologic Investigation; Tech. Memo. #1; Summary of results – exploratory Boreholes. Prepared for California American Water; RBF Consulting. July 8, 2014.

Table 5-5. Standard Seawater and Central California Coast Seawater

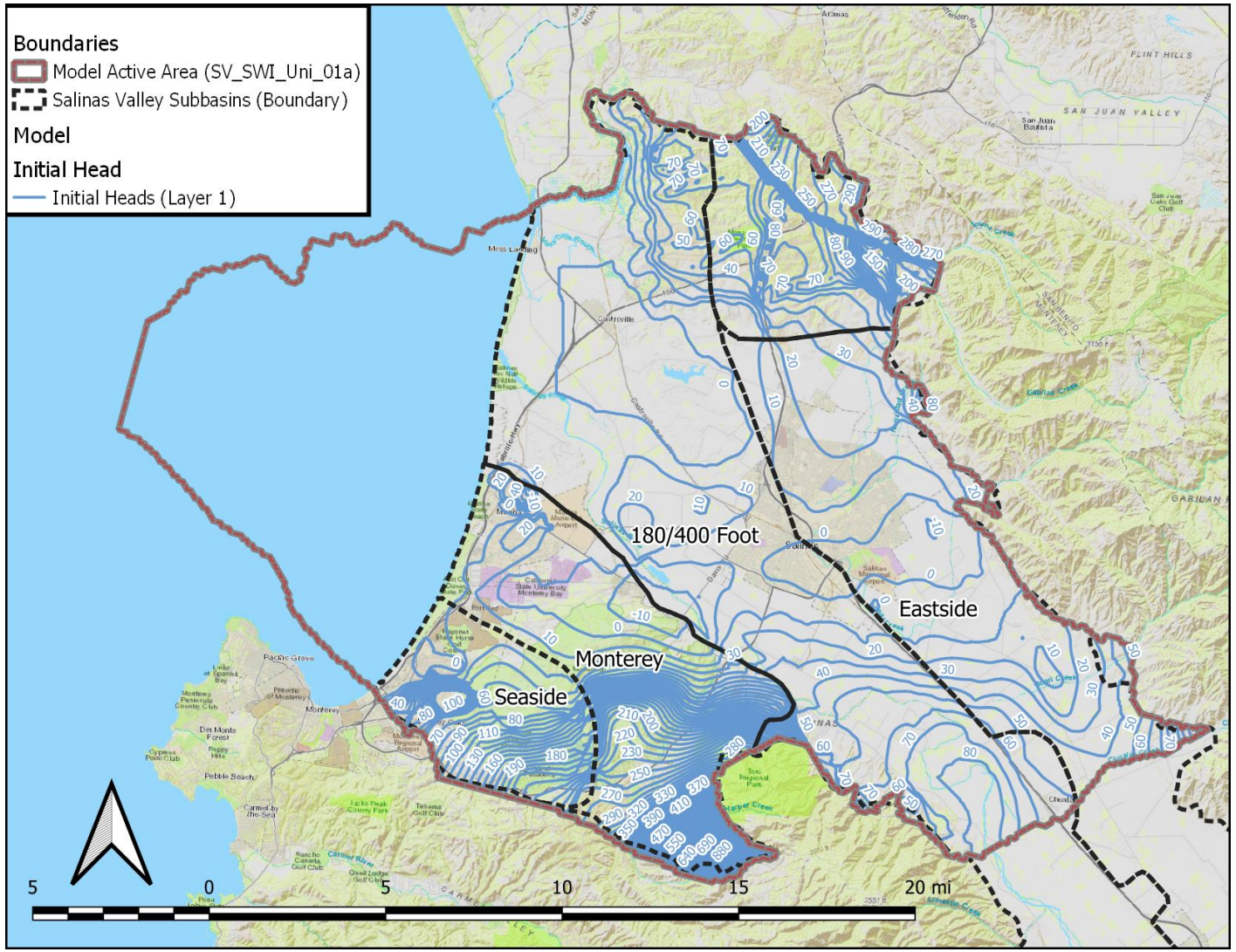
Parameter	Units	Mean Seawater Values	Central California Coast Average Seawater Values **
Total Dissolved Solids	mg/L	35,176	33,694
Salinity	PSU*	35.17	33.69
Potassium	mg/L	399	382
Sodium	mg/L	10,784	10,329
Magnesium	mg/L	1,284	1,230
Calcium	mg/L	412	395
Strontium	mg/L	7.9	7.57
Bicarbonate	mg/L	108	103
Chloride	mg/L	19,352	18,537
Fluoride	mg/L	1.3	1.25
Sulfate	mg/L	2,712	2,598
Total Boron	mg/L	4.55	4.35
Bromide	mg/L	67.3	64.5

* PSU = Practical Salinity Unit

** Ocean water composition calculated from mean salinities measured at the Granite Canyon Monitoring Station by Moss Landing Marine Laboratories. Average Salinity based on 1988 – 2011 monitoring data.

Model Water Level Starting Point

- Estimated water levels at the end of 1974
- Water levels for each model layer (aquifer/aquitard) were estimated
- Image is of the shallow sediments



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Starting Concentrations

Ocean and Seawater Intrusion Area

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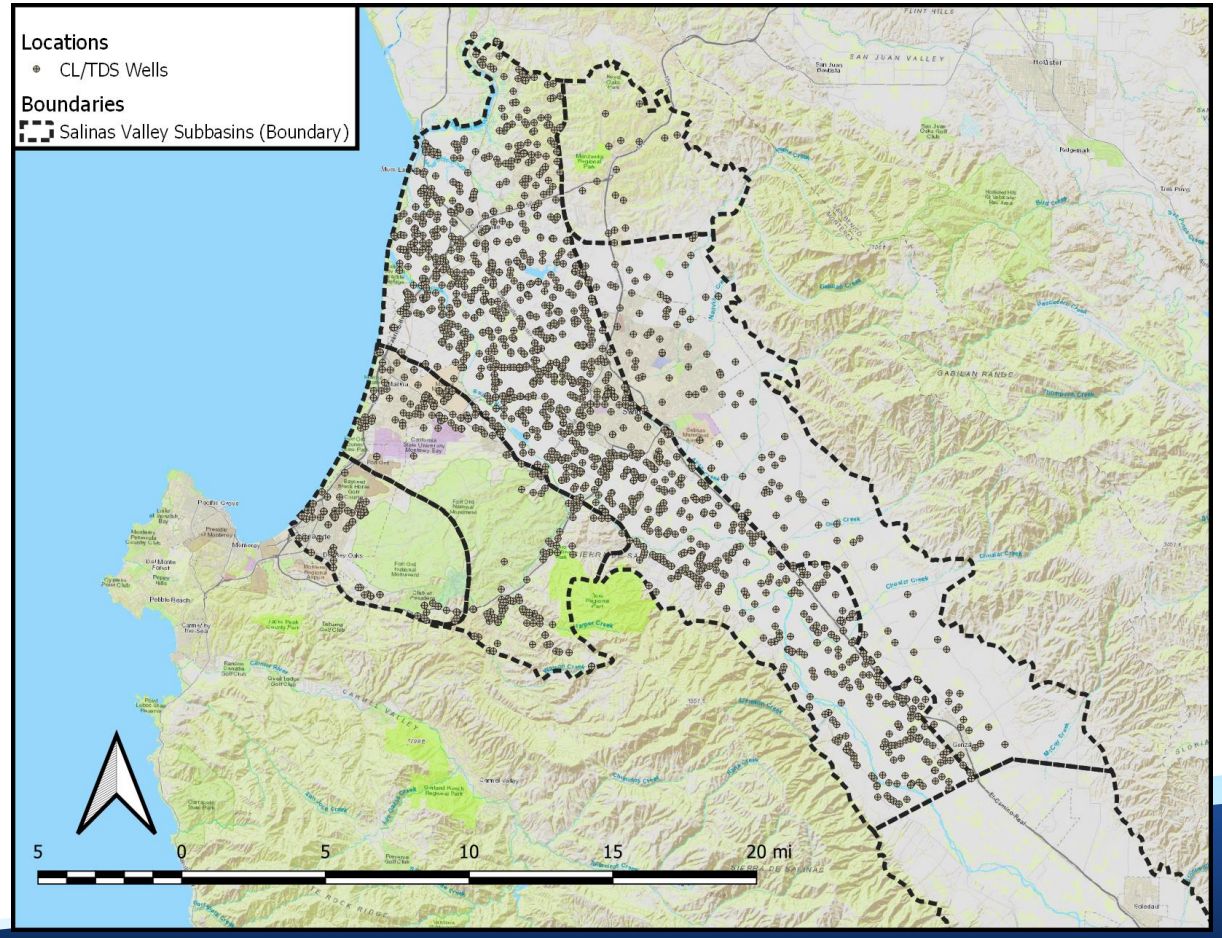
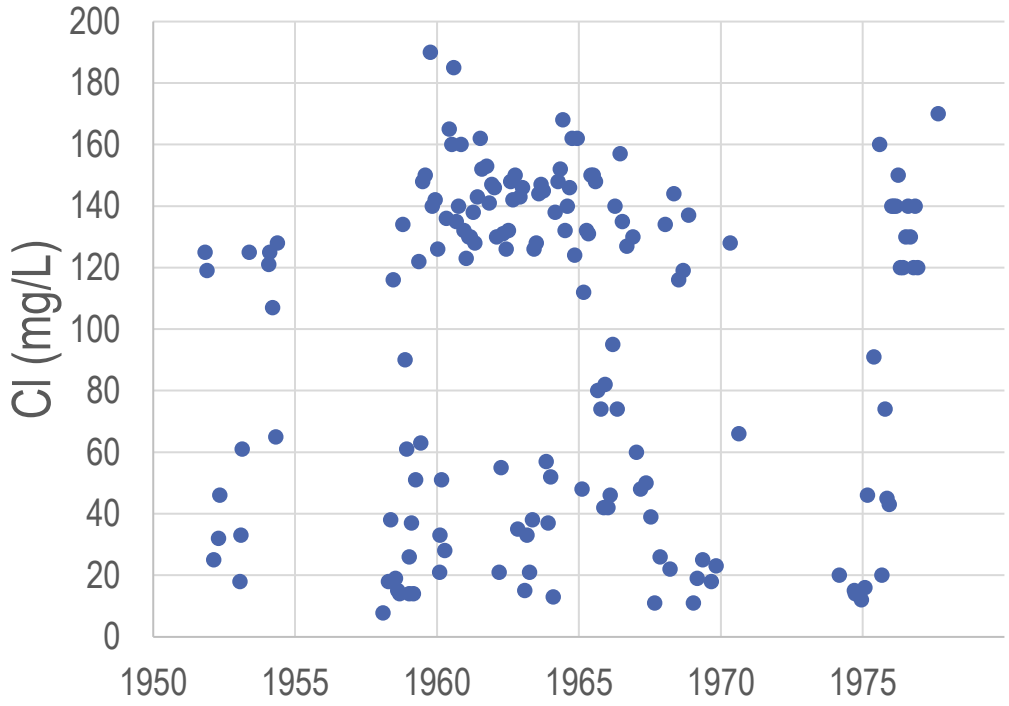
Background Concentration



Background Cl Concentration

Surface Water

Average:74 mg/L



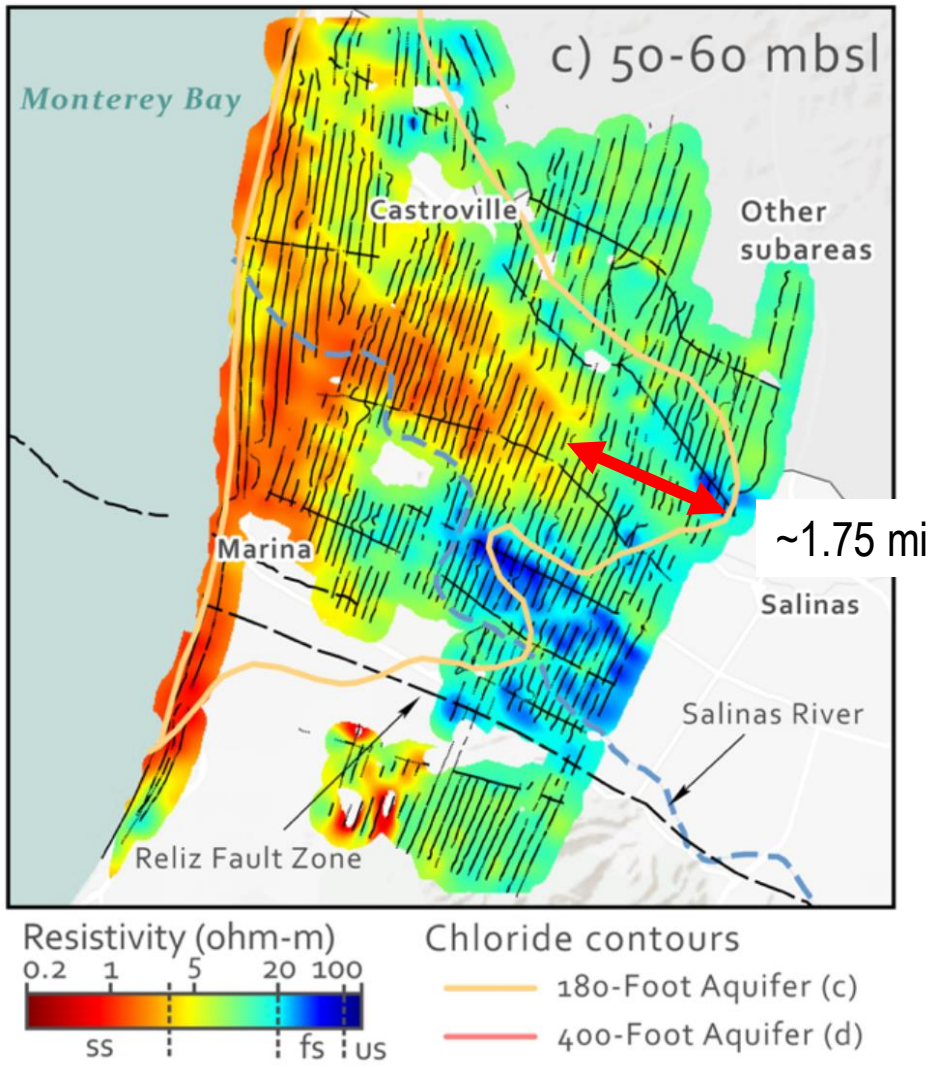
Groundwater

Average: 120 mg/L

- Excluding all values near or within the seawater intrusion areas

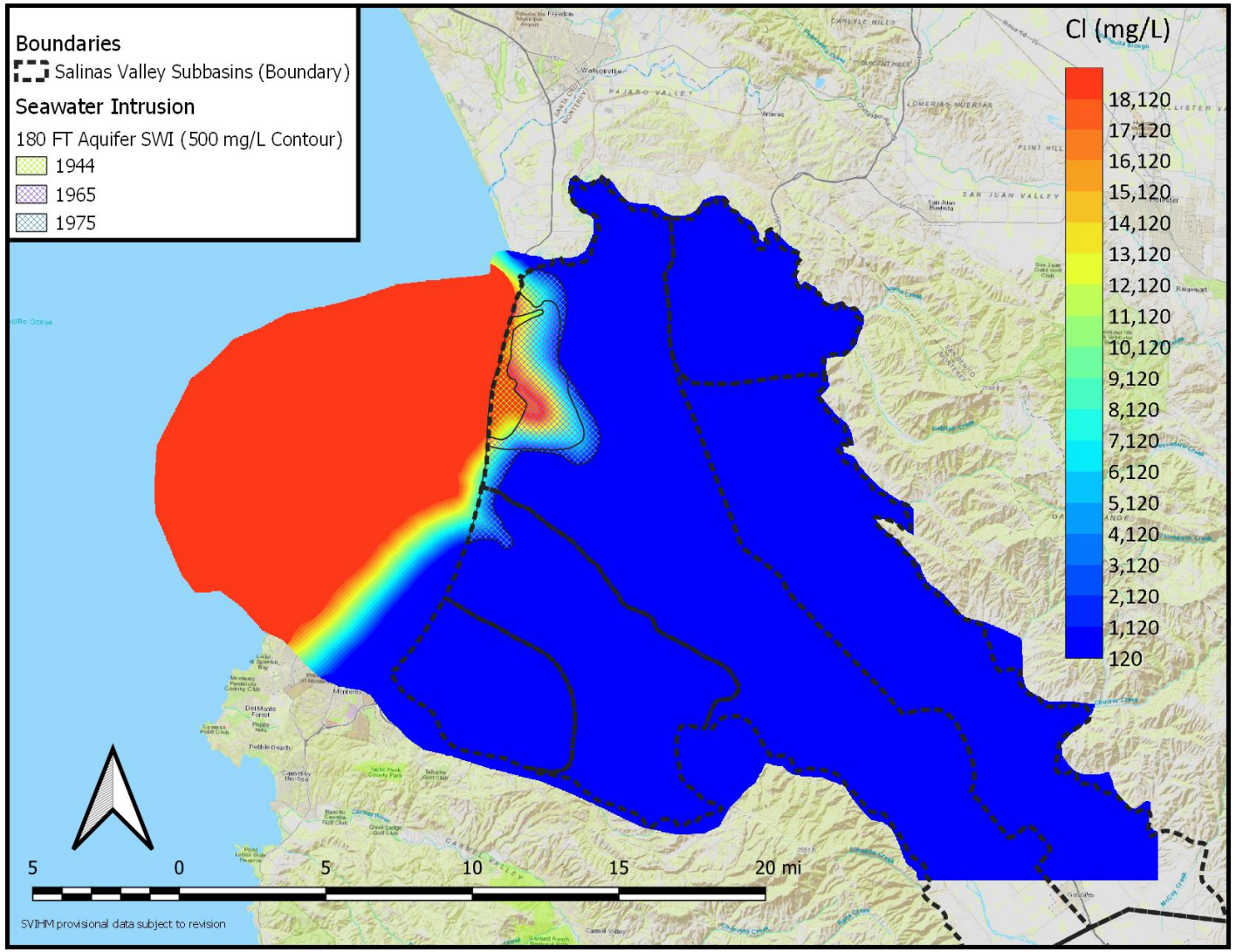
Starting Concentration

Transition Zone Width



Initial Concentration

- 1975 500 mg/L contour defines impacted vs non-impacted
- Background everywhere not impacted with SWI (120 mg/L)
- Apply an ~1.75 mi transition zone between 500 mg/L and 18,537 mg/L



Variable Density Flow

- Historically codes have dealt with flow using equivalent freshwater head (EFH)
- USG-Transport calculates flow using hydraulic head (HH)
- Flow due to density differences

- Density of freshwater: 1,000 g/L
- Density of seawater: 1,025 g/L
- Freshwater concentration (chloride):
  - 120 mg/L
- Seawater concentration (chloride):
  - 18,537 mg/L

Dispersivity

Gelhar et al. (1992)

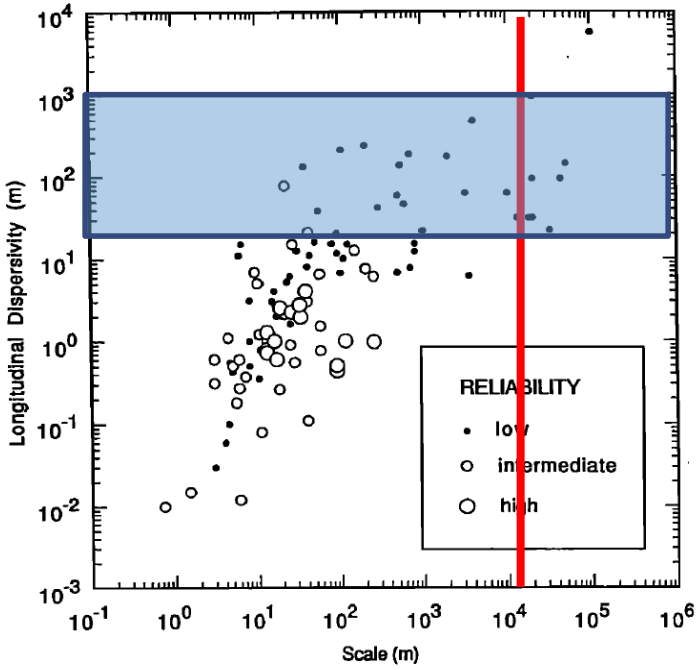
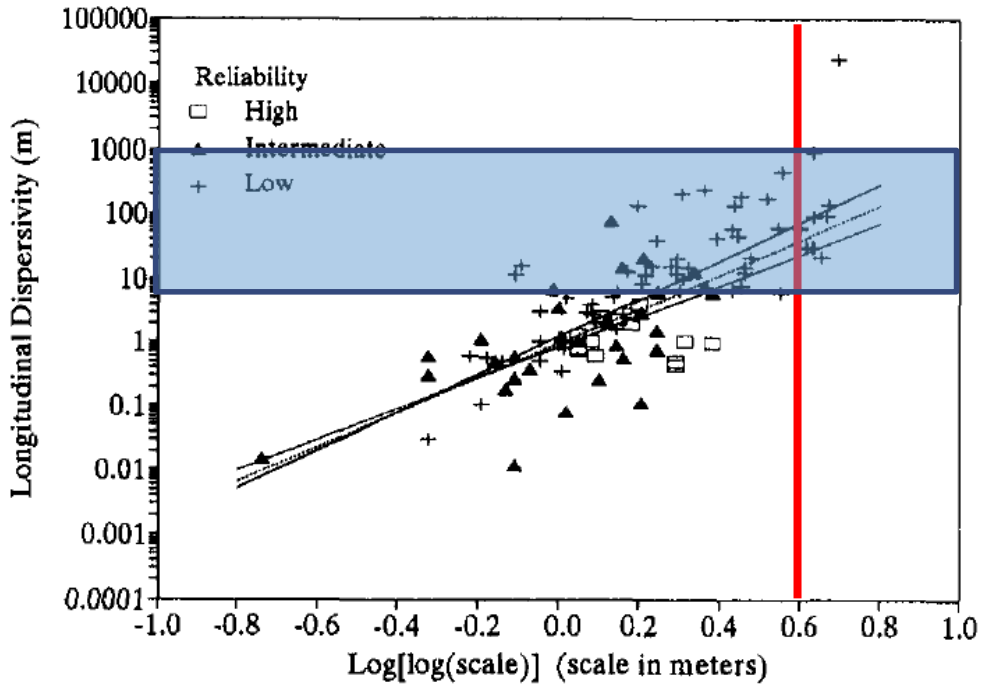
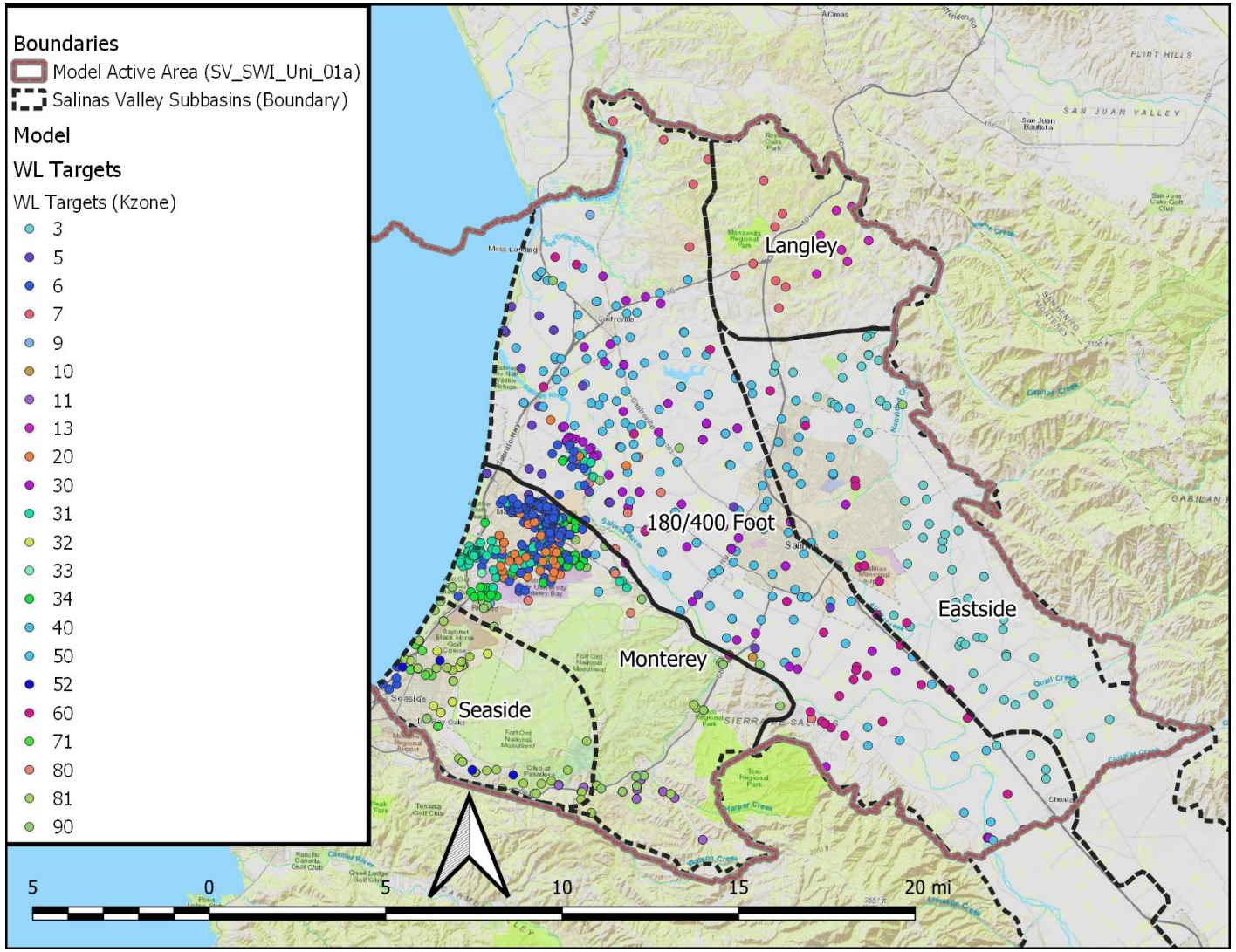


Fig. 2. Longitudinal dispersivity versus scale with data classified by reliability.

Xu and Eckstein (1995)



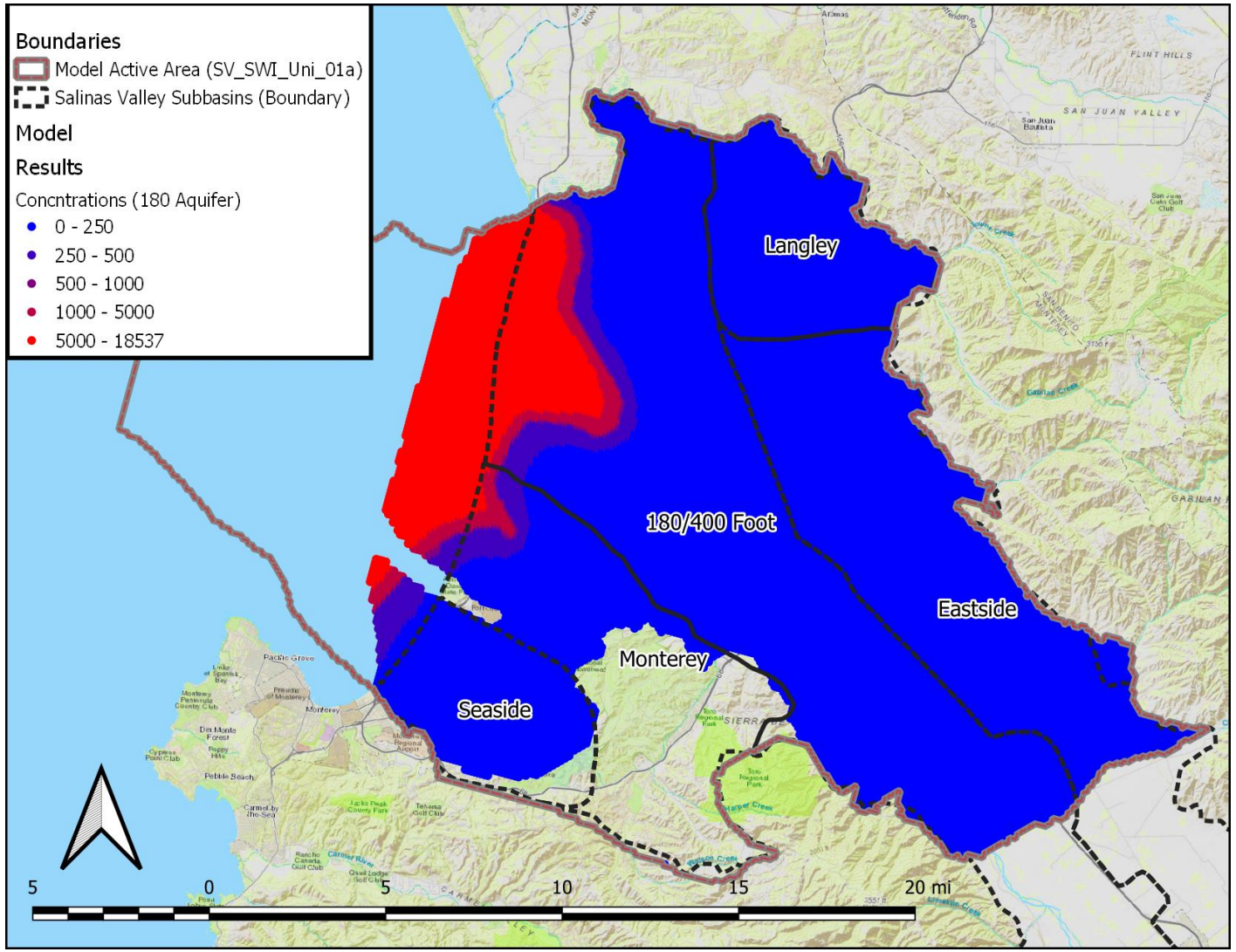
Model Calibration



SWI

180 ft Aquifer

Predicted concentration in 1985



Questions

Greg Nelson, P.G. (Lead Modeler)

gnelson@elmontgomery.com

720 383 2008

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