SANTA CRUZ MID-COUNTY GROUNDWATER AGENCY

SANTA CRUZ MID-COUNTY GROUNDWATER SUSTAINABILITY PLANNING

Advisory Committee Meeting #10

Wednesday, August 22, 2018, 5:00 – 8:30 p.m.

Simpkins Family Swim Center, Santa Cruz

Welcome and Introductions

- Groundwater Sustainability Plan (GSP) Advisory Committee
- Staff
- Public

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Meeting Objectives

- Build Advisory Committee familiarity with and understanding of:
  - the role of groundwater modeling in the GSP
  - the use of groundwater models to explain complex local hydrogeology
  - model data input, assumptions, and calibration
  - assumptions used in predictive modeling
  - predictive model scenarios developed to date and what is still to be modeled
  - the types of model results and how they will be used to evaluate Sustainable Management Criteria
- Provide Advisory Committee input on questions to address through the groundwater model

Agenda

5:00	Welcome, Introductions, Objectives, Agenda, GSP Project Timeline Review, Project Updates
5:10	Oral Communications
5:20	Role of Groundwater Modeling and Description of the Mid-County Model
6:25	Public Comment
6:35	*Break*
6:50	Groundwater Model Predictive Simulations
7:45	Public Comment
7:55	Confirm Summaries from *June 27 AC*, and *July 19 Joint MGA/AC* Meetings and Distribute/Request Review of Draft Minimum Thresholds Proposals for Subsidence and Water Quality
8:25	Recap and Next Steps
8:30	*Adjourn*

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GSP Project Timeline

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GSP Project Timeline – Phase 2b

Santa Cruz Mid-County Groundwater Basin Groundwater Sustainability Plan Process Overview — Phase 2b: July–December 2018

2018 — PHASE 2: GSP ADVISORY COMMITTEE POLICY DEVELOPMENT

7/18 8/18 9/18 10/18 11/18 12/18

Phase 2b. July – December 2018: Projects, Management Actions and Groundwater Modeling

July 19, 2018 *(Joint Advisory Committee/MGA Board Meeting)*
- Discuss projects and management actions and how they relate to GSP.

August 2018
- Describe groundwater model and what goes into the model, including discussion of assumptions for historic and predictive simulations.
- Discuss groundwater modeling results for sample projects and management actions; evaluate project impacts against Minimum Thresholds.

September 2018
- Articulate Problem Statement.
- Identify, confirm and prioritize project evaluation criteria (to be presented in October).
- Discuss cumulative projects to model.

October 2018
- Present groundwater modeling results for cumulative projects; evaluate modeling results against Minimum Thresholds and other evaluation criteria.
- Discuss Minimum Threshold and Undesirable Result options with underlying Significant and Unreasonable Conditions for Groundwater Storage.
- Begin discussing Measurable Objectives and Interim Milestones.

November 15, 2018 *(Joint Advisory Committee/MGA Board Meeting)*
- Discuss elements of possible fee structures.
- Discuss management areas.

December 2018 *(date early in month TBD)*
- Discuss next iteration of groundwater modeling results.
- Confirm projects and management actions, and Measurable Objectives for analysis (e.g., cost allocation, legal issues) in 2019.

7/18 8/18 9/18 10/18 11/18 12/18

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Share

Project Updates

Oral Communications

GROUNDWATER MODEL OF THE SANTA CRUZ MID-COUNTY BASIN

SANTA CRUZ MID-COUNTY GROUNDWATER AGENCY

Presenter: Georgina King, Montgomery & Associates

Objectives

Provide Understanding of:

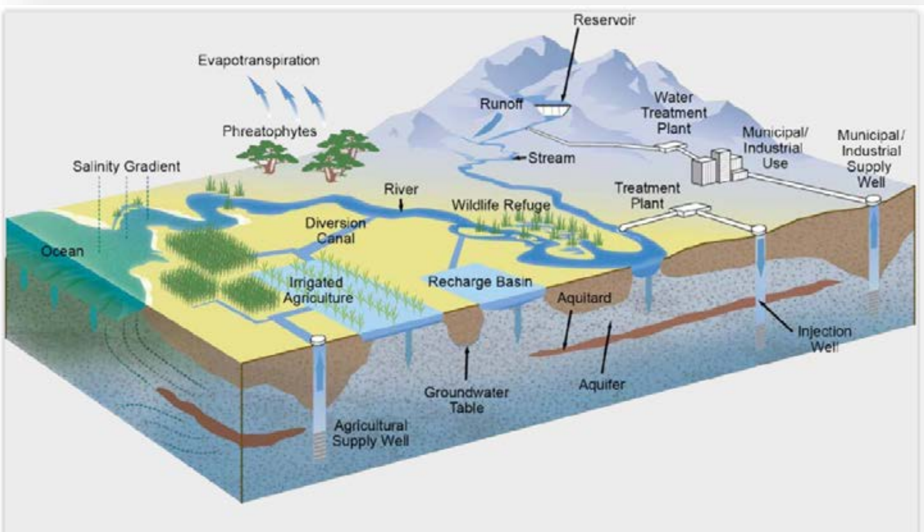
- Role of Groundwater Modeling
- How a Groundwater Flow Model Works
- Data and Assumptions used in Model Development
- Model Calibration

BREAK

- Assumptions used in Predictive Simulations
- Type of Results from Predictive Simulations

Role of Groundwater Modeling

General Role of Models



- Paint a picture of what the groundwater systems looks like
- Assess how groundwater behaves under different conditions
- Predict what happens if you change any of the inputs, outputs or other factors affecting the system

General Role of Models

- Help build a better understanding of the relationships between natural resources and human activities – understanding these variables help us to make <u>better management decisions </u>about how to manage human activities in the Basin

Role in Groundwater Management

- Groundwater management is complex because of constantly changing conditions:
  - Water demand
  - Climate
  - Water projects that influence the occurrence and movement of groundwater
- For effective groundwater management you need a tool that can:

Predict future conditions by taking into account multiple separate & inter-related hydrologic processes

A groundwater flow model can simulate and predict the movement and use of water

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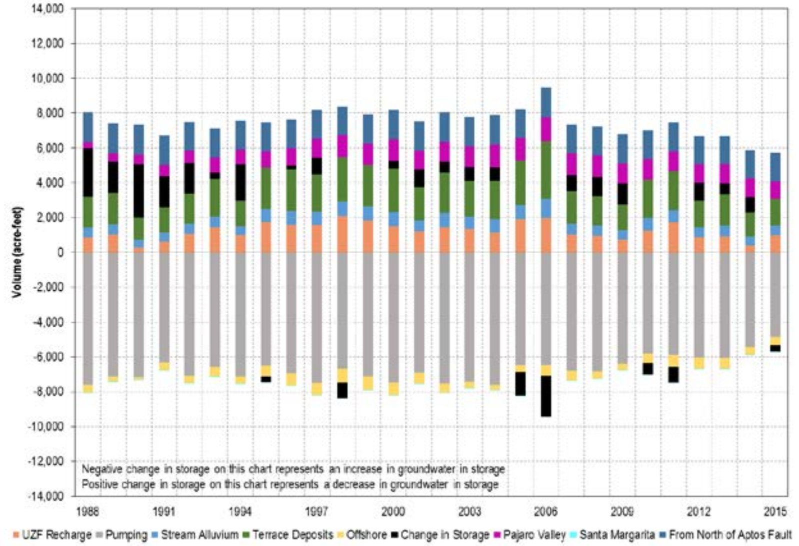
Role in the GSP – Section 2

Section 2: Plan Area and Basin Setting

- Historical and current groundwater budgets
  - Groundwater recharge
  - Groundwater pumping
  - Change in groundwater in storage
  - Estimate of Sustainable Yield
- Future groundwater budget
  - Include effects of climate change



Role in the GSP – Section 3

Section 3: Sustainable Management Criteria

- Evaluate if groundwater level Minimum Thresholds can be met for Sustainability Indicators:
  - Seawater intrusion,
  - Chronic lowering of groundwater levels, and
  - Depletion of interconnected surface water
- Inform Measurable Objectives which are defined by Operational Flexibility
- Develop Interim Milestones based on planned projects and management actions

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Role in the GSP – Section 4

Section 4: Projects and Management Actions to Achieve Sustainability Goal

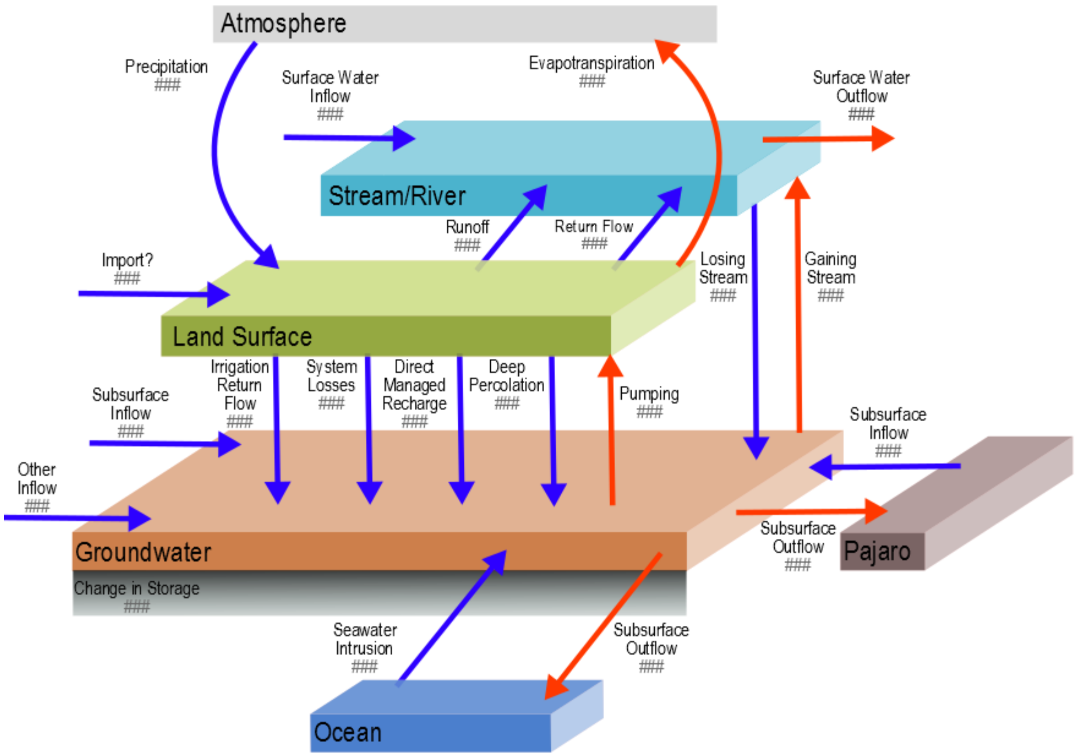
- Demonstrate projects and programs achieve sustainability within 20 years
- Demonstrate basin will maintain sustainability for 30 years thereafter
- Assess **who benefits** from programs and agree on who pays for these programs

Projects & Programs → 2020 – 2040 Achieve Sustainability within 20 years → 2040 – 2070 Maintain Sustainability for next 30 years

How a Groundwater Model Works

What a Model Is

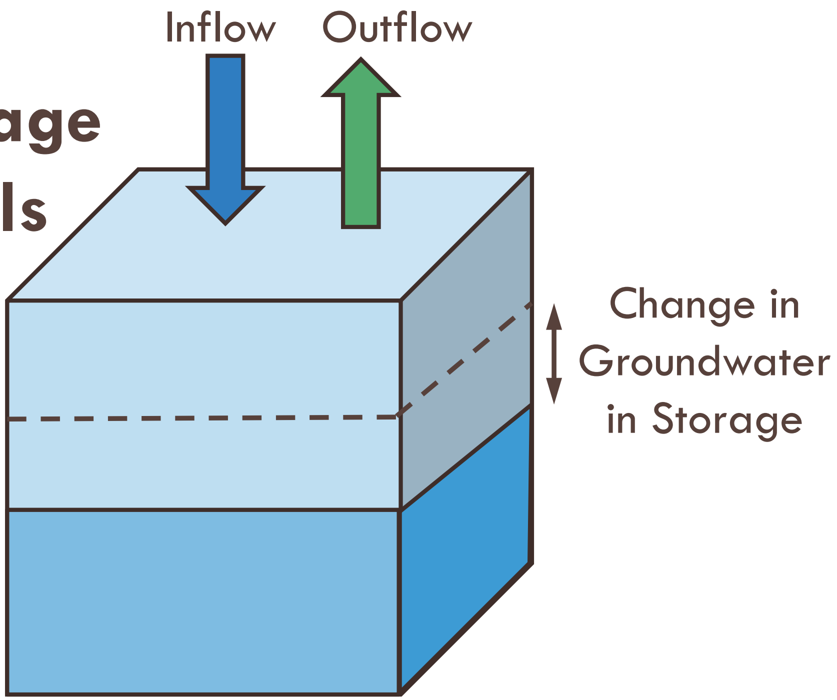
- A simplified representation of the complex natural world
- Takes into account components of the landscape, aquifer system, and water cycle



Models Calculate Water Budgets

Inflow – Outflow = Change in Groundwater in Storage

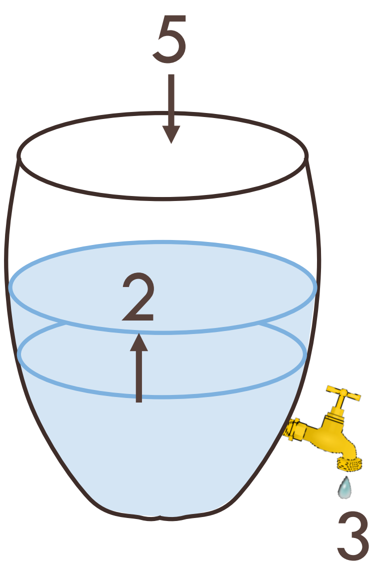
Change in Groundwater in Storage
~ Change in Groundwater Levels



How Models Deal with Change in Storage

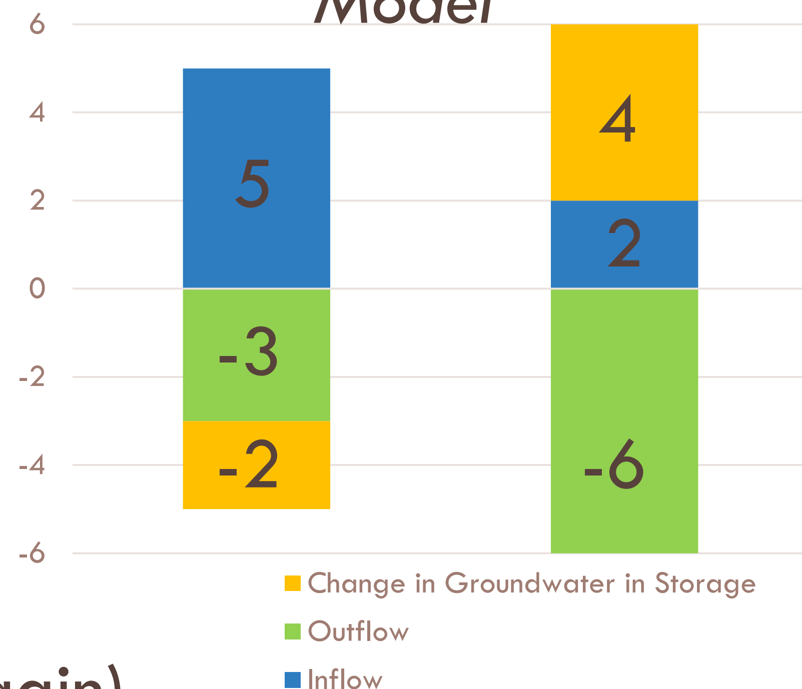
Inflow – Outflow = Change in Groundwater in Storage

Reality

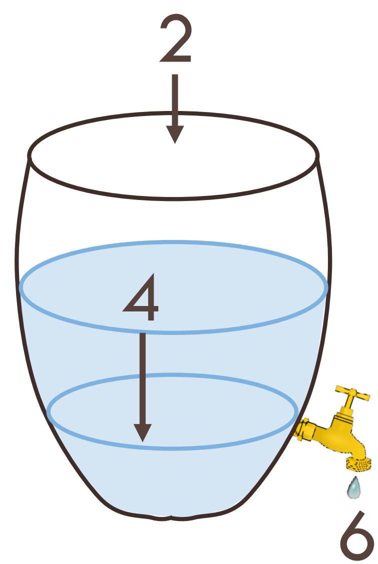


5 – 3 = +2 (gain)

Model



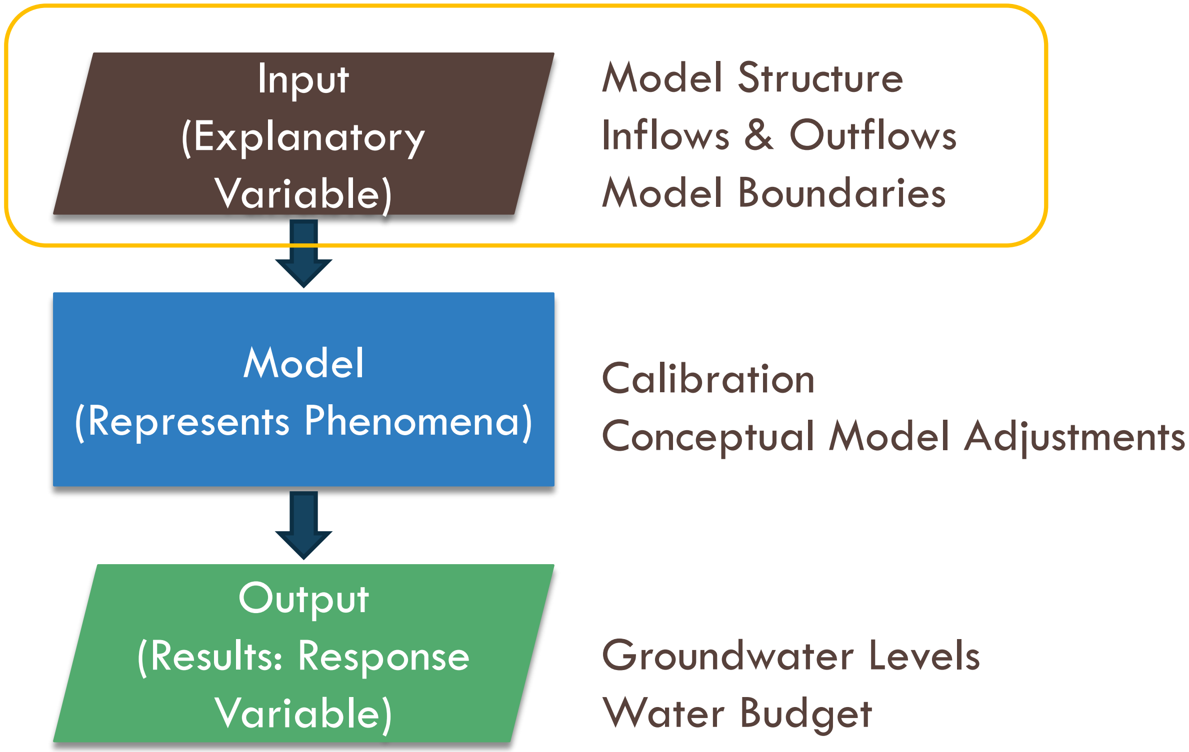
Reality



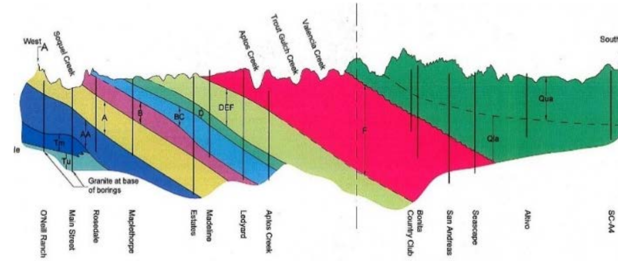
2 – 6 = -4 (loss)

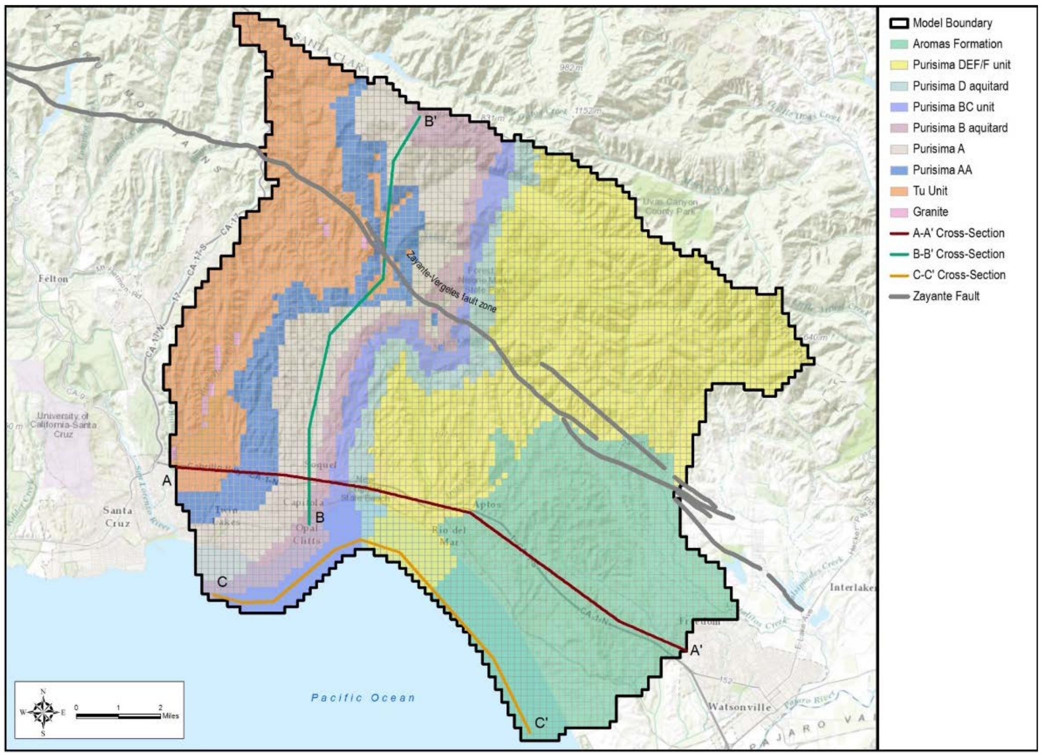
Data and Assumptions used in Model Development

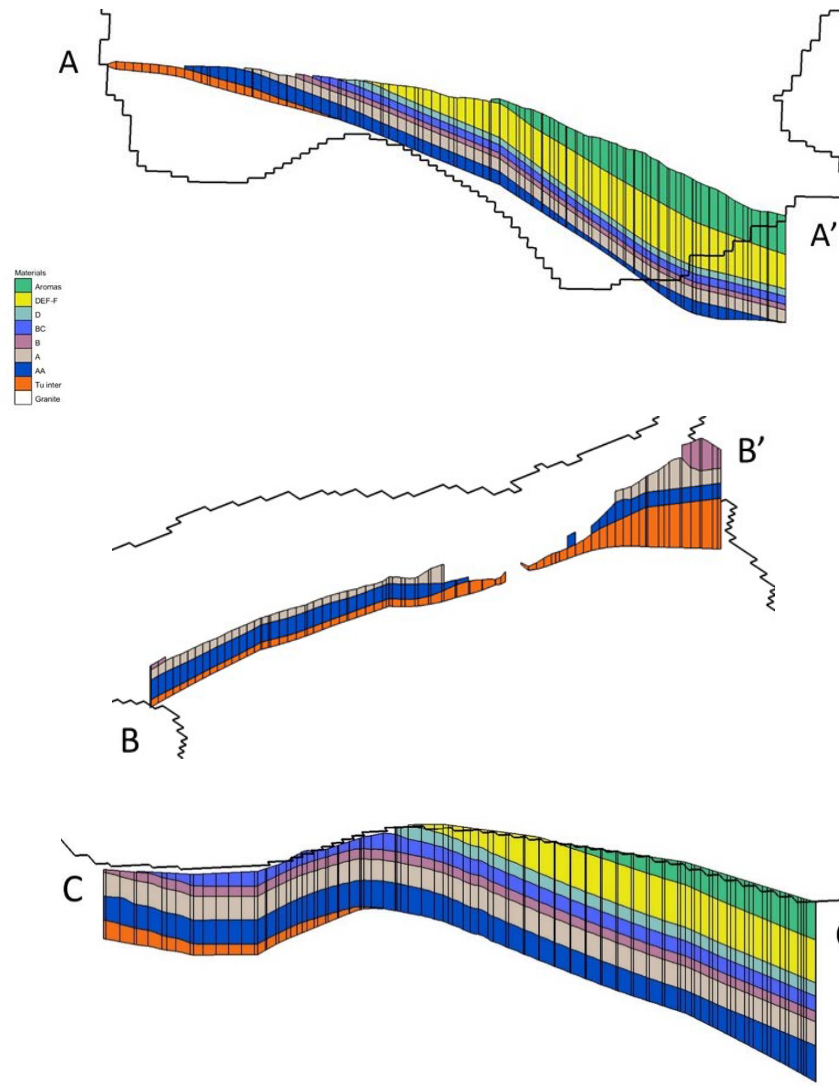
Model Process



Model Structure



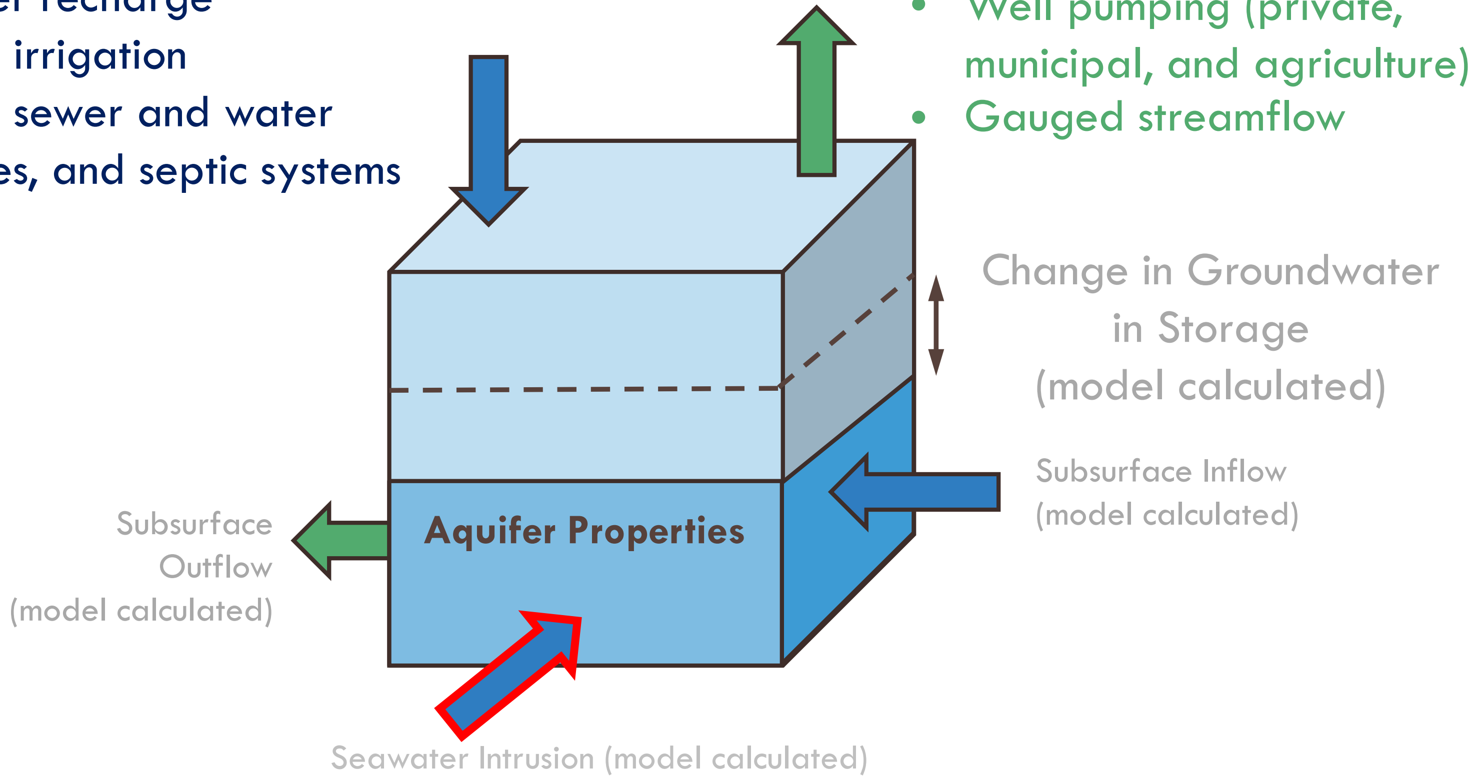




Model Input Flow Data

Inflow (input data)
- Direct percolation of precipitation
- Managed aquifer recharge
- Return flow from irrigation
- Return flow from sewer and water transmission losses, and septic systems

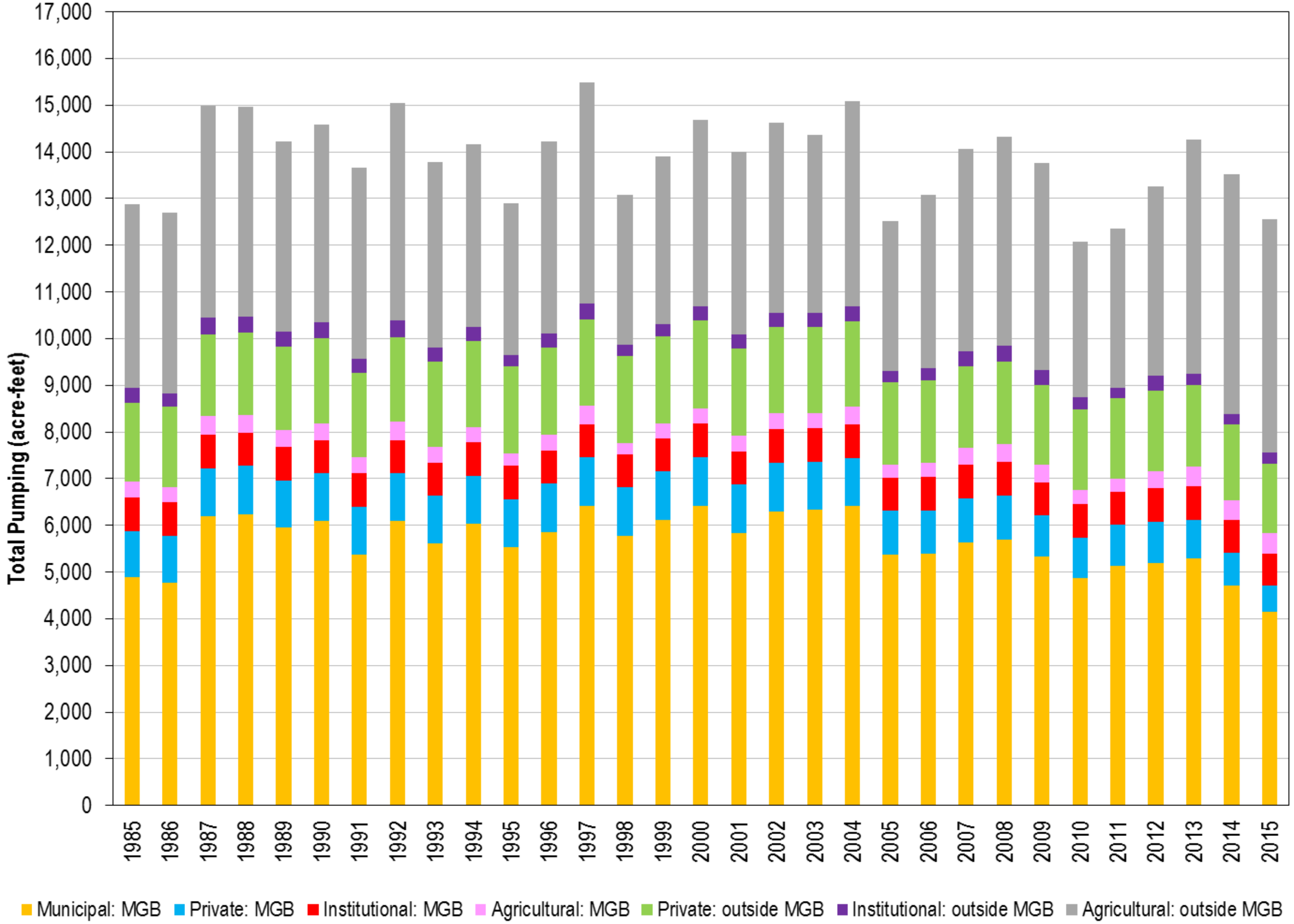
Outflow (input data)
- Evapotranspiration
- Well pumping (private, municipal, and agriculture)
- Gauged streamflow



Difficult and complex to estimate all inputs accurately

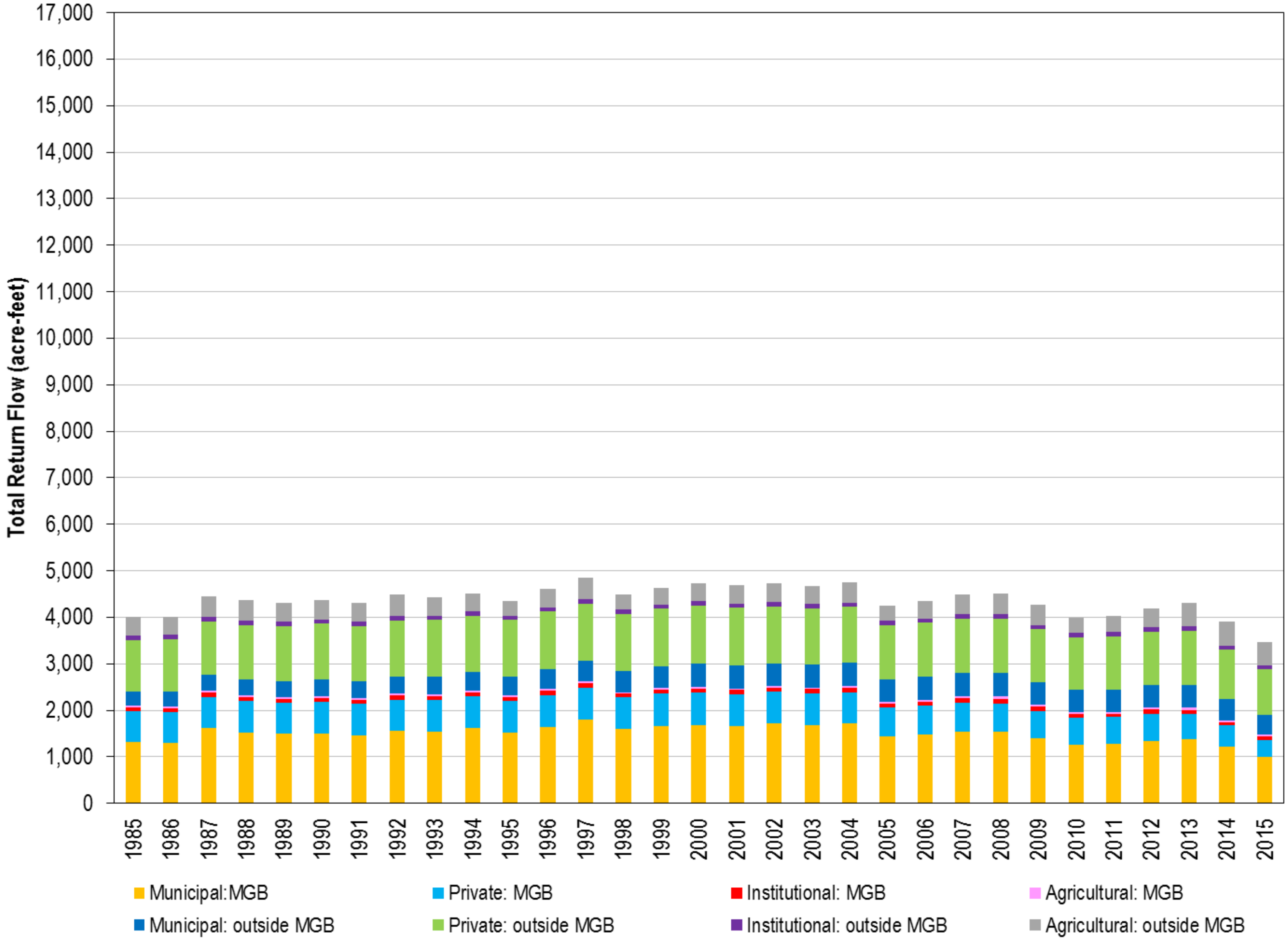
Many assumptions are made and documented in model report

Pumping



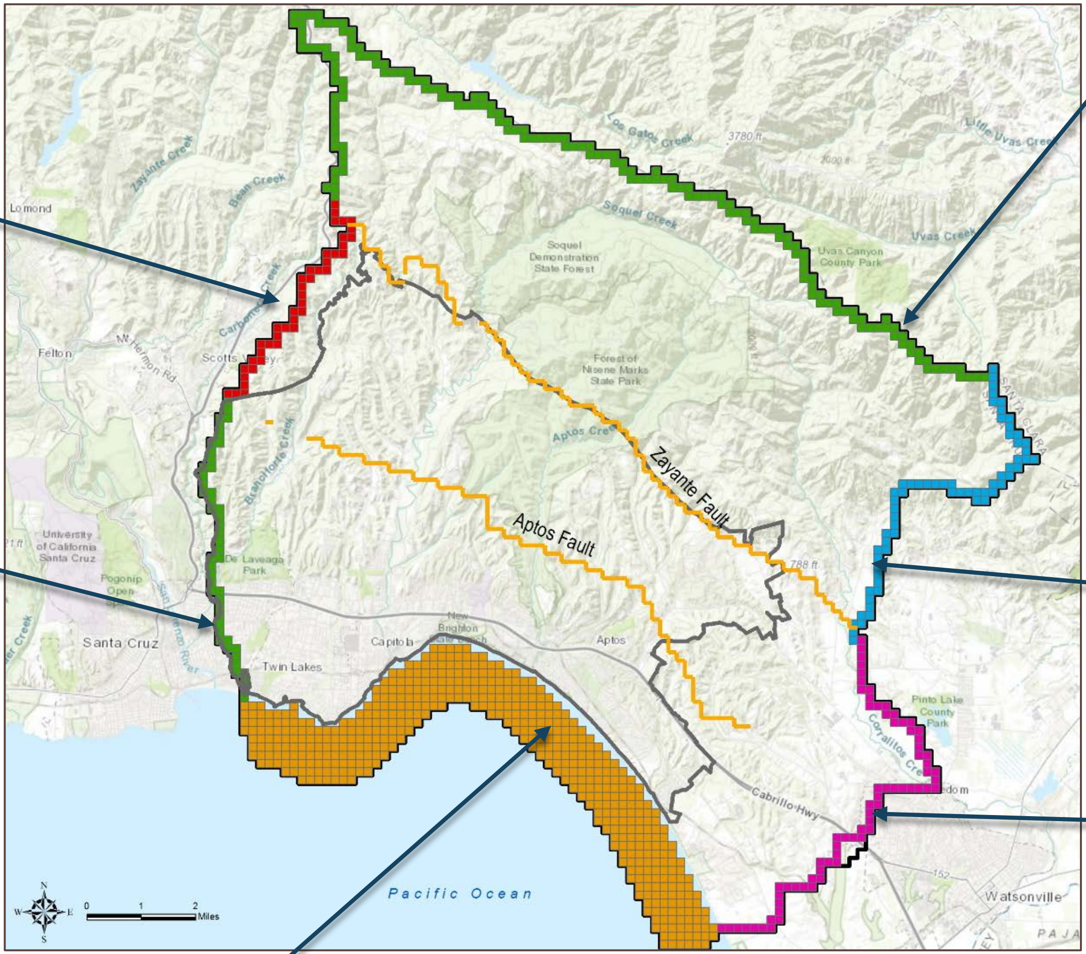
MGB = Mid-County Groundwater Basin

Return Flows



MGB = Mid-County Groundwater Basin

Model Boundaries



Santa Margarita Basin (based on data)

No Flow

No Flow

General Heads (based on Central Water District [CWD] model)

Pajaro Valley Subbasin (based on data)

Offshore General Heads (estimated based on saltwater density)

Model Calibration

Model Process

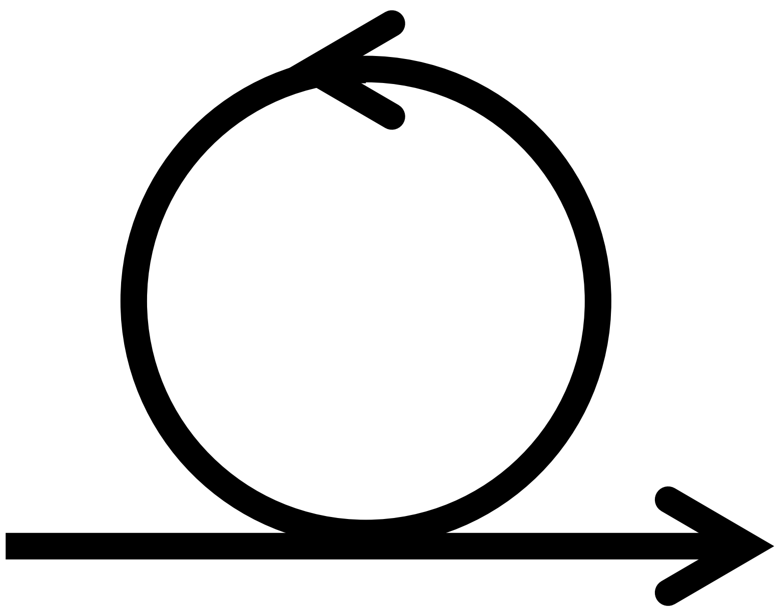
Input (Explanatory Variable)
- Model Structure
- Inflows & Outflows
- Model Boundaries

Model (Represents Phenomena)
- **Calibration**
- Conceptual Model Adjustments

Output (Results: Response Variable)
- Water Budget
- Groundwater Levels

Model Calibration

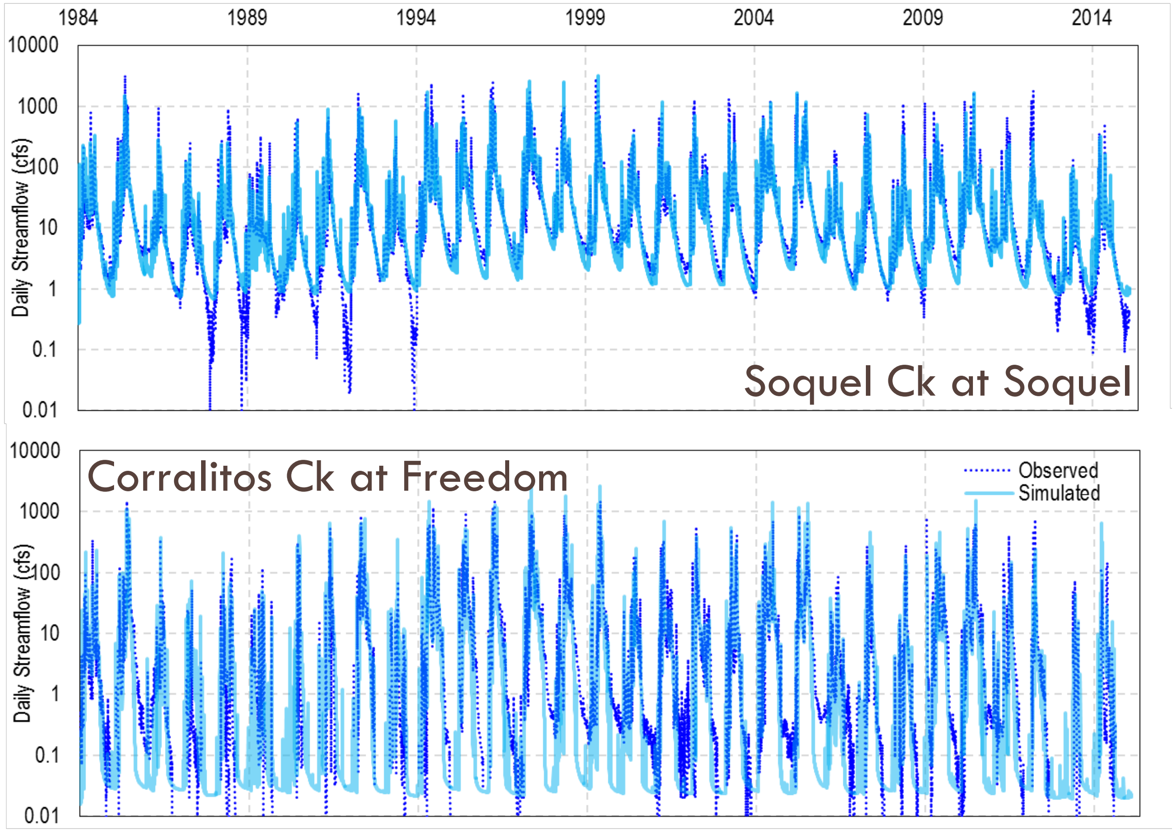
- Process of adjusting selected model parameters so that model outputs approximate historical observations



Surface Water Calibration Parameters

- Watershed PRMS parameters by zone
- Streambed Hydraulic Conductivity

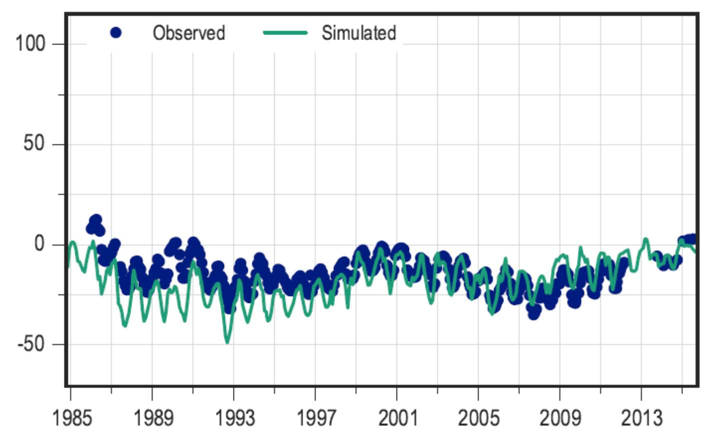
Calibrating to Gauged Streamflow

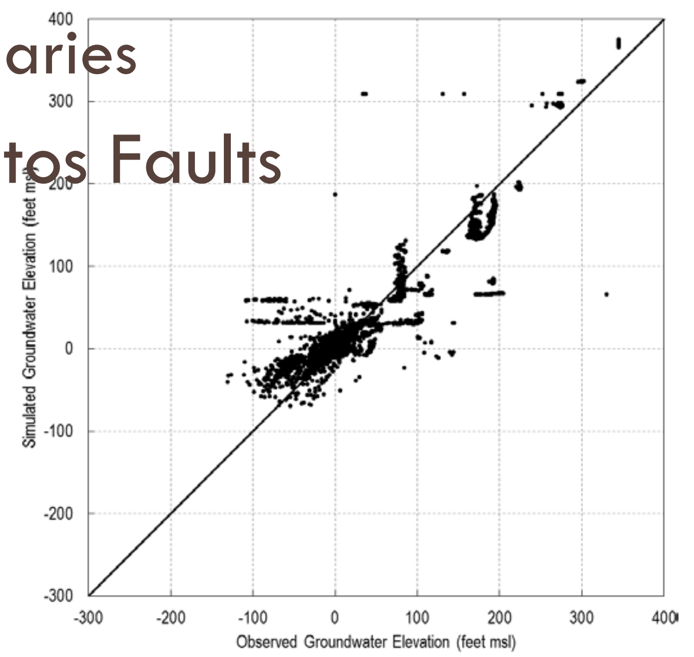


Groundwater Flow Calibration Parameters

- Horizontal and Vertical Hydraulic Conductivity
- Specific Storage and Specific Yield
- General Head Boundary Conductance
  - Offshore and Seafloor
  - Santa Margarita Basin and SE boundaries
- Fault Leakance for Zayante and Aptos Faults

Calibrating to Measured Groundwater Levels



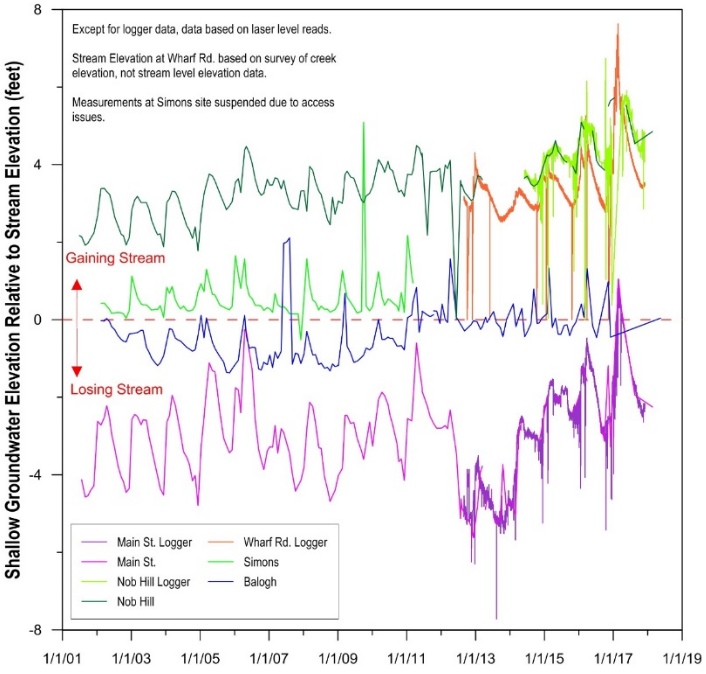


Uses Supported by Calibration

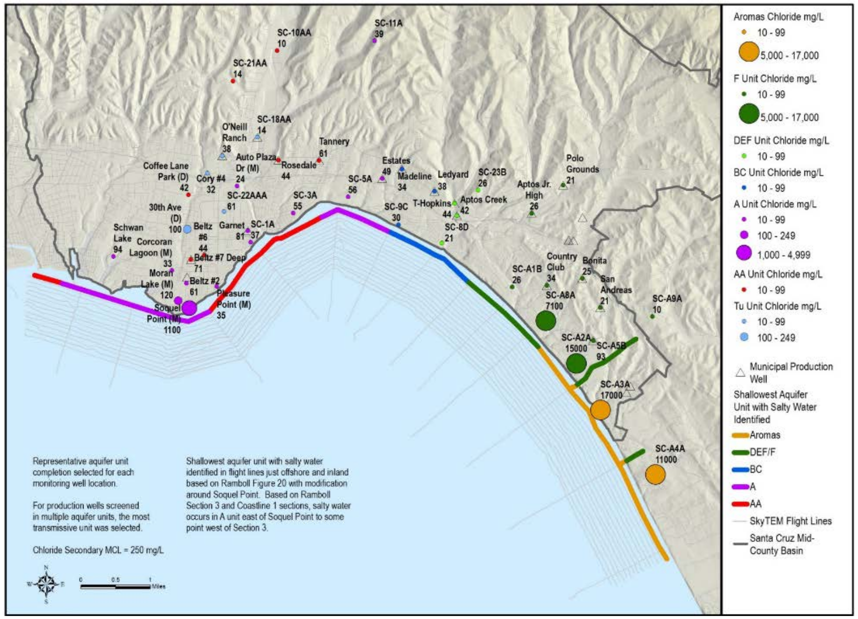
- Supports evaluation of groundwater management projects
  - Evaluate seawater intrusion by comparison to protective elevations
  - Evaluate groundwater level response in municipal pumping area
- Limitations
  - Pumping response in DEF unit
  - Evaluation of inland response to management actions
  - Quantify stream-aquifer interactions

Additional Enhancements

- Calibrate groundwater levels in stream alluvium to shallow groundwater levels



- Implement seawater intrusion package



Questions?

Assumptions used in Predictive Simulations

Climate change

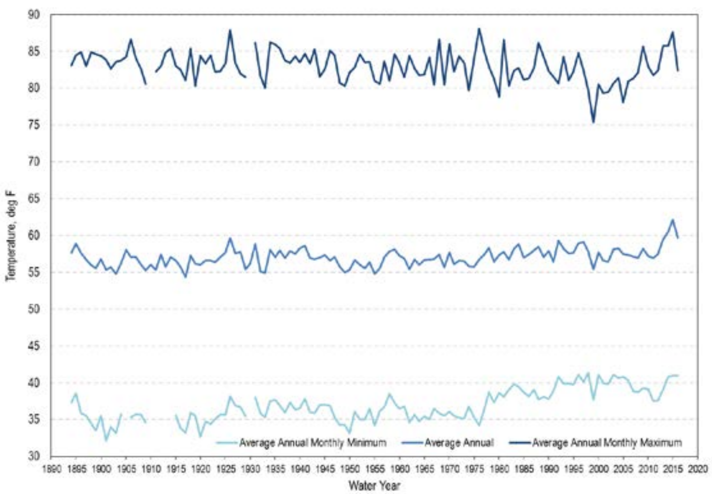
Sea level rise

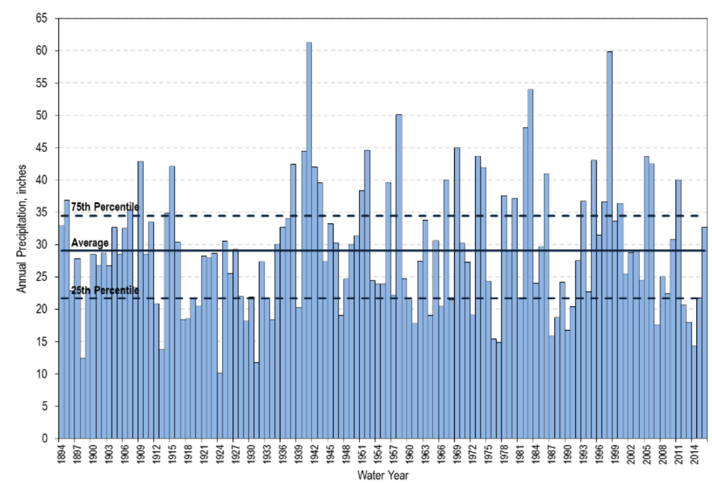
Groundwater demand

Projects and management actions

Future Climate Choices

- Water Years 1985-2015 (calibration period)
- Water Years 1969-1984 (drought shortfall for City of Santa Cruz ASR)
- Catalog Climate (select mostly warm years from 1909-2016)
- Downscaled Global Circulation Model GFDL2.1-A2 from CMIP 3 (City of Santa Cruz WSAC)
- Updated CMIP5 ensemble of Global Circulation Models (GCM)
  - DWR guidance based on selected GCMs
  - City of Santa Cruz stochastic combination





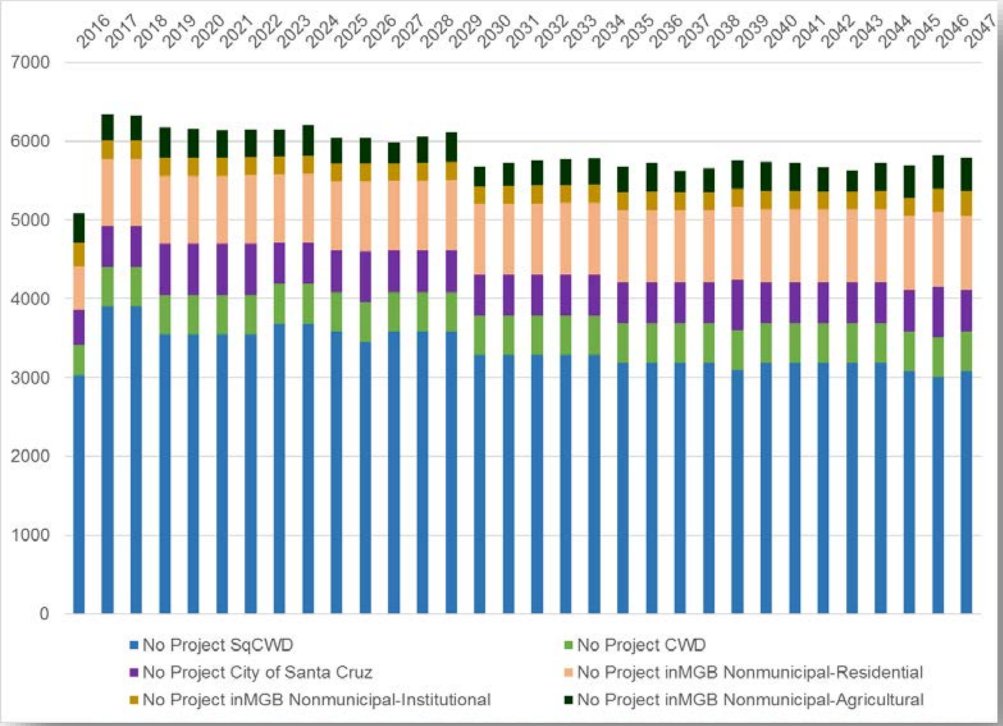
Sea Level Rise

- Based on mean projections from National Research Council 2012 report: 2070 vs 2000: +1.5 feet
- Applied at offshore General Head Boundary

Groundwater Demand Assumptions

- CWD pre-drought average 2008-2011
- Soquel Creek Water District (SqCWD) Urban Water Management Plan projections
- City of Santa Cruz cooperative agreement
- Pre-drought estimates for non-municipal pumping

No Projects Projected Pumping in Basin



Modeled Projects and Management Actions

Project/Action	Assumptions	Purpose
Projected existing conditions	Demand based on Urban Water Management Plan Climate change scenario	To compare project scenarios against
Reduced Pumping	Reduce municipal pumping to post 2045 projection	Test to evaluate basin impacts of less municipal pumping
Replenish basin with highly purified water	Inject into Purisima A & BC aquifers Slightly more pumped by SqCWD Project modeled for 20 years	Evaluation for SqCWD's Pure Water Soquel EIR
Aquifer Storage and Recovery (ASR)	City of Santa Cruz stores and recovers treated surface water when available	ASR feasibility

MGA likely to evaluate variations of Pure Water Soquel and ASR

→ Focus on basinwide sustainability

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(note: title on this slide has been corrected from the original presented at the Aug 23 Advisory Committee meeting)

To Be Modeled Sensitivity Runs

Project/Action	Assumptions	Purpose
Change non-municipal pumping and return flow (use calibration run 1985 – 2015)	Turn off inland pumping and associated return flow	Evaluate impact of private pumping and return flows on groundwater levels and streams
	Move non-municipal pumping from aquifers to alluvium and terrace deposits	
	Turn off non-municipal pumping in lower Soquel Creek and Bates Creek Valleys	
	Reduce septic return flow assuming 50% return flow in septic areas instead of 90% currently assumed	
Modify municipal pumping to reduce potential stream impacts	Move municipal pumping near Soquel Creek deeper to the Tu unit instead of the Purisima	Evaluate effects of pumping near Soquel Creek

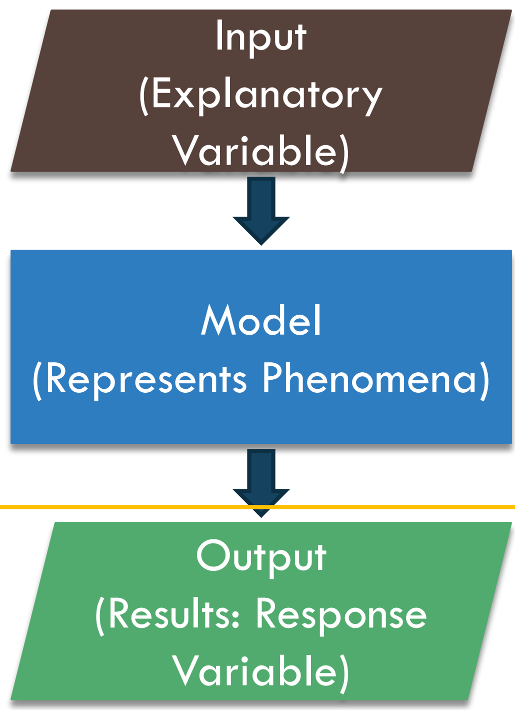
Type of Results from Predictive Simulations

Water Budget

Groundwater Levels

Groundwater Travel Time

Model Process



Model Structure
Inflows & Outflows
Model Boundaries

Calibration
Conceptual Model Adjustments

Water Budget
Groundwater Levels

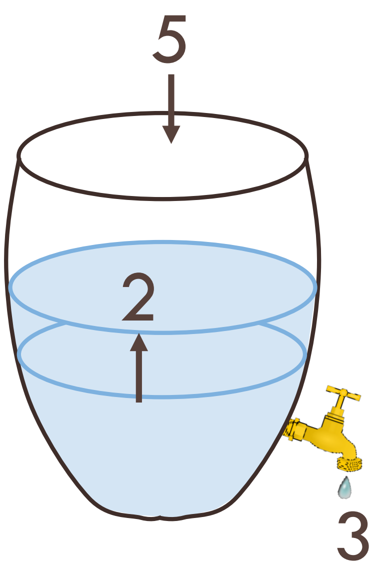
Water Budget

- Model calculated outputs
  - Deep percolation of rainfall
  - Subsurface inflows and outflows, including from offshore
  - Streambed percolation
  - Groundwater flow to creeks
  - Change in groundwater in storage
- The rest of the water budget components are data inputs

How Models Deal with Change in Storage

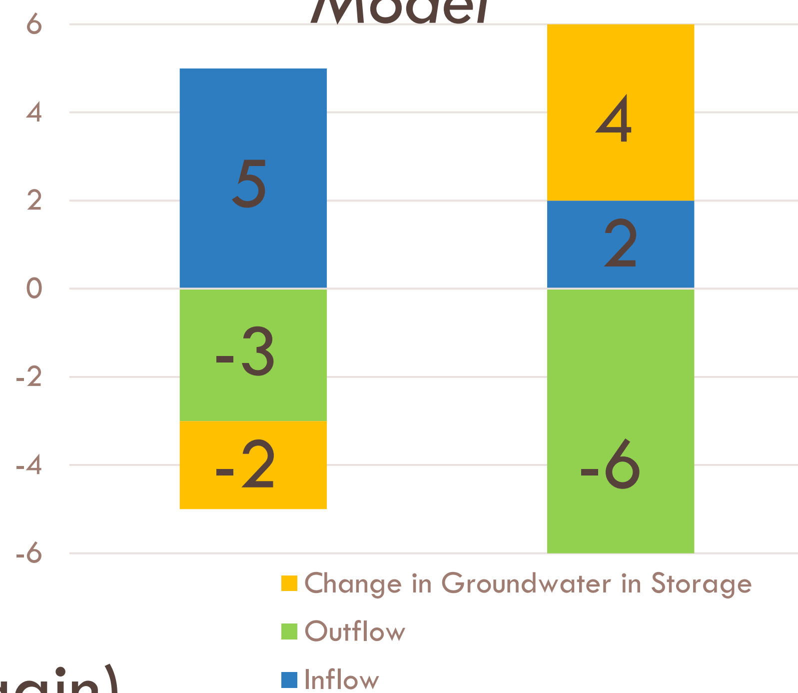
Inflow – Outflow = Change in Groundwater in Storage

Reality

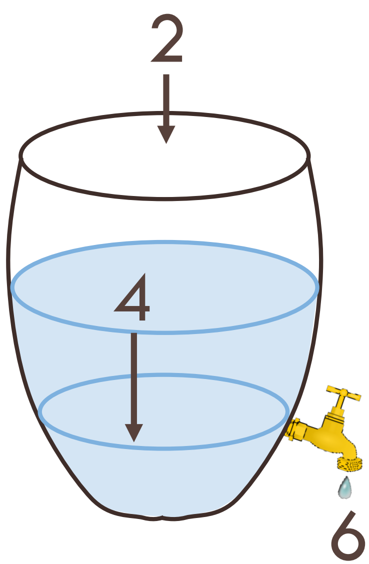


5 – 3 = +2 (gain)

Model



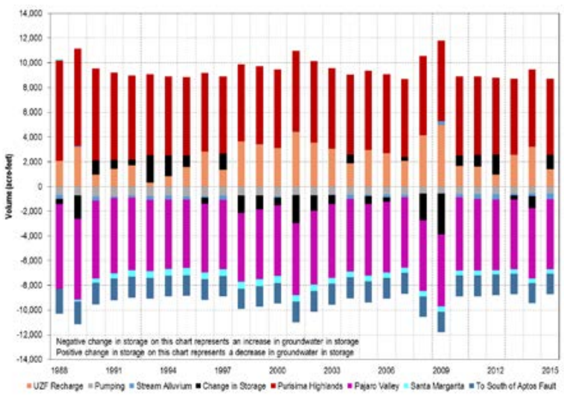
Reality

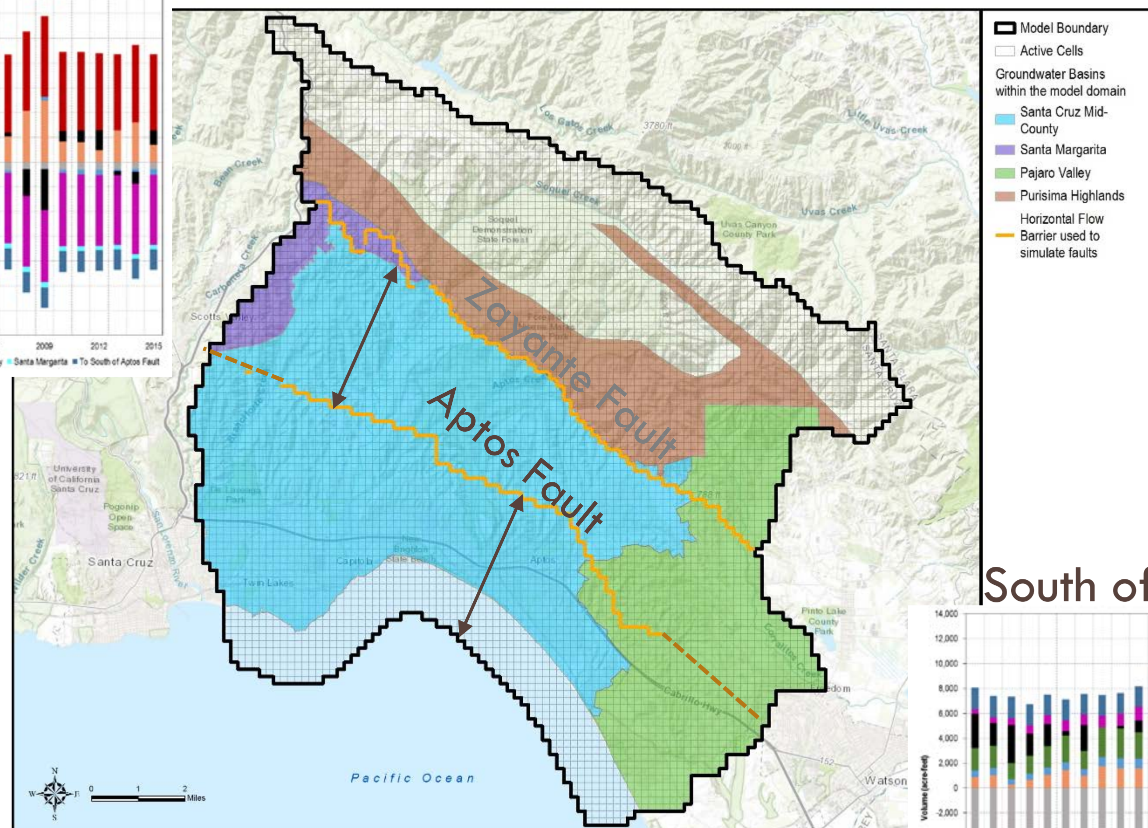


2 – 6 = -4 (loss)

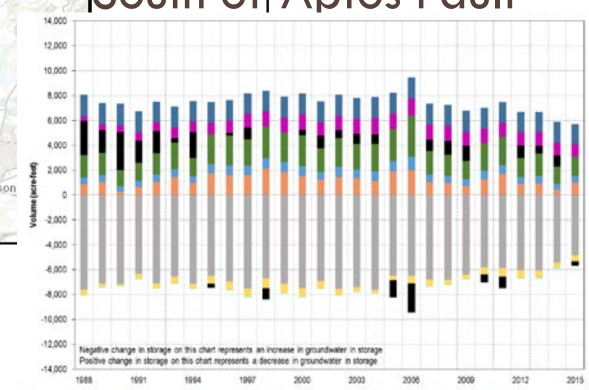
Basin Water Budget

North of Aptos Fault





South of Aptos Fault



South: Majority of Basin pumping & more informative for evaluating seawater intrusion

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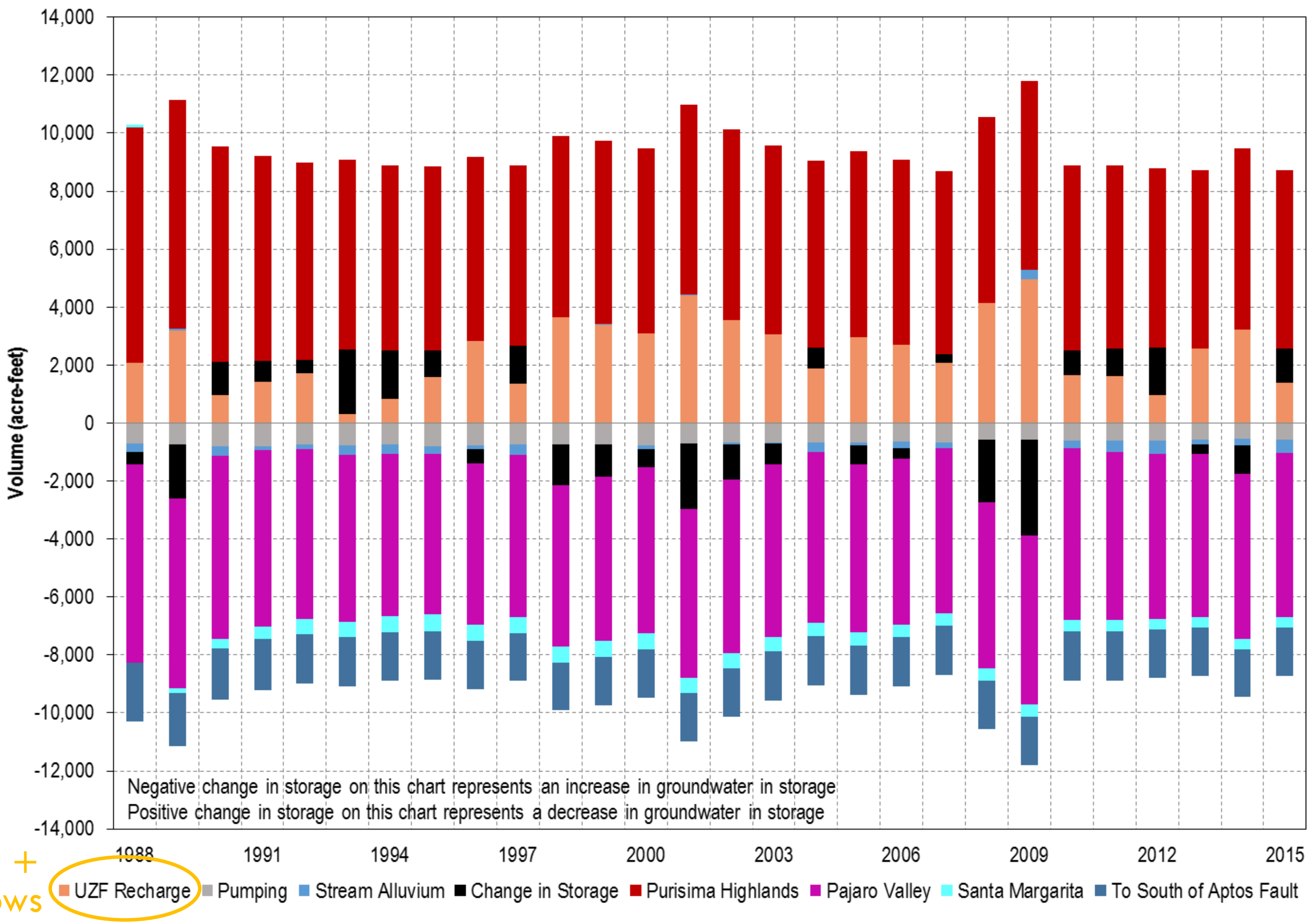
Water Budget North of Aptos Fault

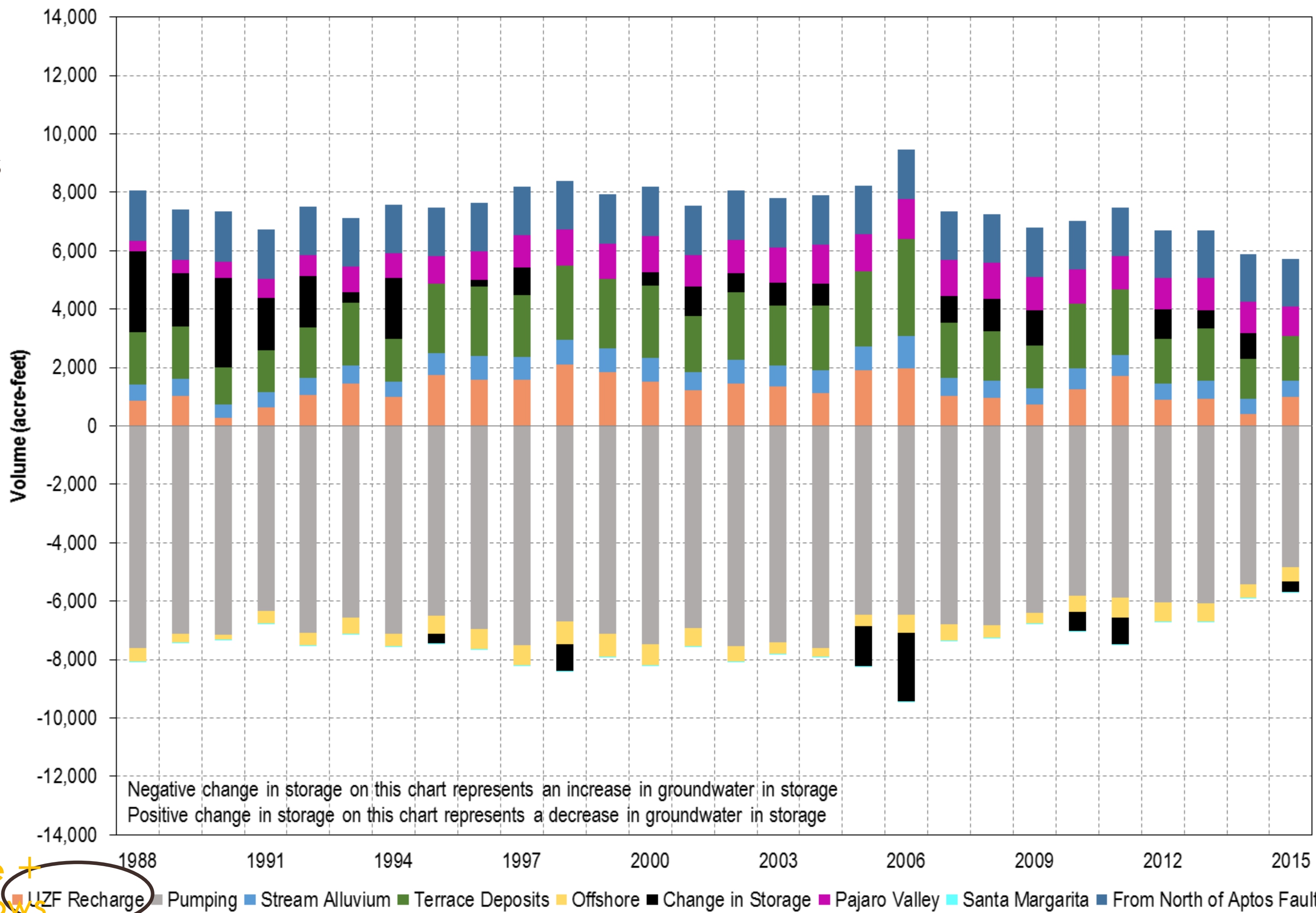
- UZF recharge is an important component of recharge
- Similar volumes coming in from Purisima Highlands and leaving to Pajaro Valley
- Some flow to south of Aptos Fault



Rainfall Recharge + Return flows

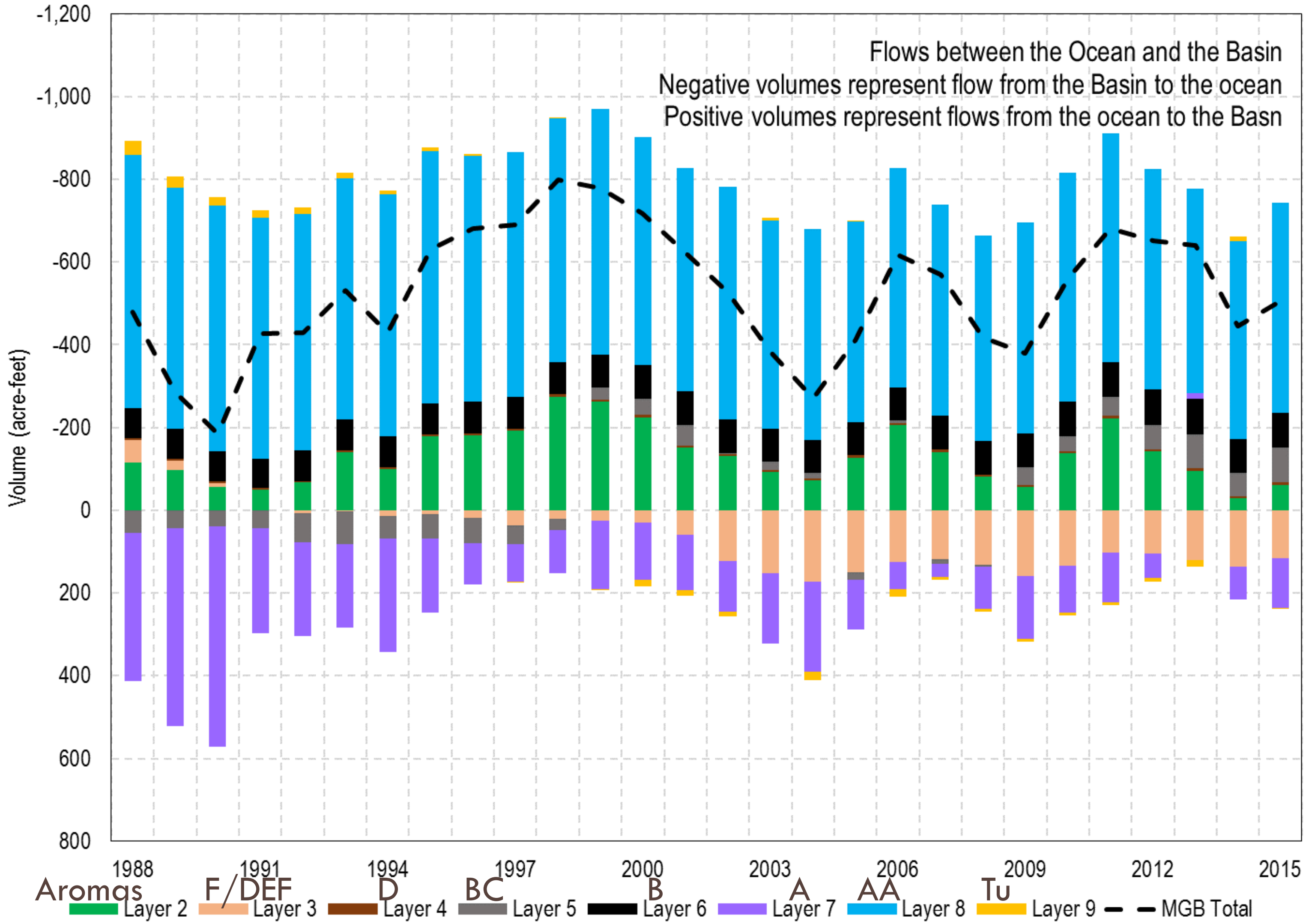
Water Budget South of Aptos Fault

- Recharge through stream alluvium and terrace deposits are an important component of recharge
- UZF recharge contributes less, but still important
- Most outflow is from pumping
- There is a net outflow to the ocean

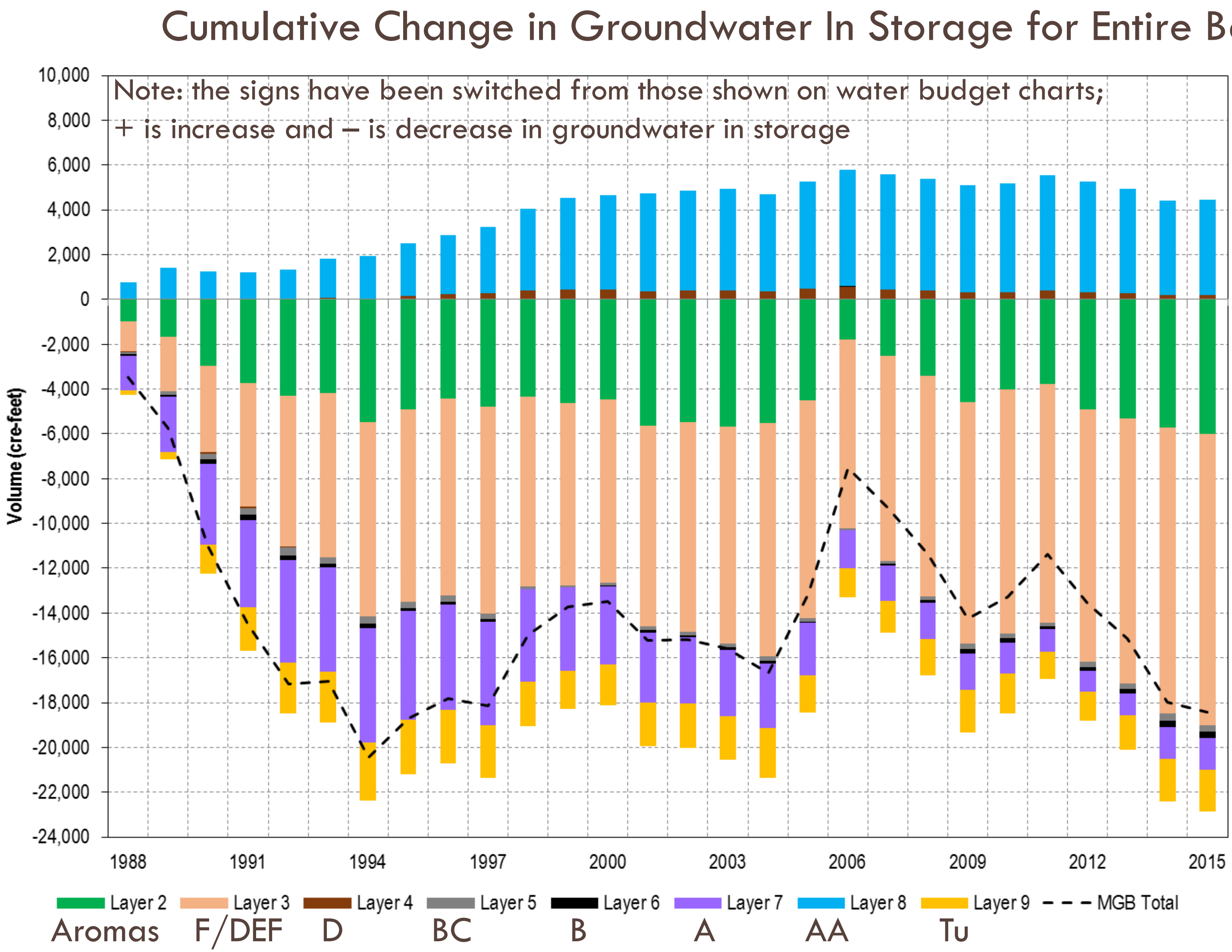


Rainfall Recharge + Return flows

Offshore Outflows

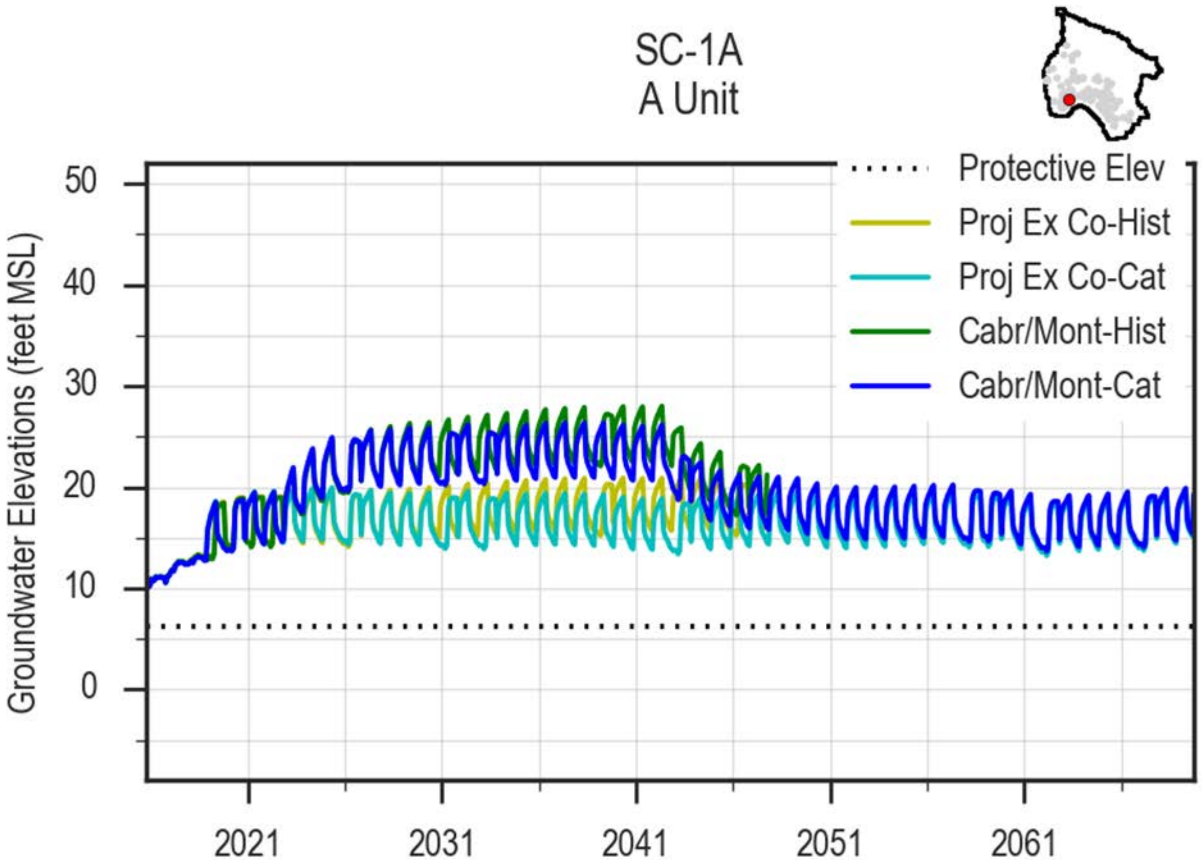


Change in Groundwater in Storage



(note: the data on this chart has been corrected from what was presented at the meeting)

Groundwater Levels



Projected Existing Conditions – Historic Climate

Projected Existing Conditions – Catalog Climate

ASR wells – Historic Climate

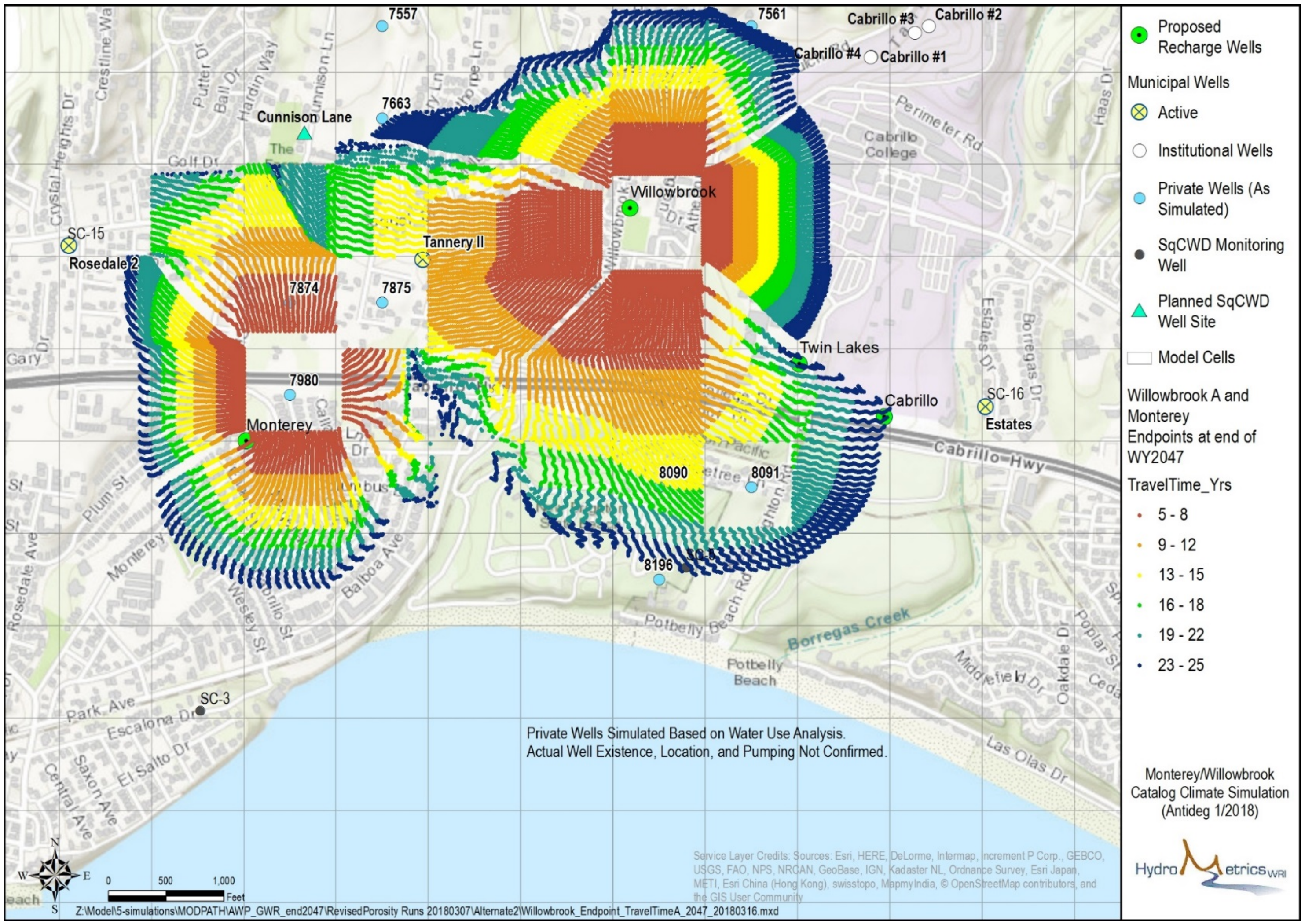
ASR wells – Catalog Climate

- Compare against Minimum Thresholds
- Determine if Undesirable Results are caused

Sustainability Indicators Relying on Groundwater Levels

Sustainability Indictors	Groundwater Level Minimum Threshold or Proxy	Non-Groundwater Level Minimum Threshold	Significant & Unreasonable Conditions Currently Exist
Seawater Intrusion	Proxy Seawater Intrusion		✓
Surface Water Depletion	Proxy Surface Water Depletion		?
Lowering GW Levels	Lowering GW Levels		✗
Reduction of Storage	Proxy Reduction of Storage		✗
Degraded Quality		Degraded Quality	✗
Land Subsidence	Proxy Land Subsidence	Land Subsidence	✗

Groundwater Flow Directions
Example of Particle Tracking



Questions?

What other questions would you like answered by the model?

Public Comment

Confirm

June 27, 2018
GSP Advisory Committee Meeting
and
July 19, 2018 Joint MGA/Advisory Committee Meeting
Summaries

Review Request

1. **Proposed Draft Sustainable Management Criteria for Subsidence**

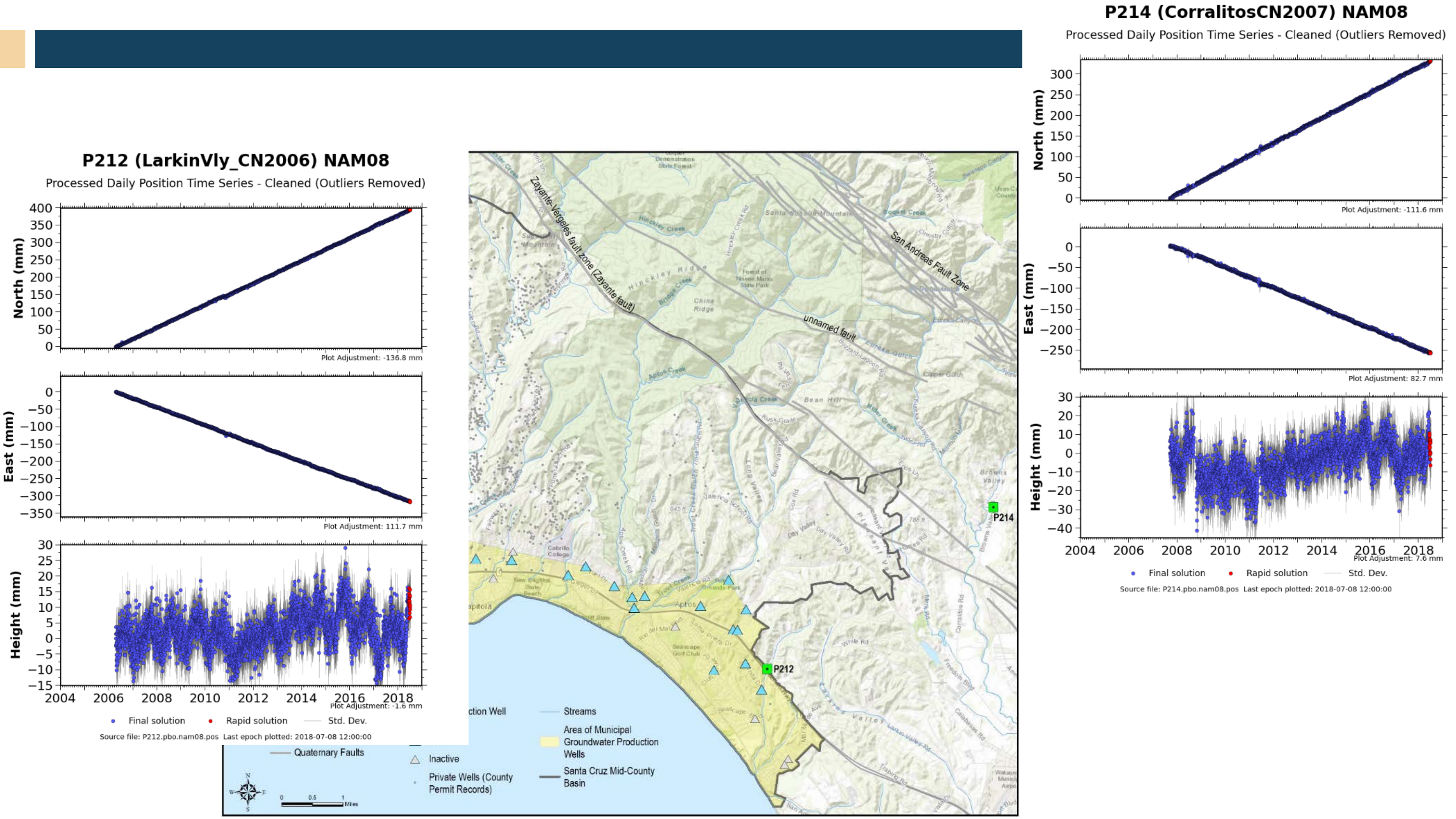
and

2. **Proposed Draft Sustainable Management Criteria for Groundwater Quality**

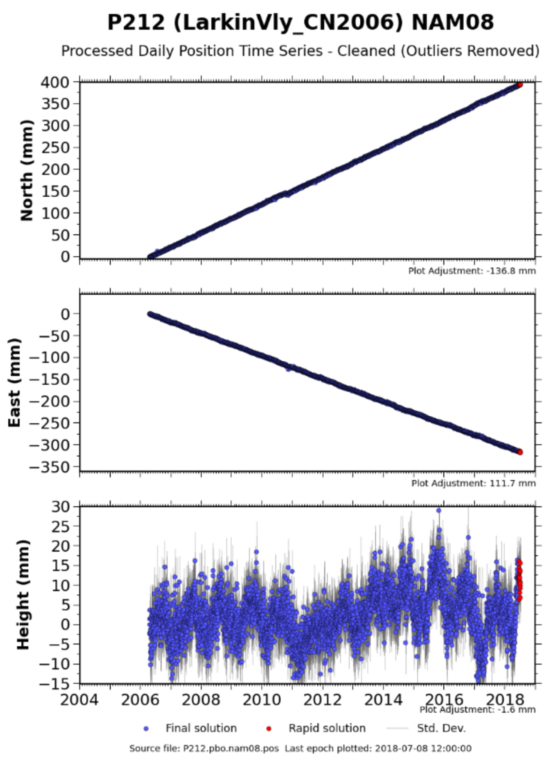
Proposed Subsidence Approach

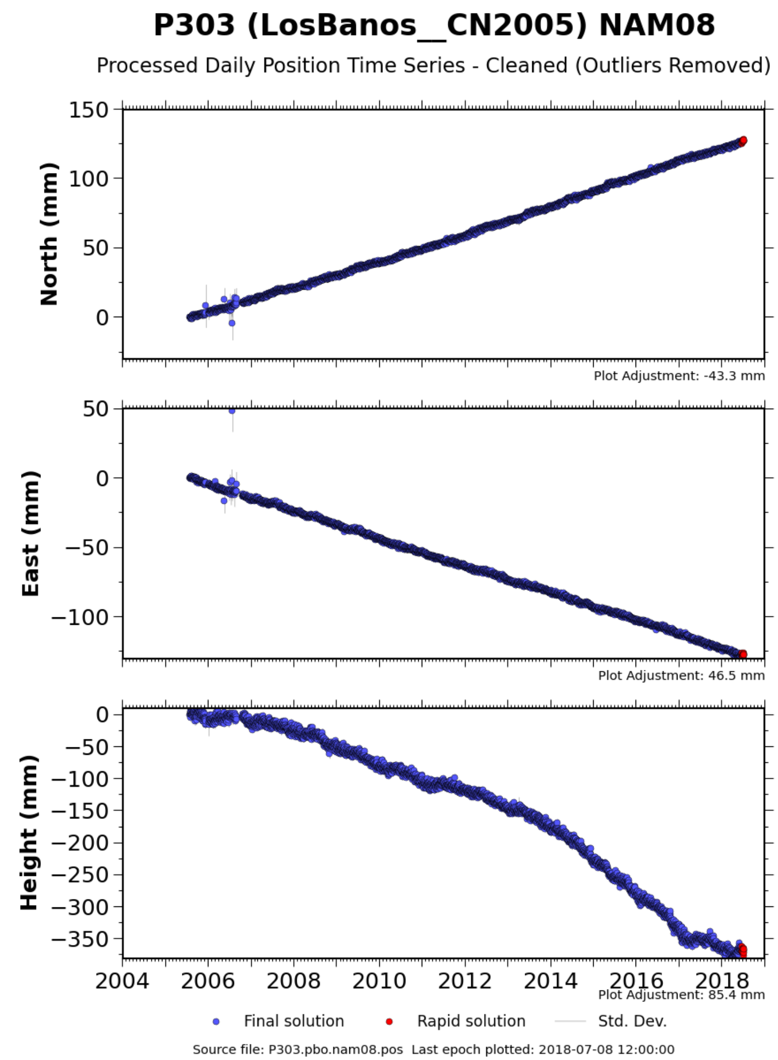
- Section C: Evidence for the Inapplicability of the Subsidence Sustainability Indicator in the Santa Cruz Mid-County Basin
  - No Historical Reports of Subsidence due to Lowered Groundwater Levels
  - Basin Geology is Not Susceptible to Subsidence
  - Subsidence Monitoring near the Santa Cruz Mid-County Basin Shows No Evidence of Subsidence

Continuous GPS Monitoring



What Subsidence Looks Like





If Subsidence is Observed

- MGA to:
  - Immediately regulate groundwater pumping in the area of land subsidence
  - Establish dedicated subsidence monitoring
  - Write an amendment to the GSP that includes development of Sustainable Management Criteria for the land subsidence sustainability indicator

Recap and Next Steps

GSP Project Timeline – Phase 2b

Santa Cruz Mid-County Groundwater Basin Groundwater Sustainability Plan Process Overview — Phase 2b: July–December 2018

2018 — PHASE 2: GSP ADVISORY COMMITTEE POLICY DEVELOPMENT

7/18 | 8/18 | 9/18 | 10/18 | 11/18 | 12/18

Phase 2b. July – December 2018: Projects, Management Actions and Groundwater Modeling

July 19, 2018 *(Joint Advisory Committee/MGA Board Meeting)*

- Discuss projects and management actions and how they relate to GSP.

August 2018

- Describe groundwater model and what goes into the model, including discussion of assumptions for historic and predictive simulations.
- Discuss groundwater modeling results for sample projects and management actions; evaluate project impacts against Minimum Thresholds.

September 2018

- Articulate Problem Statement.
- Identify, confirm and prioritize project evaluation criteria (to be presented in October).
- Discuss cumulative projects to model.

October 2018

- Present groundwater modeling results for cumulative projects; evaluate modeling results against Minimum Thresholds and other evaluation criteria.
- Discuss Minimum Threshold and Undesirable Result options with underlying Significant and Unreasonable Conditions for Groundwater Storage.
- Begin discussing Measurable Objectives and Interim Milestones.

November 15, 2018 *(Joint Advisory Committee/MGA Board Meeting)*

- Discuss elements of possible fee structures.
- Discuss management areas.

December 2018 *(date early in month TBD)*

- Discuss next iteration of groundwater modeling results.
- Confirm projects and management actions, and Measurable Objectives for analysis (e.g., cost allocation, legal issues) in 2019.

7/18 | 8/18 | 9/18 | 10/18 | 11/18 | 12/18

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Next Steps: Meetings 11, 12, Late Fall 2018

- **September 26 Meeting (#11)**
  - Articulate Problem Statement
  - Identify, confirm and prioritize project evaluation criteria (to be presented in October)
  - Discuss cumulative projects to model
- **October 24 Meeting (#12)**
  - Groundwater modeling results for cumulative projects; evaluate results against Minimum Thresholds and other criteria
  - Minimum Thresholds and Undesirable Result options/Significant and Unreasonable Conditions for Groundwater Storage
  - Measurable Objectives and Interim Milestones

November 15 and December 12: confirmed dates for Meetings #13 &14

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THANK YOU!

FOR ANY QUESTIONS, PLEASE CONTACT:
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