# MONTEREY SUBBASIN GROUNDWATER MODEL

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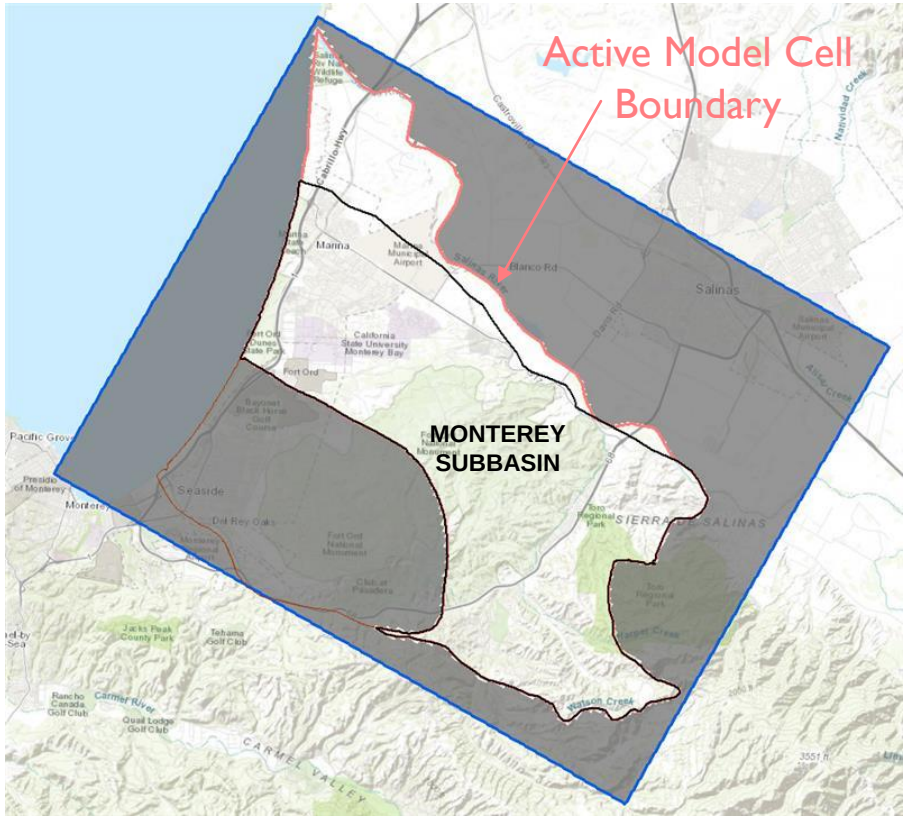
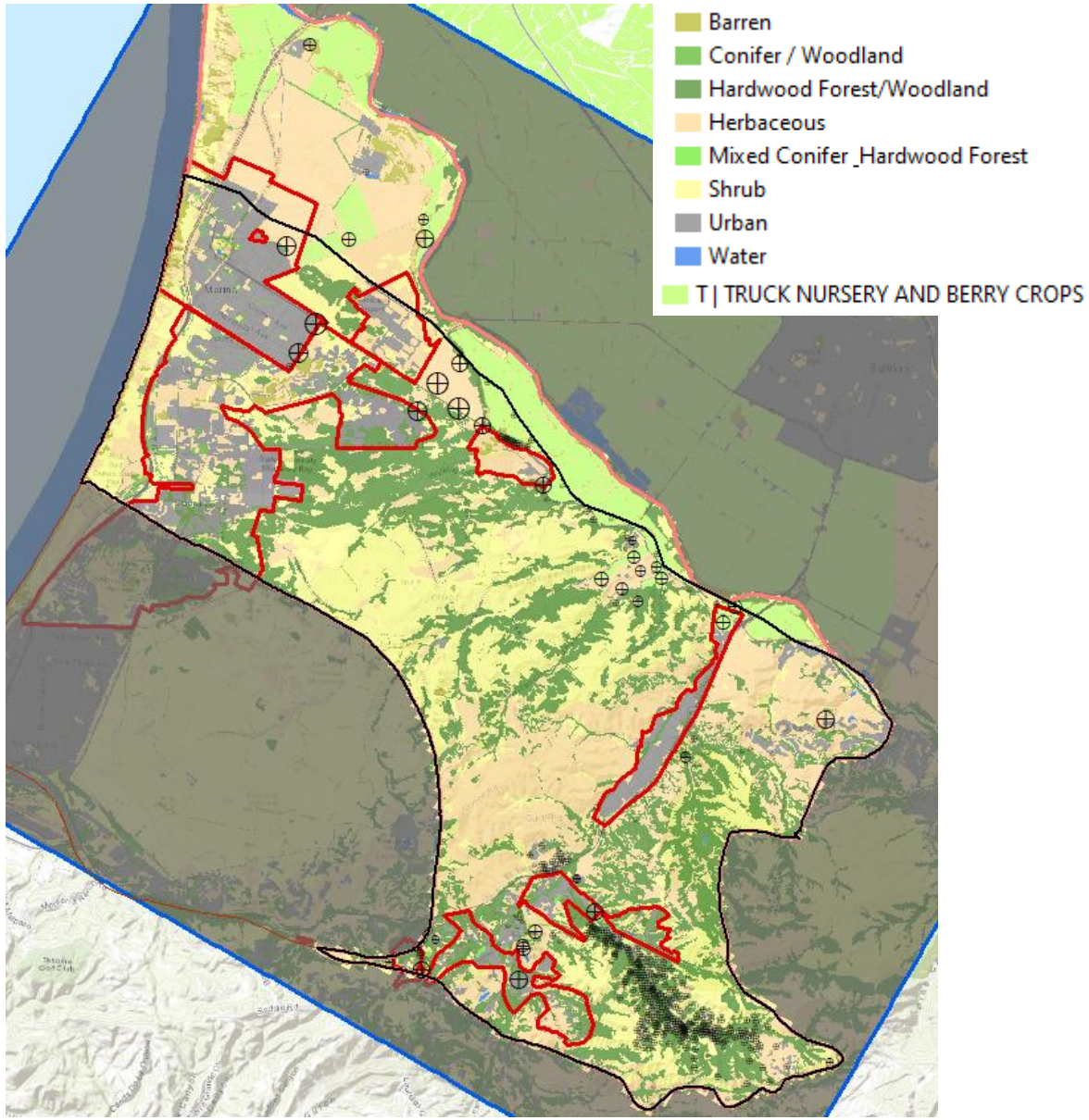
- Water budget results in the Monterey Subbasin are based on the Monterey Subbasin Groundwater Model
  - Prepared by MCWD in coordination with SVBGSA
  - Incorporates observed boundary conditions with the adjoining Seaside and 180/400-Foot Aquifer Subbasins
  - Will inform the basis of the planned seawater intrusion model for the Monterey Subbasins
- Monterey Subbasin model is anticipated to eventually be coordinated with SVHIM
  - It is anticipated that the Monterey Subbasin model and its inputs will assist in calibrate and improve the SVIHM



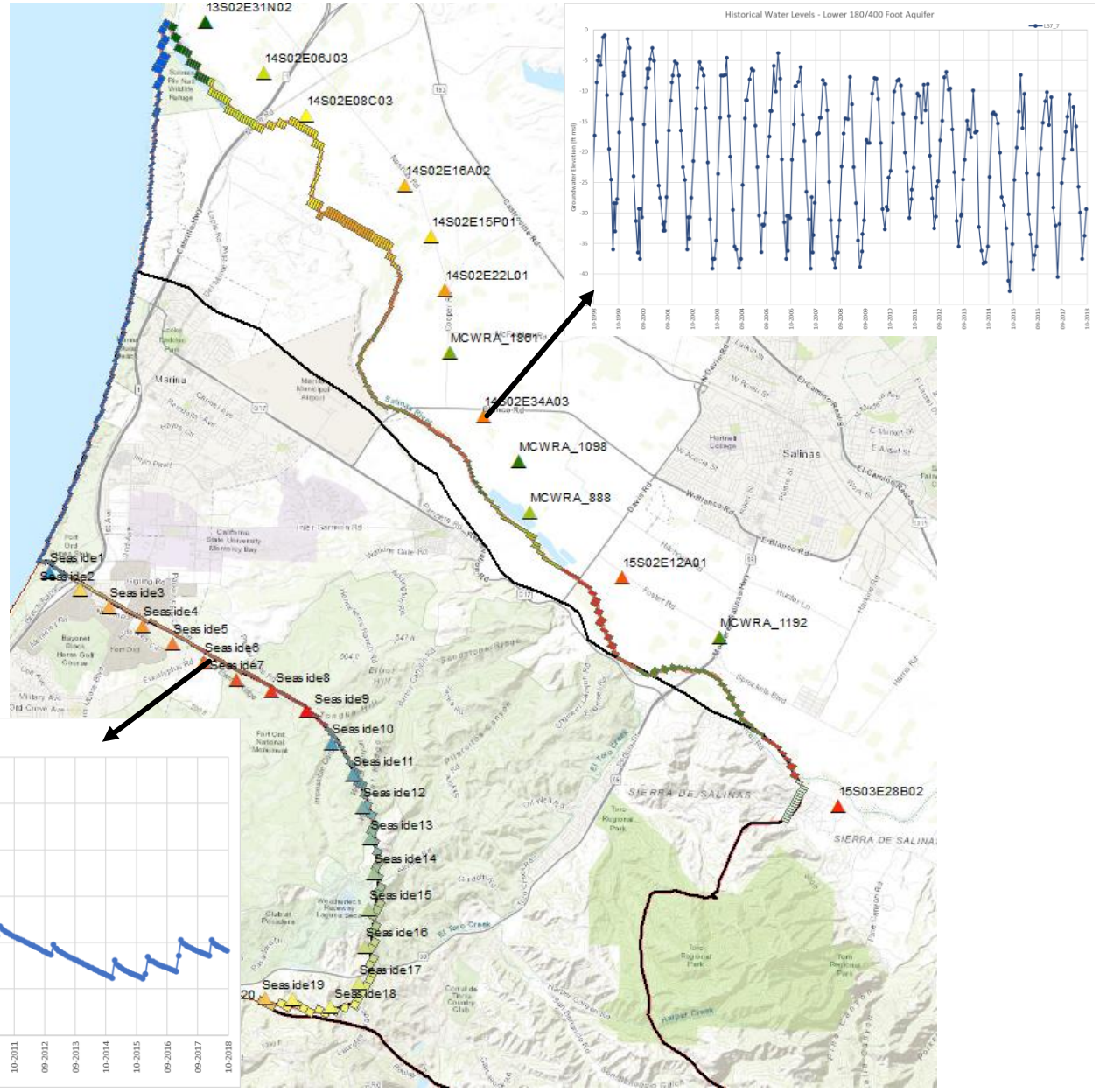
# SOURCE OF DATA INPUTS

- Climate
  - Daily precipitation data from PRISM
  - Daily reference evapotranspiration data from CIMIS stations
- Land use
  - CalVeg – native land use classes
  - MCWD / SVBGSA – urban, water service area footprints
  - DWR – agricultural fields
- Groundwater pumping
  - MCWD supply well historical pumping records
  - SVBGSA historical pumping estimates for Corral de Tierra area
- Water elevation data
  - 30,555 observation from 608 wells



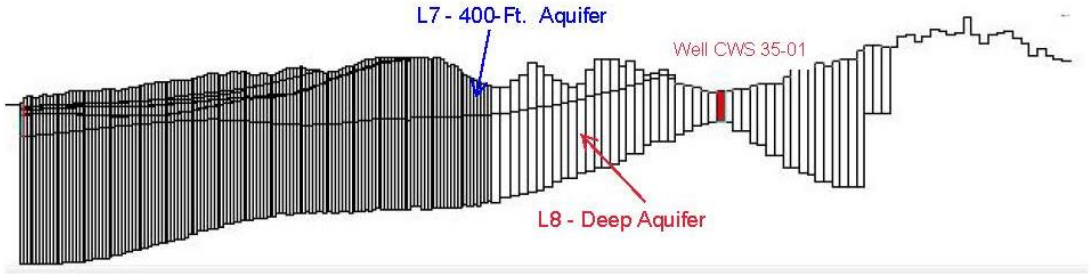
# BOUNDARY CONDITIONS

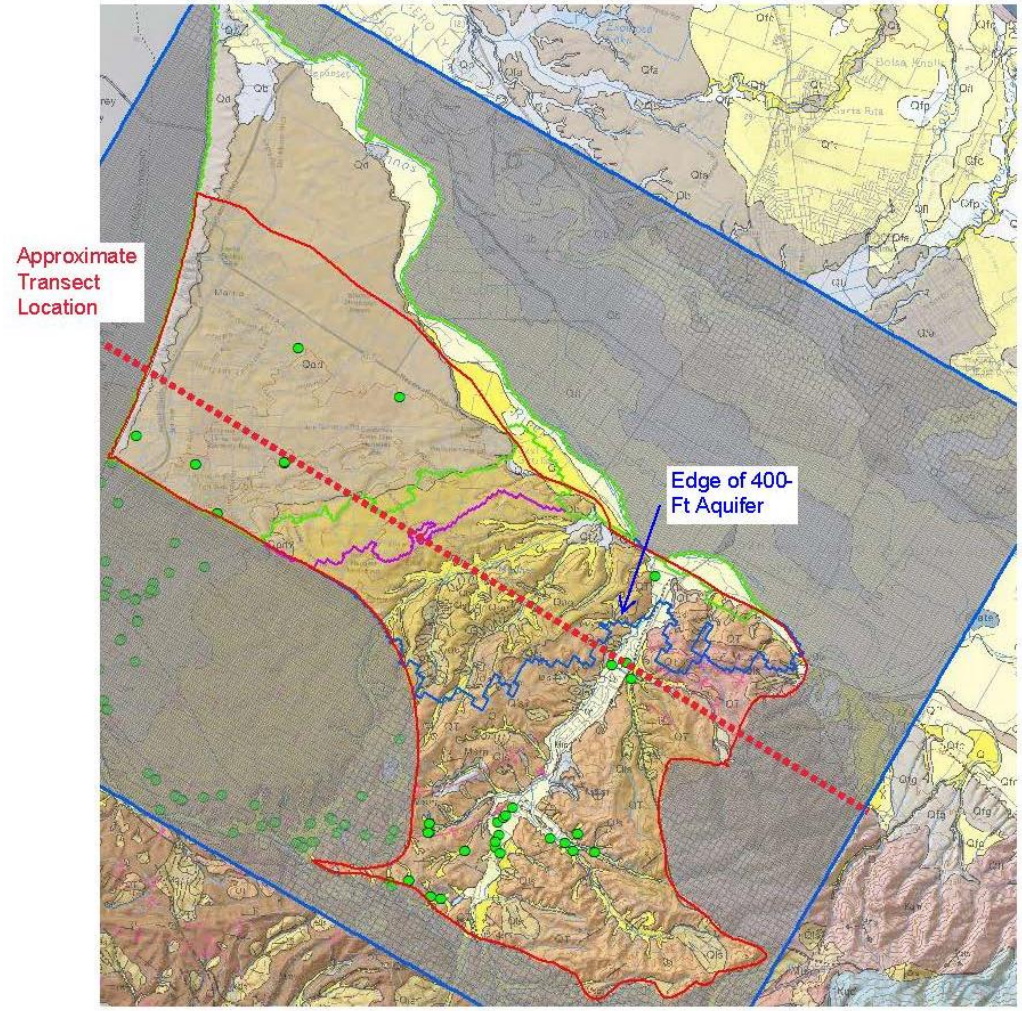
- Boundary conditions
  - 180/400 Subbasin: Observed water levels and compared to SVIHM simulated results
  - Seaside Subbasin: Seaside Model simulated water levels



# MODEL CONSTRUCTION

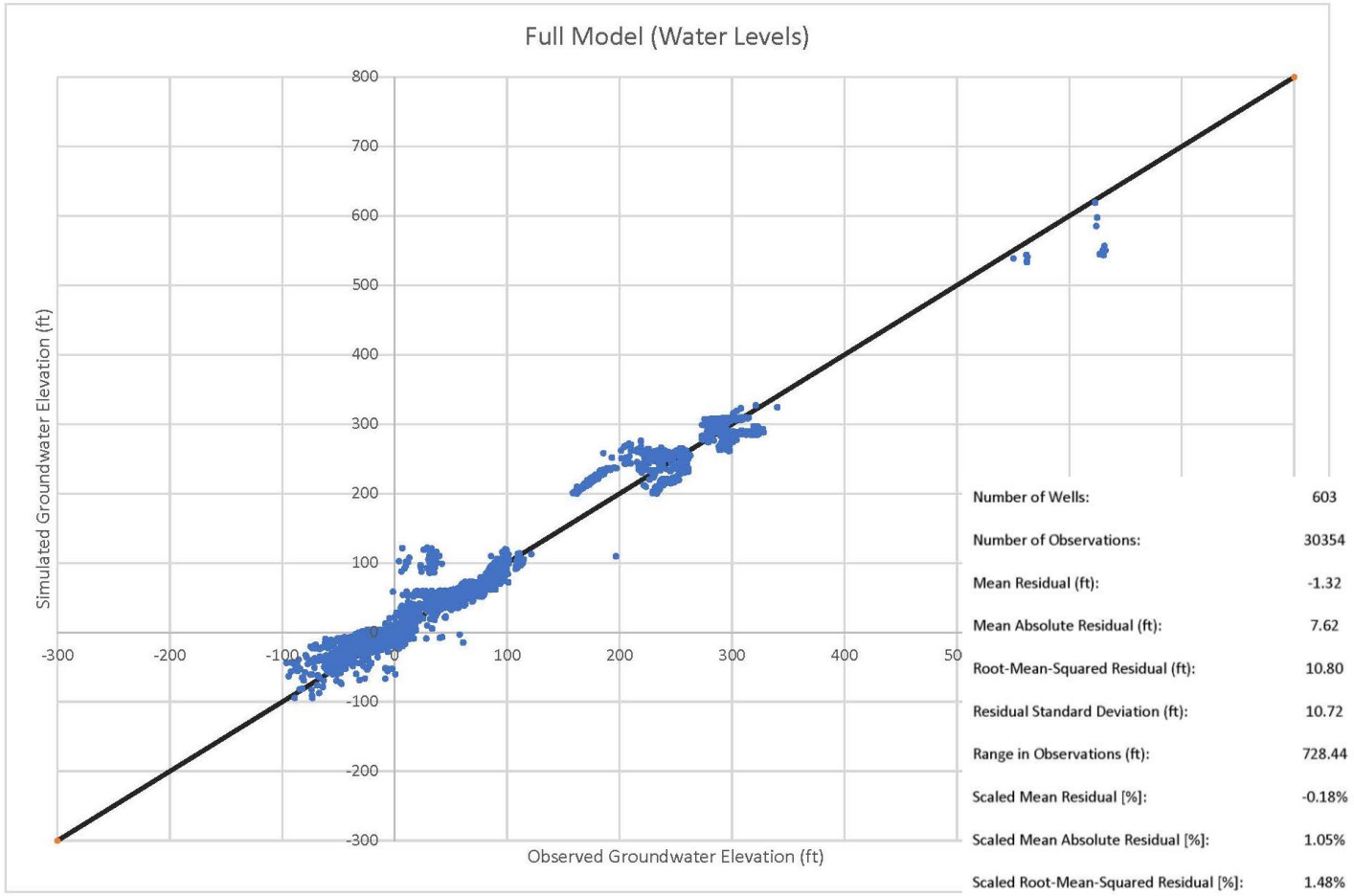
- Historical model runs from 10/1998 – 9/2018
  - Water budget results reported for 10/2003 – 9/2018
- Eight model layers, representing:
  - Dune Sand
  - Salinas Valley Aquitard
  - Upper 180-Foot Aquifer
  - 180 Aquitard
  - Lower 180-Foot Aquifer
  - 180/400 Aquitard
  - 400 Foot Aquifer – El Toro Primary Aquifer
  - Deep Aquifer – El Toro Primary Aquifer
- Accompanying Soil Moisture Balance Model calculates monthly recharge rates based on:
  - Precipitation, evapotranspiration rates
  - Soil and land use types
  - Deliveries, leakage in water agency service areas
  - Agricultural water use estimates



# MODEL CALIBRATION

- Model calibrated to historical observed water levels by layer and management area
  - All calibration metrics meet or exceed minimum standards for reasonable calibration
- Water budget results compared to Seaside, SVIHM, other historical sources of information to confirm acceptable range in flux volumes

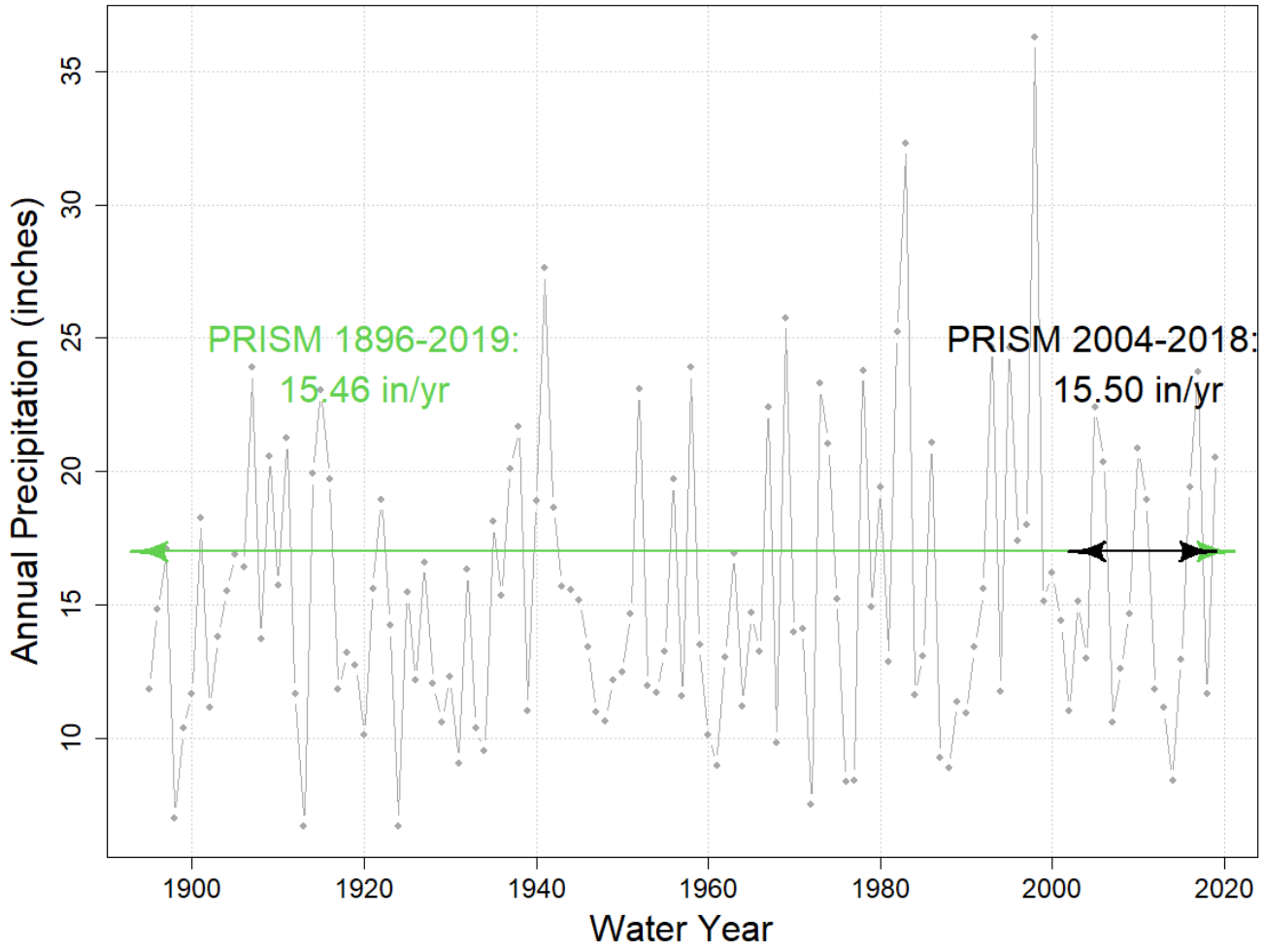



| | |
|---|---|
| Number of Wells: | 603 |
| Number of Observations: | 30354 |
| Mean Residual (ft): | -1.32 |
| Mean Absolute Residual (ft): | 7.62 |
| Root-Mean-Squared Residual (ft): | 10.80 |
| Residual Standard Deviation (ft): | 10.72 |
| Range in Observations (ft): | 728.44 |
| Scaled Mean Residual [%]: | -0.18% |
| Scaled Mean Absolute Residual [%]: | 1.05% |
| Scaled Root-Mean-Squared Residual [%]: | 1.48% |
| Scaled Residual Standard Deviation [%]: | 1.47% |
| Coefficient of Determination (R^2): | 0.96 |

**All results are preliminary and subjet to revision.*

# WATER BUDGET ANALYSIS REQUIREMENTS

- SGMA requires every GSP include three water budgets
- Historical water budget
  - Water Years 2004 through 2018 (Oct 2003 to Sep 2018)
  - Average precipitation aligns with long-term record during WY 1986 - 2019
- Current water budget - completed
- Projected water budget - in progress

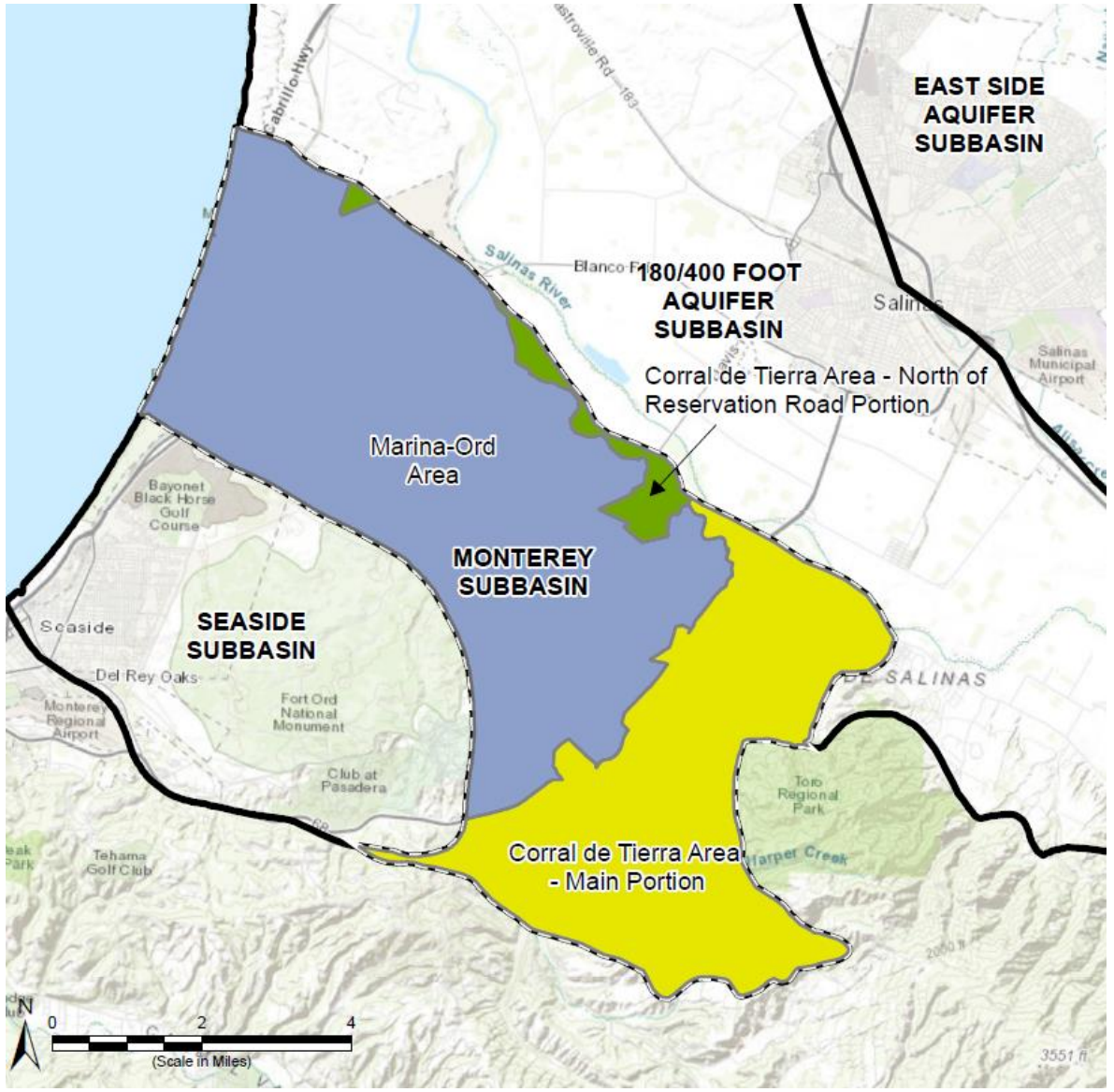


# HISTORICAL WATER BUDGET

# WATER BUDGET ZONES

- For informational purposes, water budgets are reported for
  1. Basin-wide
  2. Marina-Ord Area plus the Reservation Road portion of the Corral de Tierra Area (Dune Sand, 180-Foot, 400-Foot, and Deep Aquifers)
  3. Remainder of the Corral de Tierra Area (El Toro Primary Aquifer System)

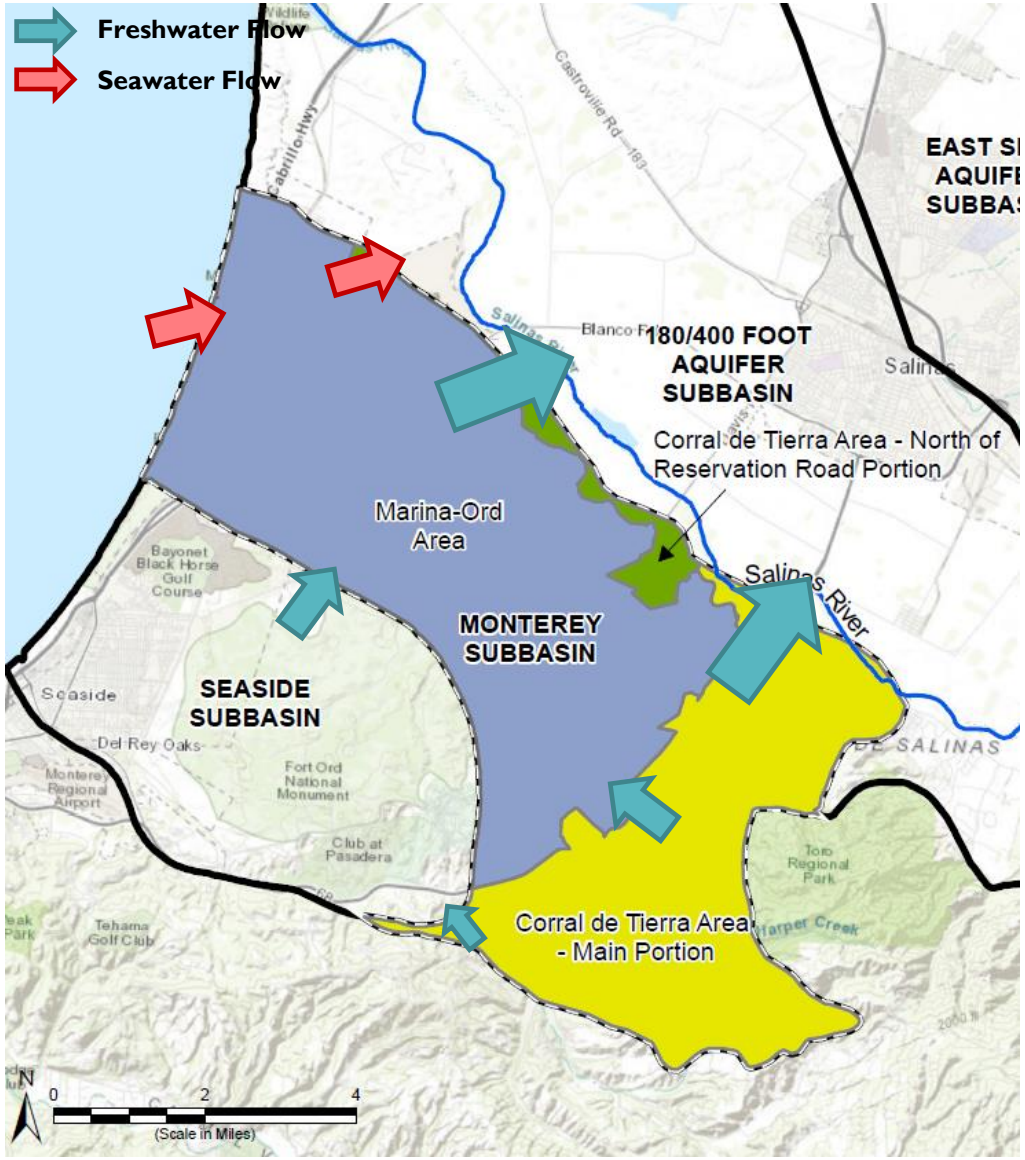
Note: The Reservation Road portion is a "flow-through" between the Marina-Ord Area and the 180/400-Foot Aquifer Subbasin. Has similar hydrostratigraphy as the Marina-Ord Area



# PRELIMINARY HISTORICAL WATER BUDGET (2004-2018)

| Estimated Annual Average Flows | Basin-Wide (AFY) |
|---|---|
| **Recharge** | **10,100** |
| **Well Pumping** | **-5,600** |
| Net Inter-Basin Cross-Boundary Flow | -9,000 |
| *Flow from/to Seaside (100% Freshwater)* | *900* |
| *Flow from/to 180/400 (81% Freshwater)* | *-12,300* |
| *Flow from/to Ocean (100% Seawater)* | *2,300* |
| Salinas River Exchange | 200 |
| **Net Annual Change in Groundwater Storage** | **-4,300** |

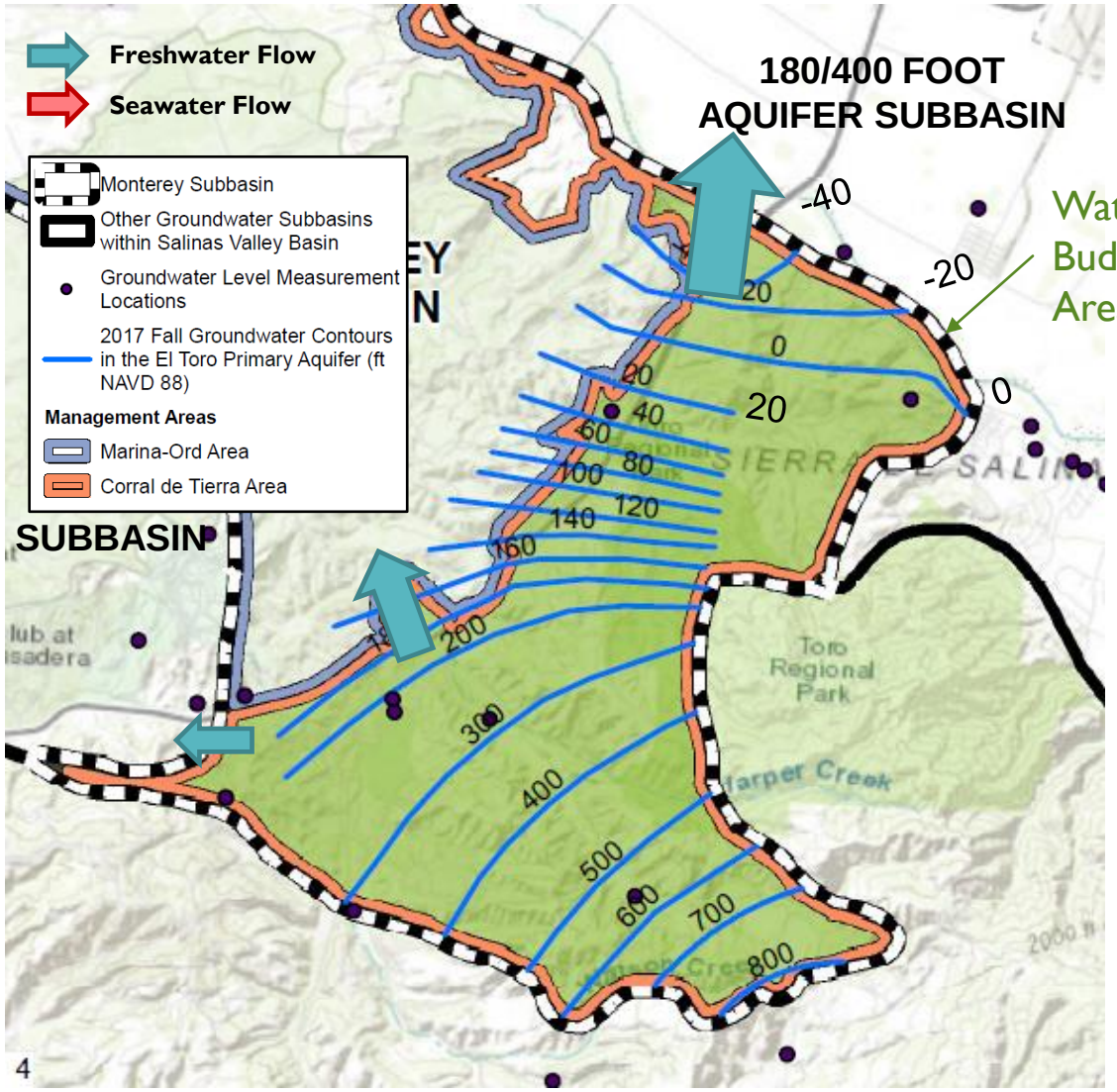
Notes: Total may not sum due to rounding.



# PRELIMINARY HISTORICAL WATER BUDGET (2004-2018)

| Estimated Annual Average Flows | Corral de Tierra Area (El Toro Primary Aquifer) (AFY) |
|---|---|
| **Recharge** | **3,900** |
| **Well Pumping** | **-1,300** |
| Net Inter-Basin Flow | -4,000 |
| *Flow from/to Seaside* | *-400* |
| *Flow from/to 180/400* | *-3,600* |
| *Flow from/to Ocean* | - |
| Net Intra-basin Flow<br>*Flow from/to Marina-Ord Area* | -1,500 |
| Salinas River Exchange | 200 |
| **Net Annual Change in Groundwater Storage** | **-2,800** |

Notes: Total may not sum due to rounding.




El Toro Primary Aquifer System

# WATER BUDGET INFORMATION/UNCERTAINTIES: CORRAL DE TIERRA

- Developed based on the best available information
- Recharge rates generally align with historical estimates for the area
- Groundwater pumping is estimated for small water systems and domestic users
  - Planned well registration program and GEMS expansion will help refine the groundwater model
- Limited groundwater elevation data near the 180/400-Foot Subbasin Boundary
  - Expansion of monitoring network will better characterize cross-boundary flows
- Evidence of heterogenous conditions in upper and lower portions of El Toro Primary Aquifer; uncertainty in groundwater flow through area

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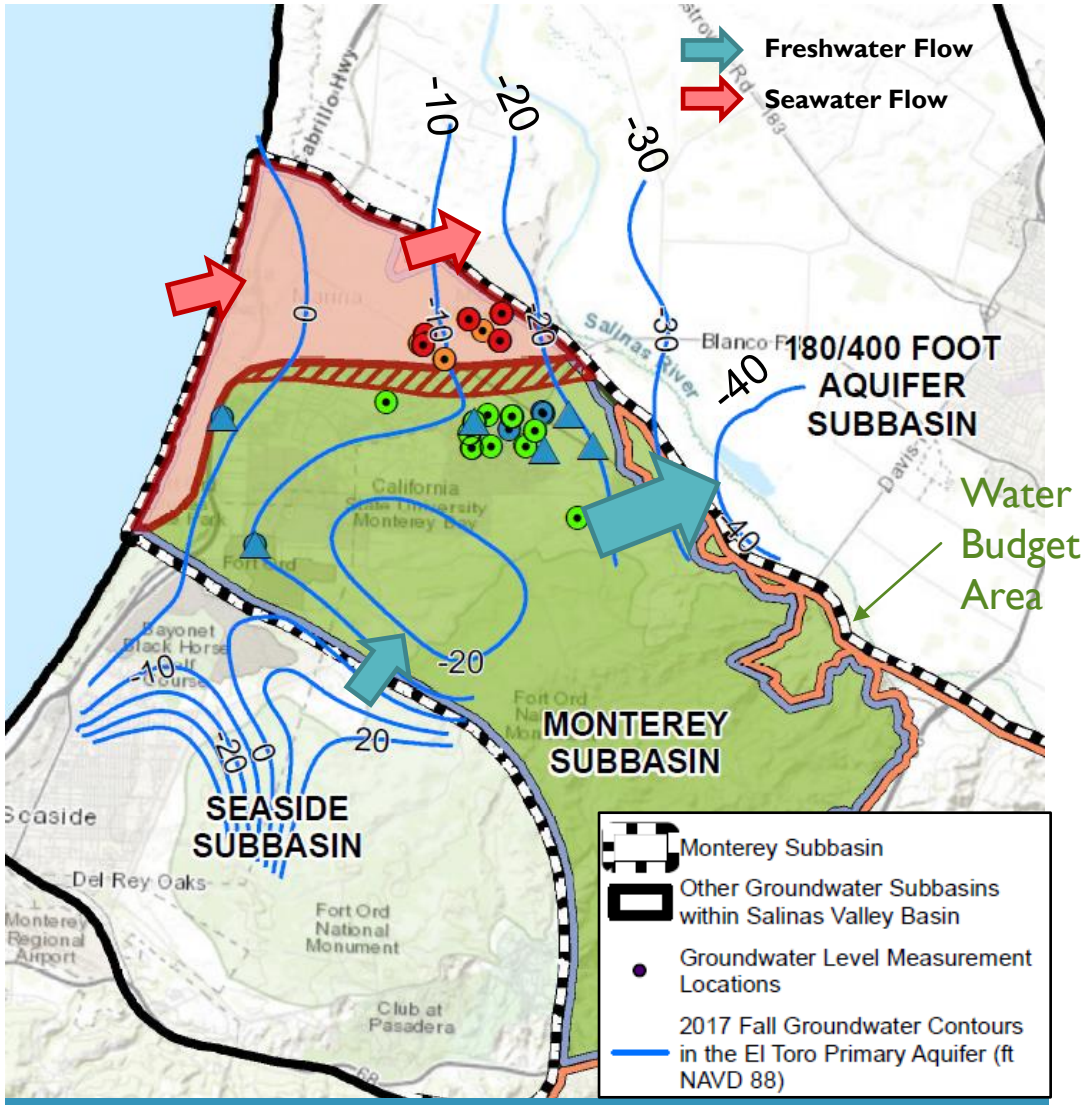
# PRELIMINARY HISTORICAL WATER BUDGET (2004-2018)

| Estimated Annual Average Flows | Marina-Ord Area (Dune Sand, 180-Foot, 400-Foot & Deep Aquifer) (AFY) |
|---|---|
| **Recharge** | **6,100** |
| **Well Pumping** | **-4,300** |
| Net Inter-Basin Cross-Boundary Flow | -5,100 |
| *Flow from/to Seaside (100% Freshwater)* | *1,300* |
| *Flow from/to 180/400 (74% Freshwater)* | *-8,600* |
| *Flow from/to Ocean (100% Seawater)* | *2,300* |
| Net Intra-basin Flow<br>*Flow from/to Corral de Tierra* | 1,500 |
| Salinas River Exchange | 0 |
| **Net Annual Change in Groundwater Storage** | **-1,400** |

Notes: Total may not sum due to rounding.




Lower 180 Ft and 400 Ft Aquifers

# WATER BUDGET INFORMATION/UNCERTAINTIES: MARINA-ORD

- Developed based on the best available information
- Recharge rates generally align with historical estimates for the area
  - Slightly higher recharge rate estimated in urban areas compared to the SVIHM
  - Accounts for water applied to landscape irrigation, pipe leakage, and managed stormwater recharge
- Limited groundwater elevation data in the eastern Fort Ord hills
- Evidence of heterogenous conditions in upper and lower portions of the Deep Aquifer, however there is not enough data to characterize them as separate aquifers
  - Planned monitoring network expansion in the Deep Aquifer may help refine the model

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# PROJECTED WATER BUDGET UNDER DEVELOPMENT

- Projected water budget calculations consider
  - Climate change
  - Future land use changes
  - Projected groundwater extraction
- Several scenarios to simulate changes in boundary conditions as a result of management actions in adjacent basins, e.g.
  - Meeting groundwater elevation Measurable Objectives
  - Meeting protective groundwater elevations and natural flat/seawater gradient to control seawater intrusion

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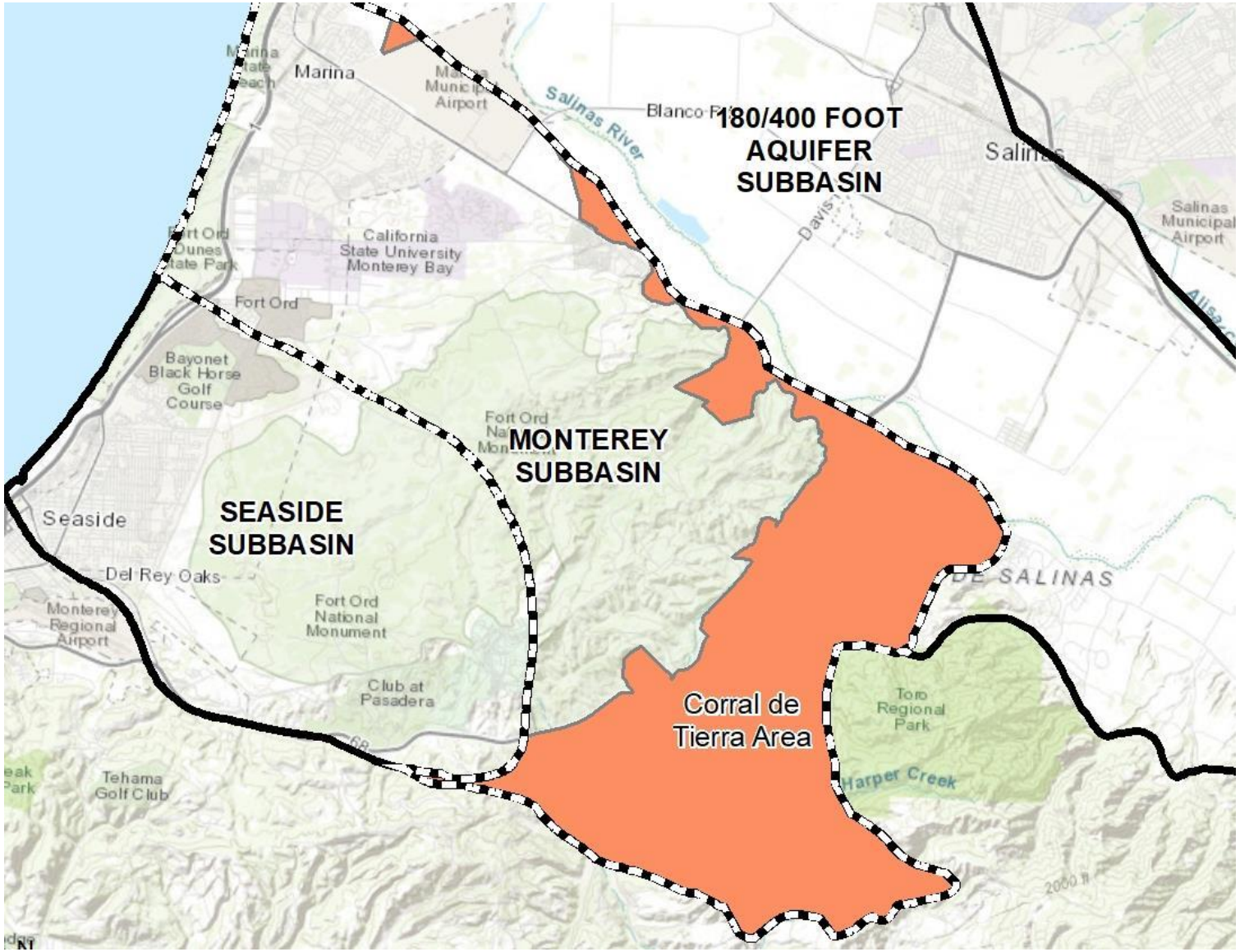
# QUESTIONS?


180/400 FOOT AQUIFER SUBBASIN
MONTEREY SUBBASIN
SEASIDE SUBBASIN
Corral de Tierra Area
Marina
Salinas River
Salinas
California State University Monterey Bay
Fort Ord
Bayonet Black Horse Golf Course
Seaside
Del Rey Oaks
Monterey Regional Airport
Fort Ord National Monument
Club at Pasadera
Tehama Golf Club
Toro Regional Park
Harper Creek
Salinas Municipal Airport