

# Ojai Basin Groundwater Model Development

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# *Acknowledgements*

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- ◆ Ojai Basin Groundwater Management Agency - Project Grantee and Overseeing Agency
- ◆ Jordan Kear (Kear Groundwater) - Grant proposal author, original project manager, and consulting hydrogeologist
- ◆ Golden State Water Company - Provided a critical peer review of a 90% completion draft of the model documentation report
- ◆ Ventura County Watershed Protection District - Provided database of groundwater monitoring data, and information regarding San Antonio Creek Spreading Grounds Rehabilitation Project (SACSGRP)



# *Ojai Groundwater Model: Project Background*

- ◆ The project objective is to develop a groundwater model to support the evaluation of:
  - ◆ Alternative basin management scenarios
  - ◆ Hydrogeologic factors, including basin storage, effects of pumping, recharge, and discharge components of the system
  - ◆ Newly proposed pumping wells
  - ◆ Proposed conservation measures



# *Ojai Groundwater Model: Project Background*

- ◆ Question: What is a “Groundwater Model”?
  - ◆ Answer: A computer model of a groundwater flow system, used by groundwater scientists to simulate and predict aquifer conditions. For this project, the computer model used is called MODFLOW-SURFACT.
- ◆ Question: How is a Groundwater Model Useful?
  - ◆ Answer: Groundwater models are used to
    - ◆ Organize all available information on factors that influence groundwater levels throughout a Basin
    - ◆ Estimate what factors most influence groundwater levels
    - ◆ Predict, based on the best available science, how groundwater levels respond to different scenarios

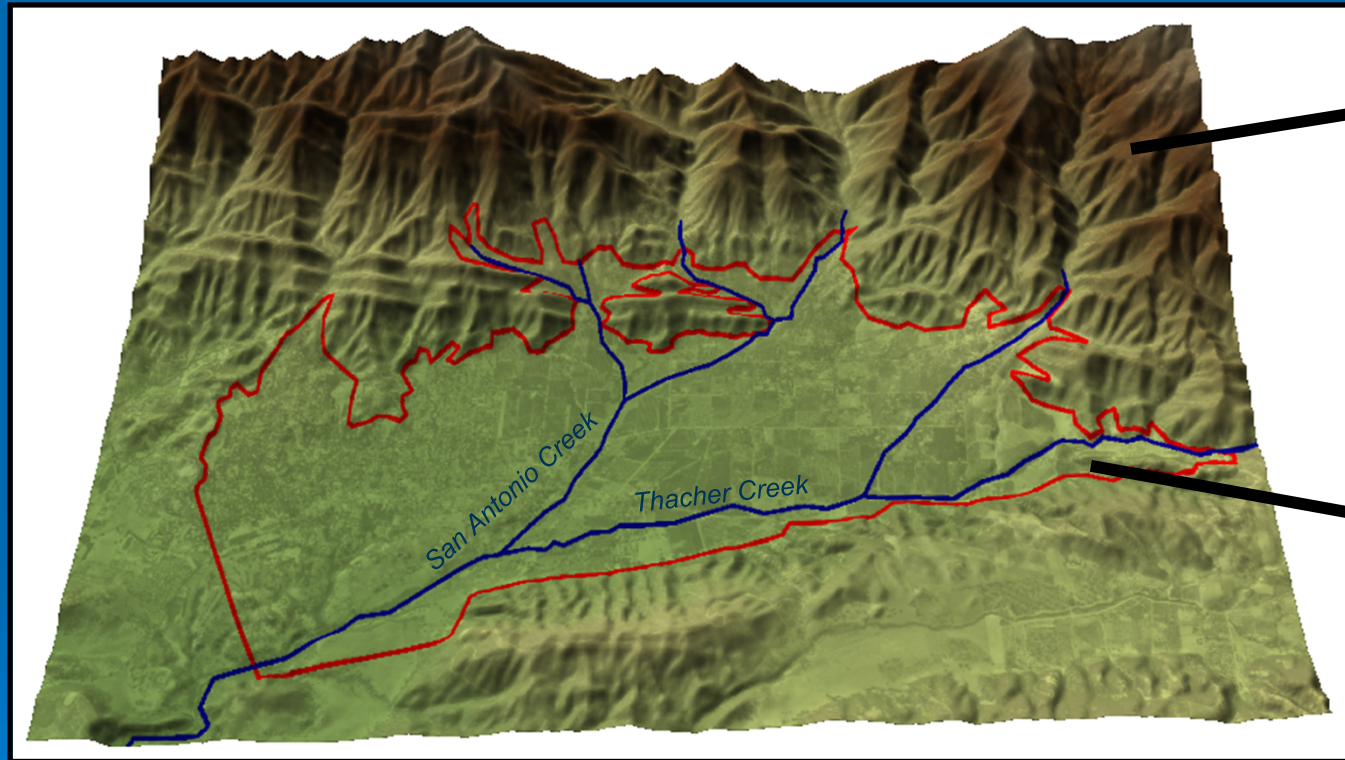


# *Ojai Groundwater Model: Project Approach*

- 1.) Data Collection and Reduction
- 2.) Develop Hydrogeologic Conceptual Model
- 3.) Translate into Numerical Groundwater Flow Computer Model
- 4.) Model Calibration
- 5.) Predictive Simulations
- 6.) Quality Assurance/Review
- 7.) Documentation



# *Ojai Groundwater Model: Basin Hydrogeology*

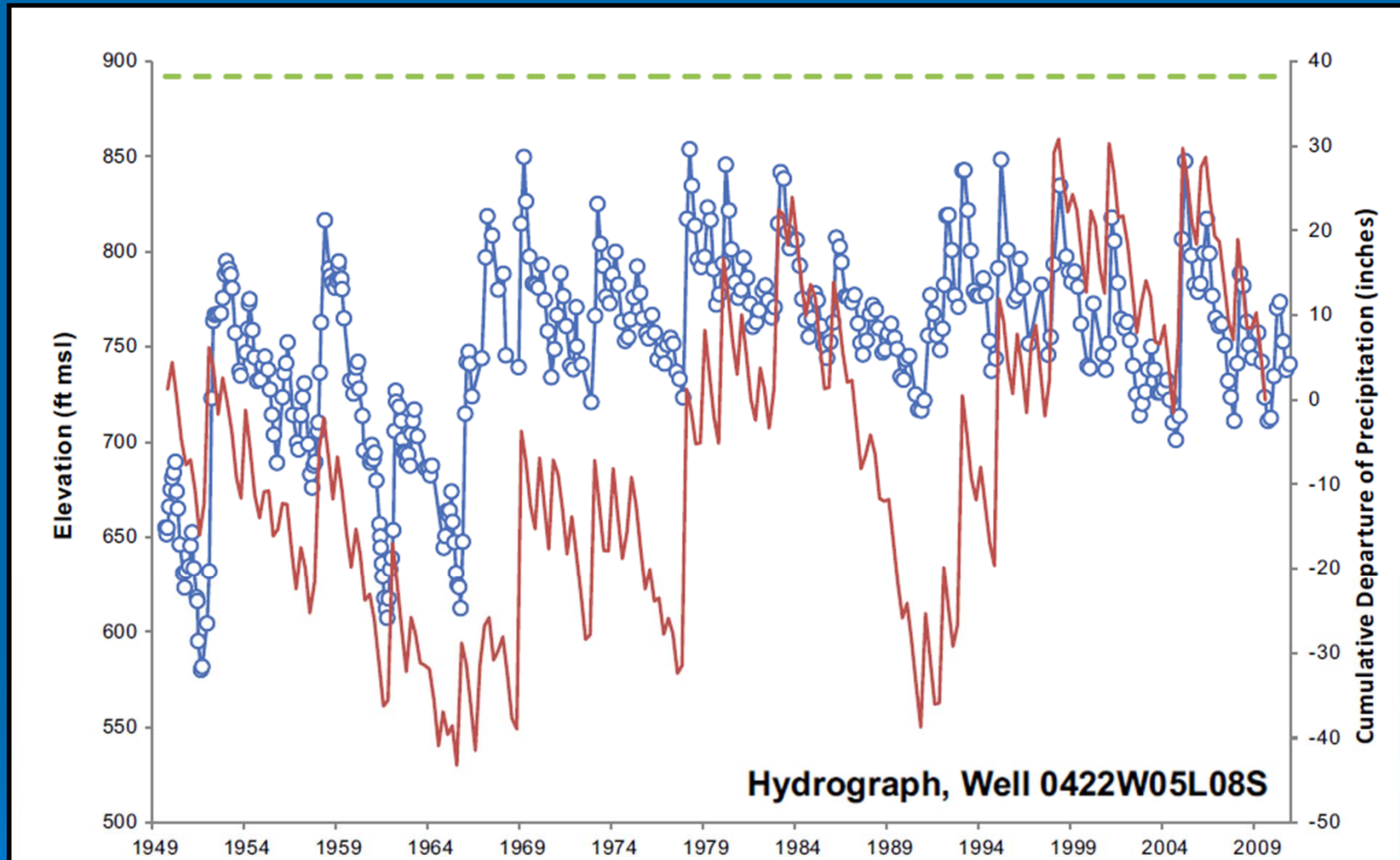


Bedrock

Alluvium



# Ojai Groundwater Model: Basin Hydrogeology



## Explanation

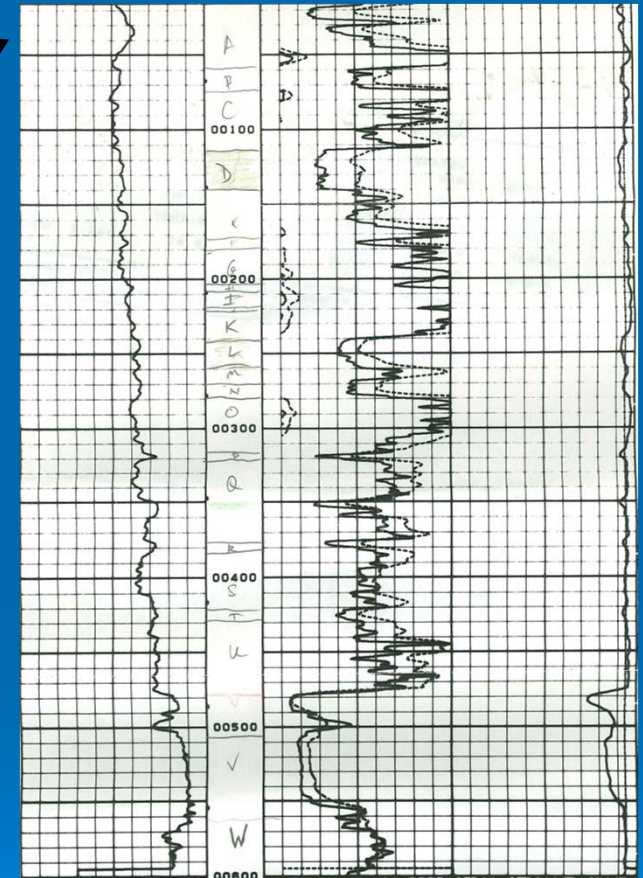
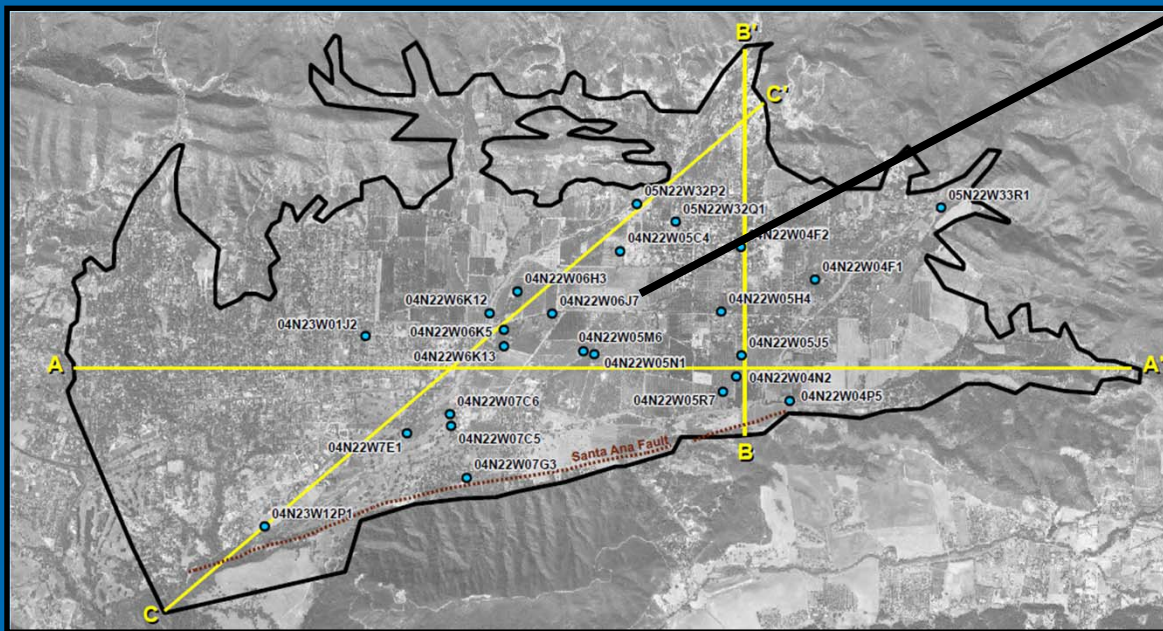
- Groundwater elevation
- Top of casing
- Precipitation cumulative departure curve



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# Ojai Groundwater Model: Basin Stratigraphy

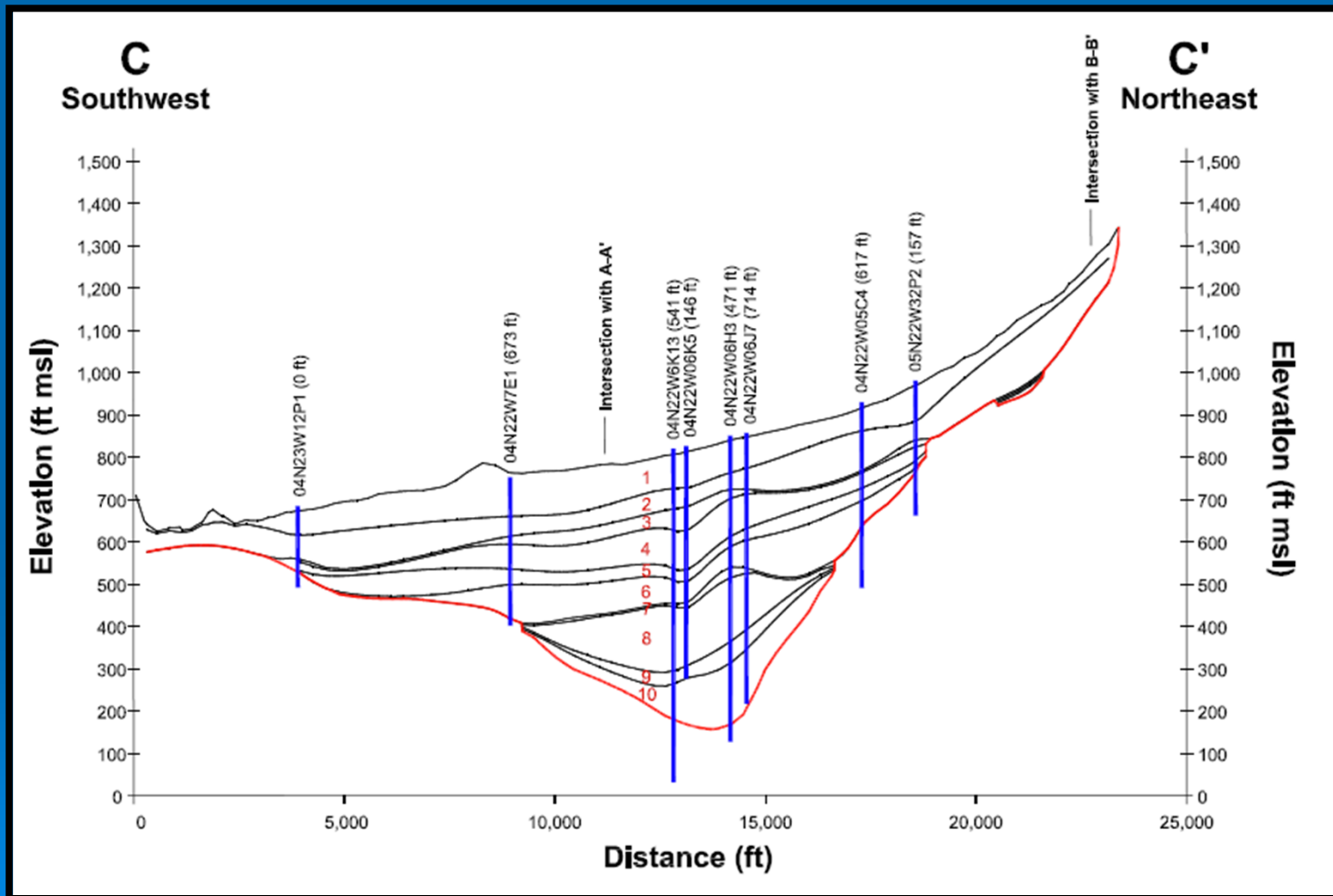


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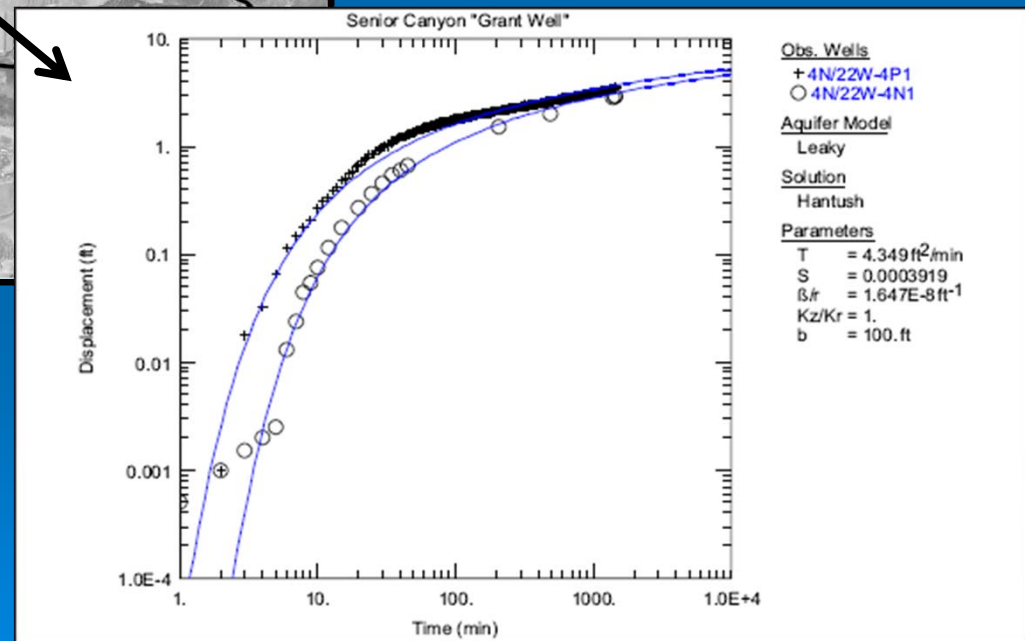
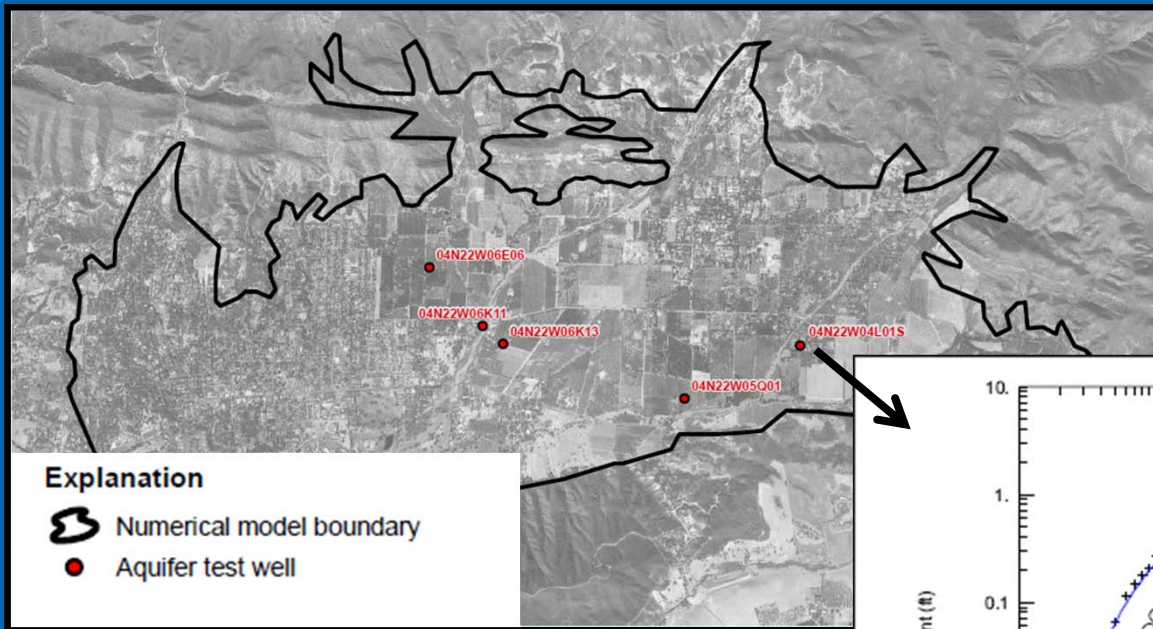




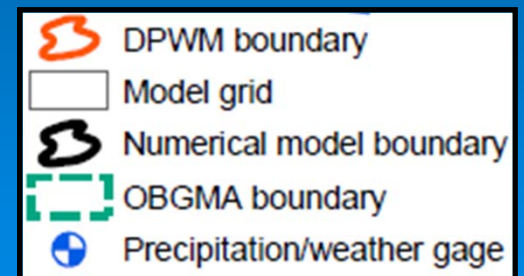
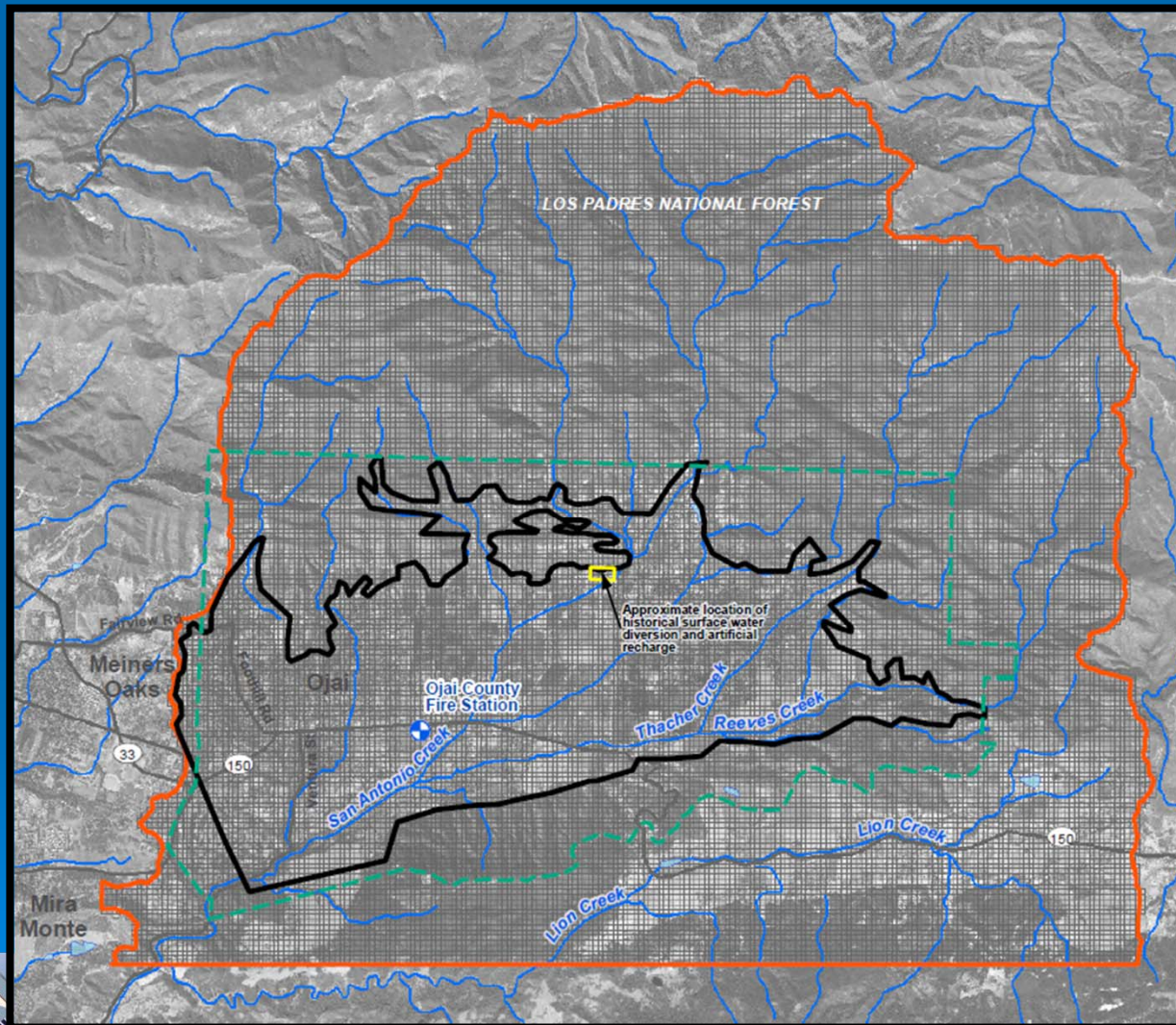
# Ojai Groundwater Model: Model Layering



# Ojai Groundwater Model: Aquifer Properties



# Ojai Groundwater Model: Model Extent and Grid



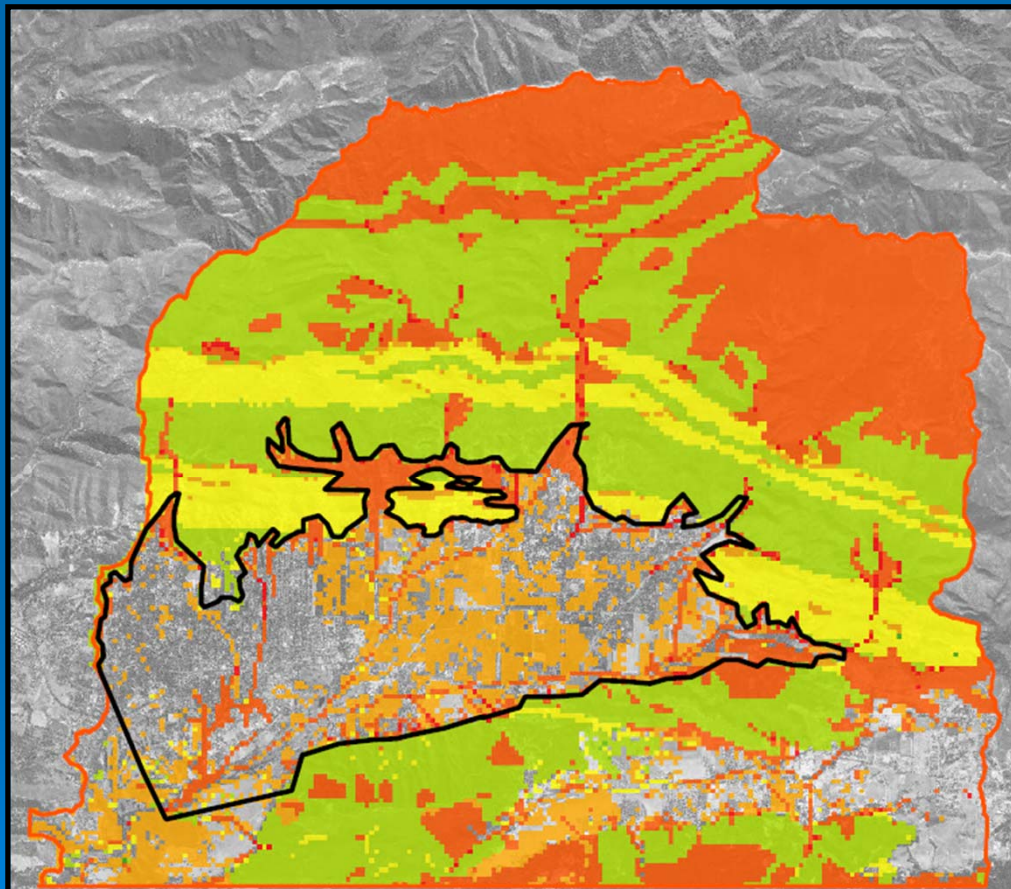


# *Ojai Groundwater Model: Model Boundary Conditions*

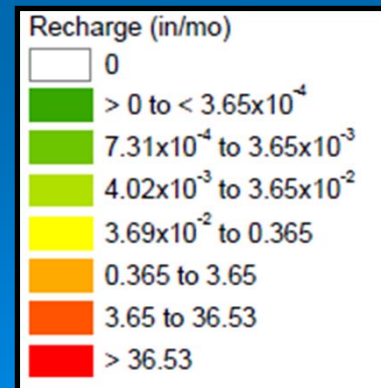
- ◆ Recharge from Precipitation
- ◆ Recharge from Irrigation
- ◆ Recharge from Septic Systems, Spreading Grounds
- ◆ Riparian Evapotranspiration
- ◆ Discharge to Stream Channels
- ◆ Bedrock/Alluvial groundwater exchange
- ◆ Groundwater Extraction
- ◆ Downgradient flow



# *Ojai Groundwater Model: Recharge from Precipitation (Distributed Parameter Watershed Model)*

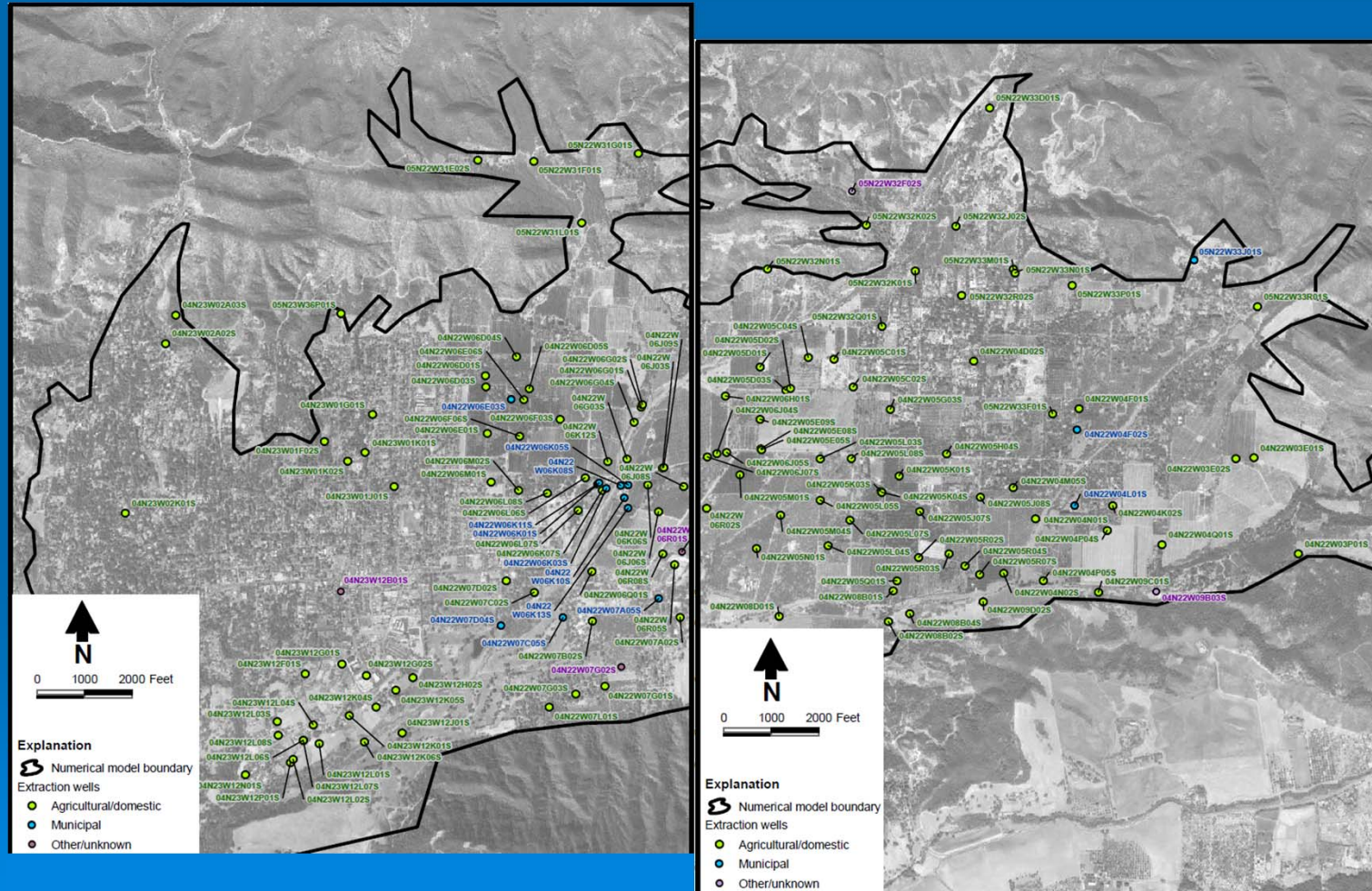


Estimated Recharge from Precipitation, Water Year 1992, Quarter 2

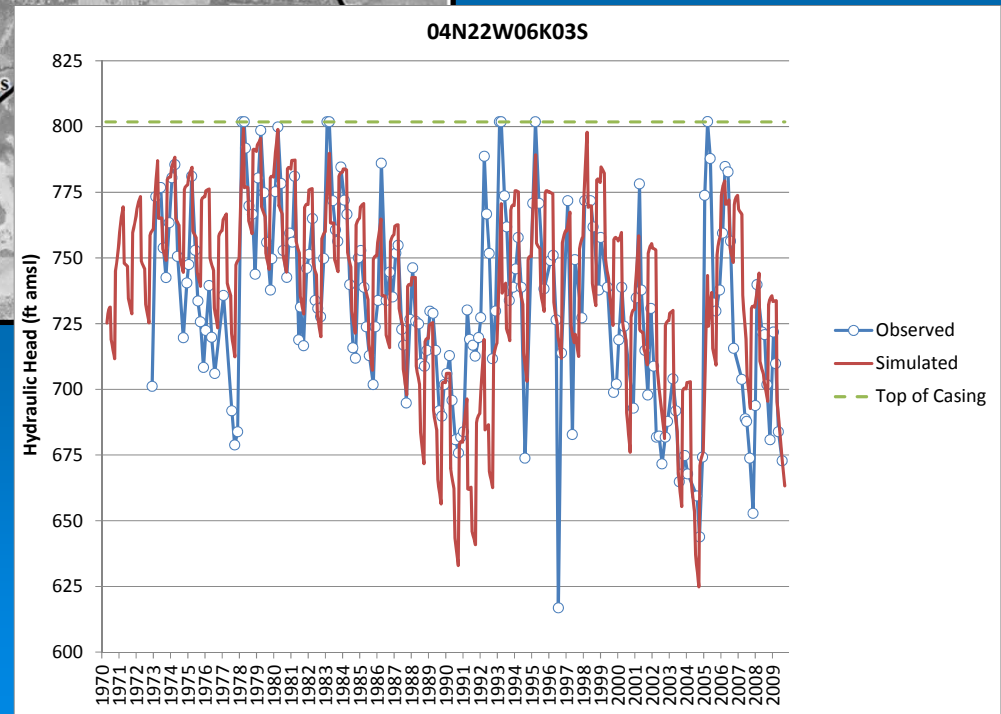
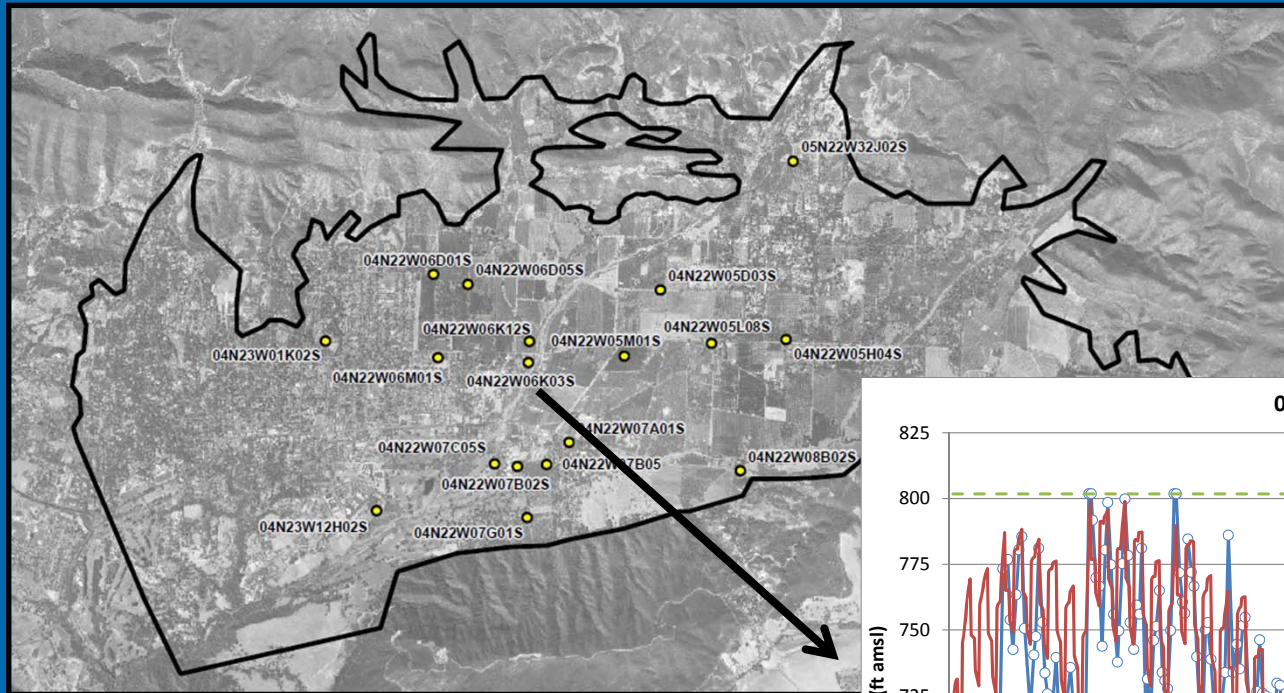




# Ojai Groundwater Model: Groundwater Extraction

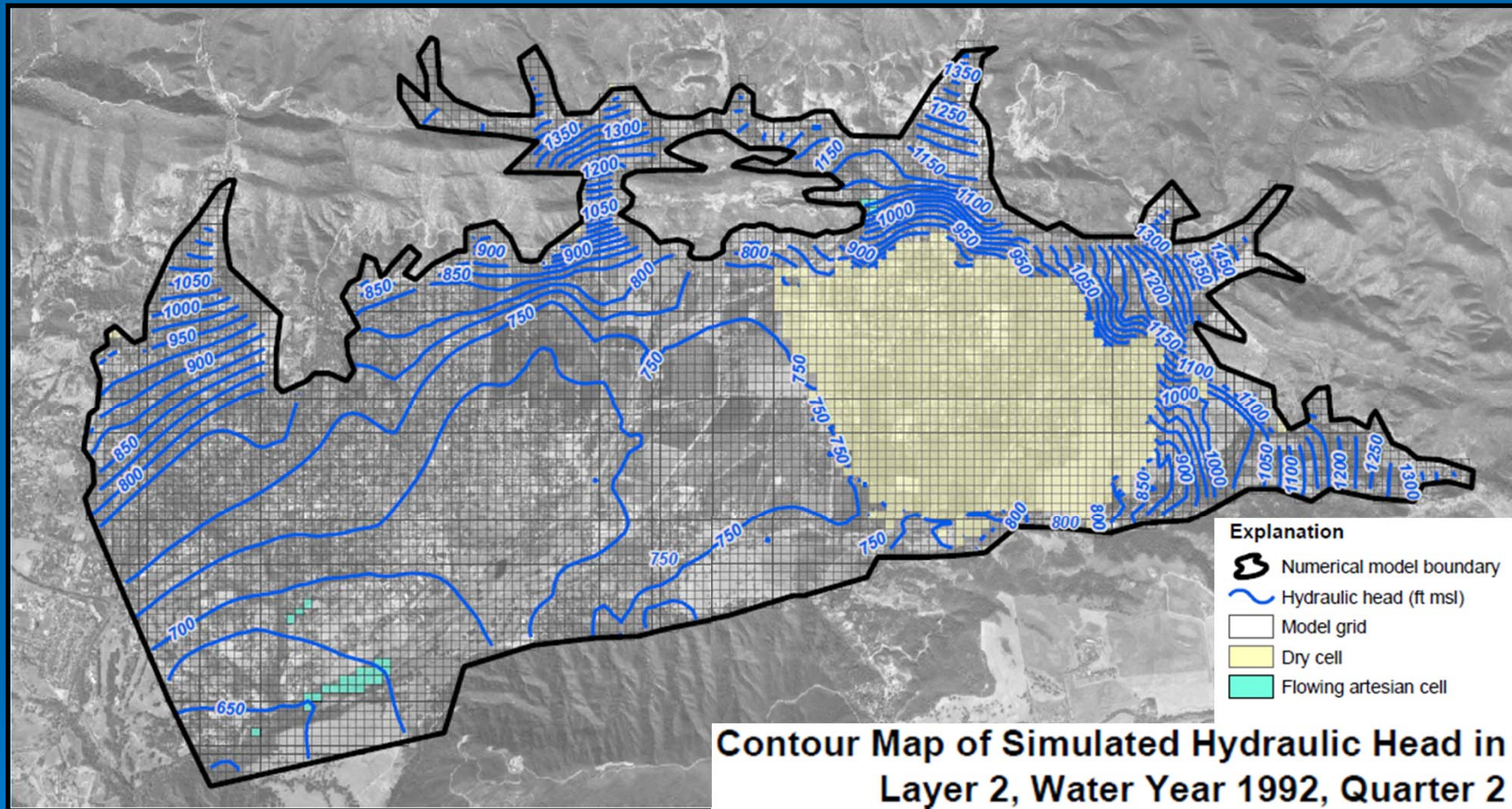


# Ojai Groundwater Model: Calibration (1970-2009)





# Ojai Groundwater Model: Results



# Ojai Groundwater Model: Model Mass Balance

	Average ac-ft/yr	Percent of Total
<b>Groundwater Inputs</b>		
Recharge from precipitation, irrigation, septic systems, spreading grounds	6,780	100%
<b>Groundwater Outputs</b>		
Groundwater pumping (wells)	4,147	61%
Discharge to streams	2,282	34%
Evapotranspiration	258	4%
Outflow to bedrock and downgradient alluvium	129	2%
<b>Total Outflow</b>	<b>6,816</b>	
<b>Change in Storage</b>		
Water released from storage	4,400	
Water entered into storage	4,371	
<b>Net change in storage</b>	<b>-30</b>	
<b>Model Error</b>		
Model Error		0.02%



# *Ojai Groundwater Model: Safe Yield Analysis*

“Safe yield is the amount of naturally occurring groundwater that can be withdrawn from an aquifer on a sustained basis, economically and legally, without impairing the native groundwater quality or creating an undesirable effect such as environmental change” - Fetter, 2001

- ◆ Average Recharge<sup>1</sup>: 6,615 ac-ft/yr
- ◆ Median Recharge<sup>1</sup>: 5,026 ac-ft/yr
  
- ◆ Average Extraction<sup>2</sup> (1996 - 2009): 4,939 ac-ft/yr

## NOTES:

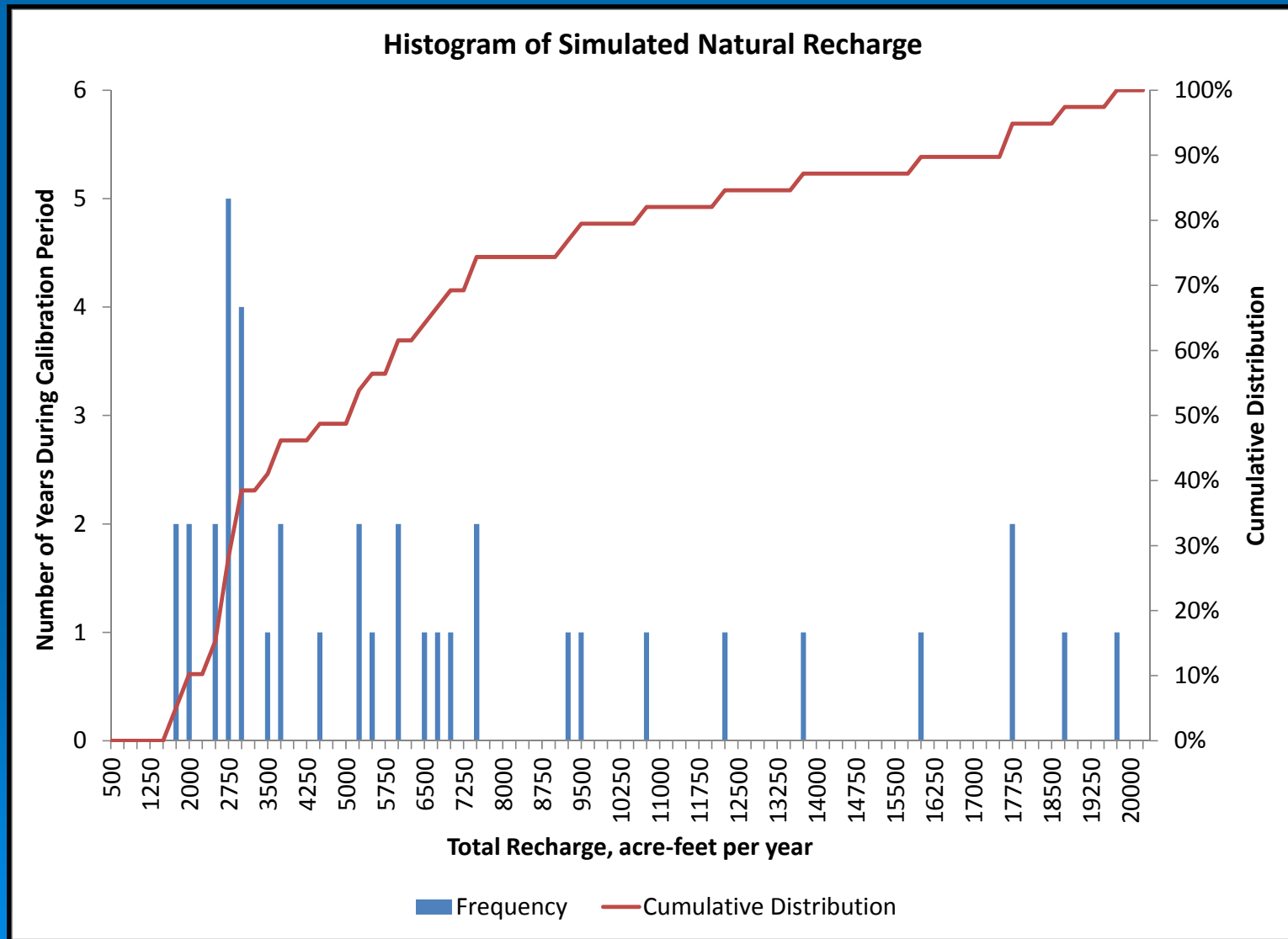
(1) Total recharge (precipitation, irrigation, septic systems) minus historical artificial recharge in San Antonio Creek Spreading Grounds

(2) Only for those wells screened within Basin Alluvium

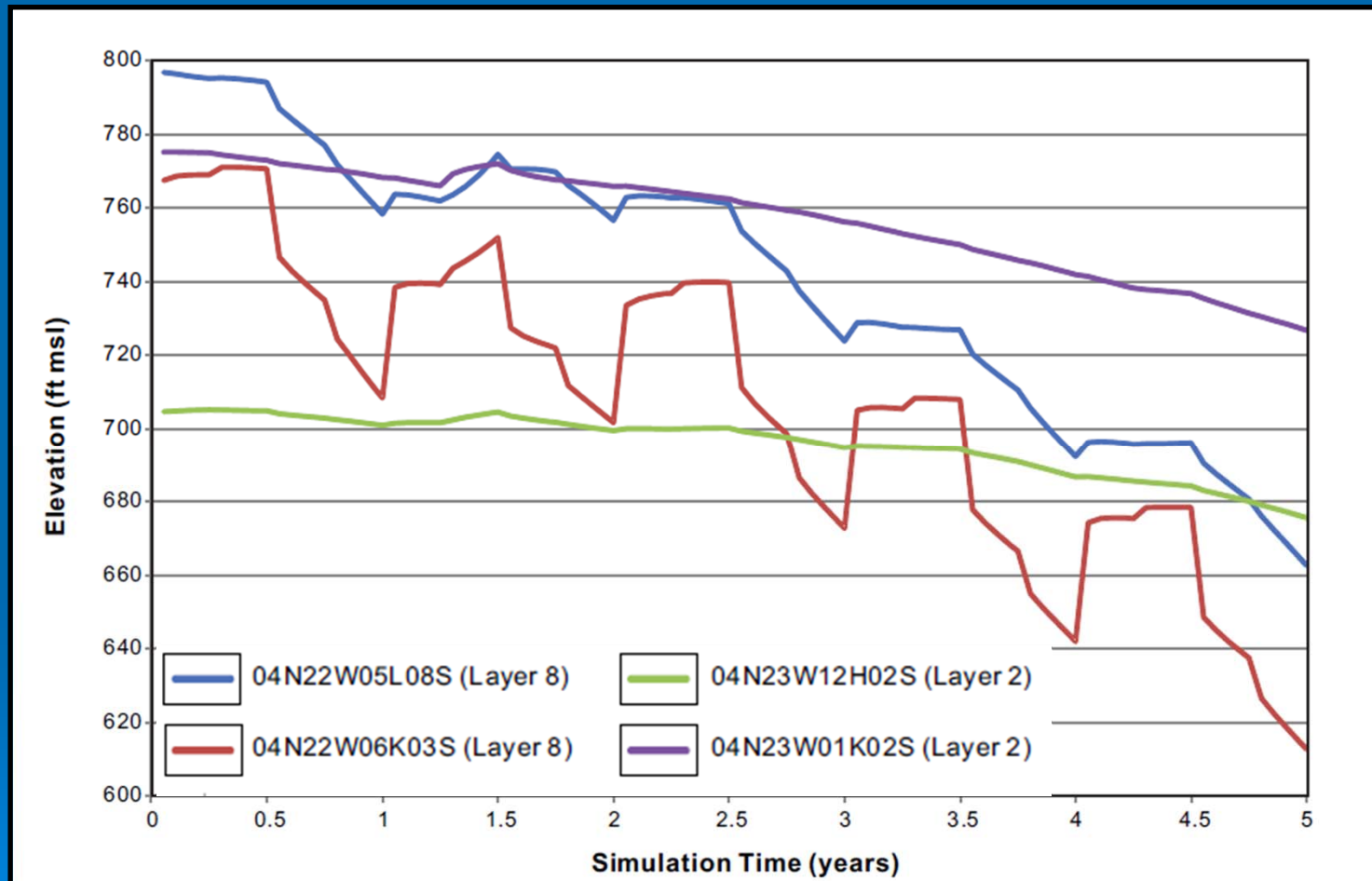




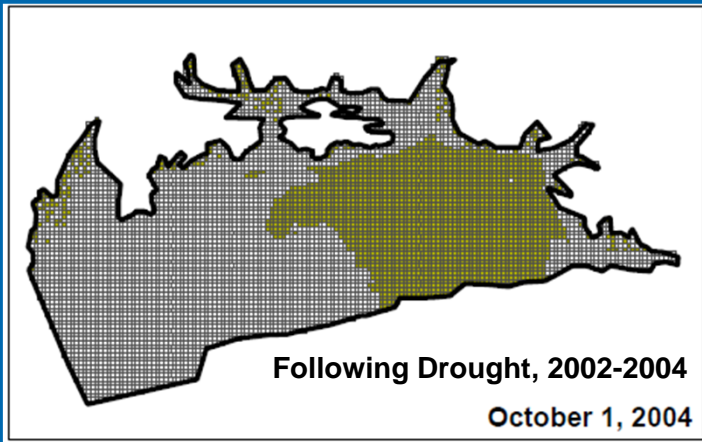
# Ojai Groundwater Model: Safe Yield Analysis



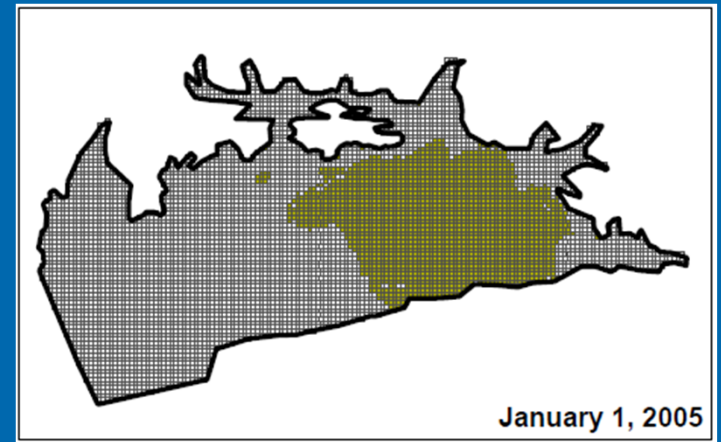
# *Ojai Groundwater Model: Effect of Long-Term Drought*



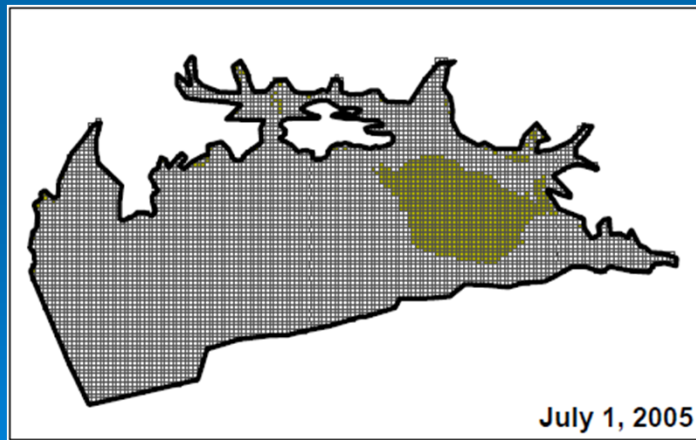
# *Ojai Groundwater Model: Basin Resaturation after Drought (Layer 2)*



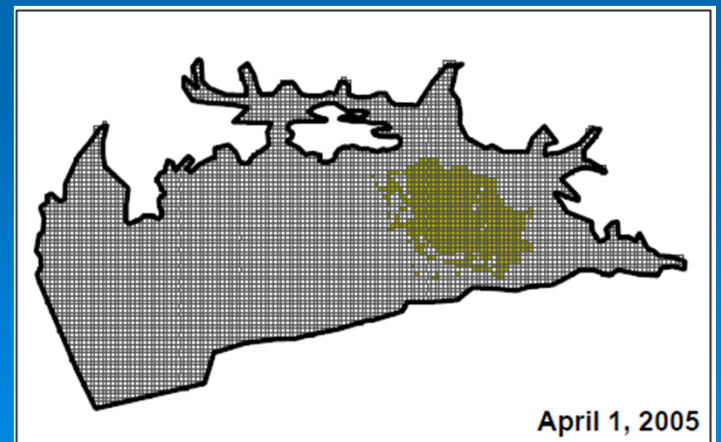
Wet Quarter  
(14 in. rainfall)



Very Wet Quarter  
(28 in. rainfall)



Dry Quarter  
(1.6 in. rainfall)



# *Ojai Groundwater Model: Basin Response to Proposed SACSGRP*

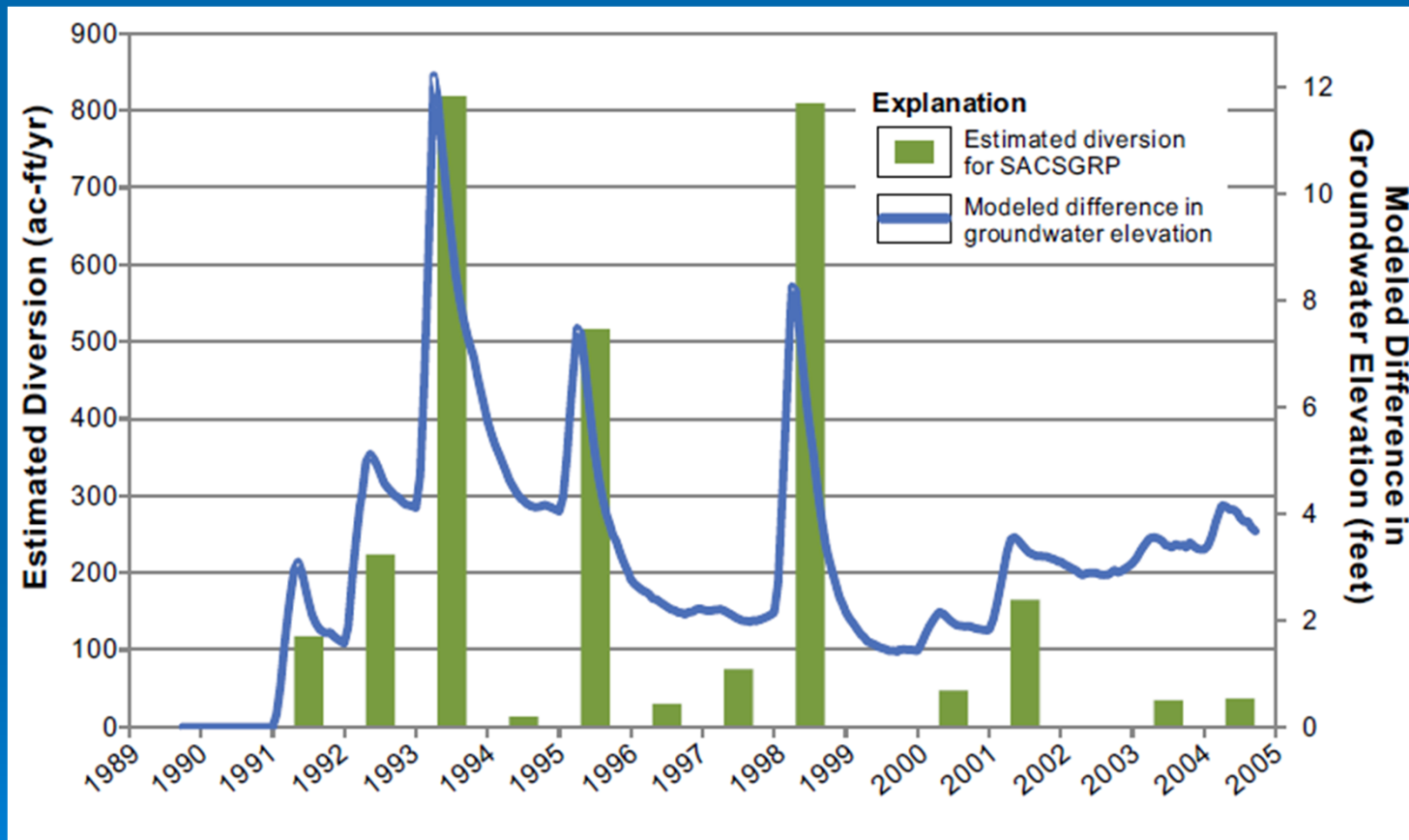
## APPROACH

- ◆ Amount of water that may be diverted is limited by regulatory requirements for a minimum of 1-foot of stream depth at the “point of compliance”
- ◆ DBS&A has previously estimated the allowed diversion based on historical stream flow data in the 100% design submittal to Ventura County Watershed Protection District.
- ◆ A simulation with the addition of recharge at SACSGRP was conducted for water years 1989-2004. The estimated allowed diversion was tabulated for each three-month model “stress period” and applied to the model.
- ◆ Model simulations assumed that all diverted water was accepted by the spreading grounds and readily recharged to the aquifer



# *Ojai Groundwater Model: Basin Response to Proposed SACSGRP*

“Benefit” = Difference in Groundwater Elevation with Addition of SACSGRP Project

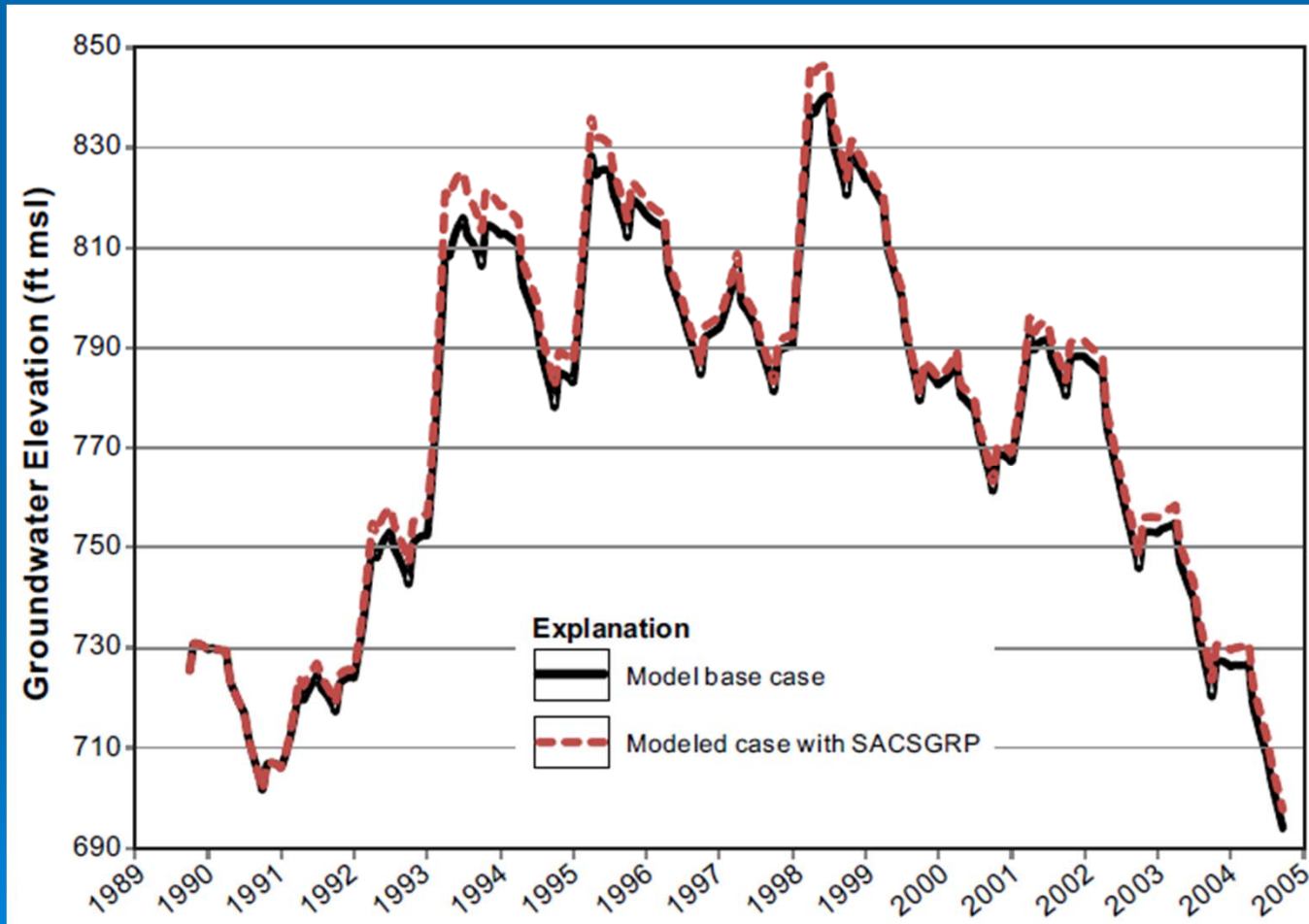


**Modeled Benefit of Proposed San Antonio Creek Spreading Grounds Rehabilitation Project (SACSGRP) at Well 04N22W05D03S**



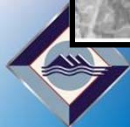
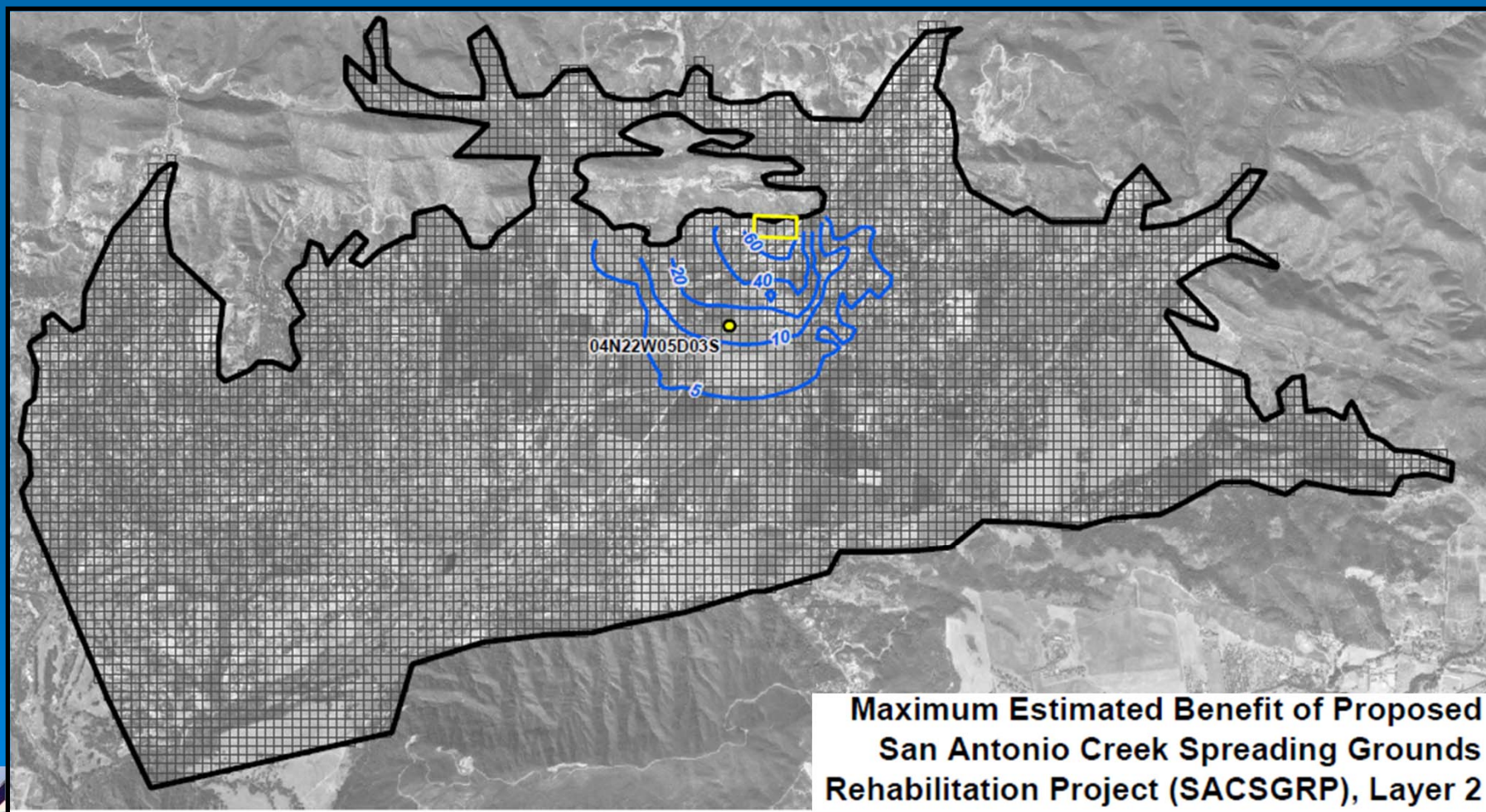


# *Ojai Groundwater Model: Basin Response to Proposed SACSGRP*



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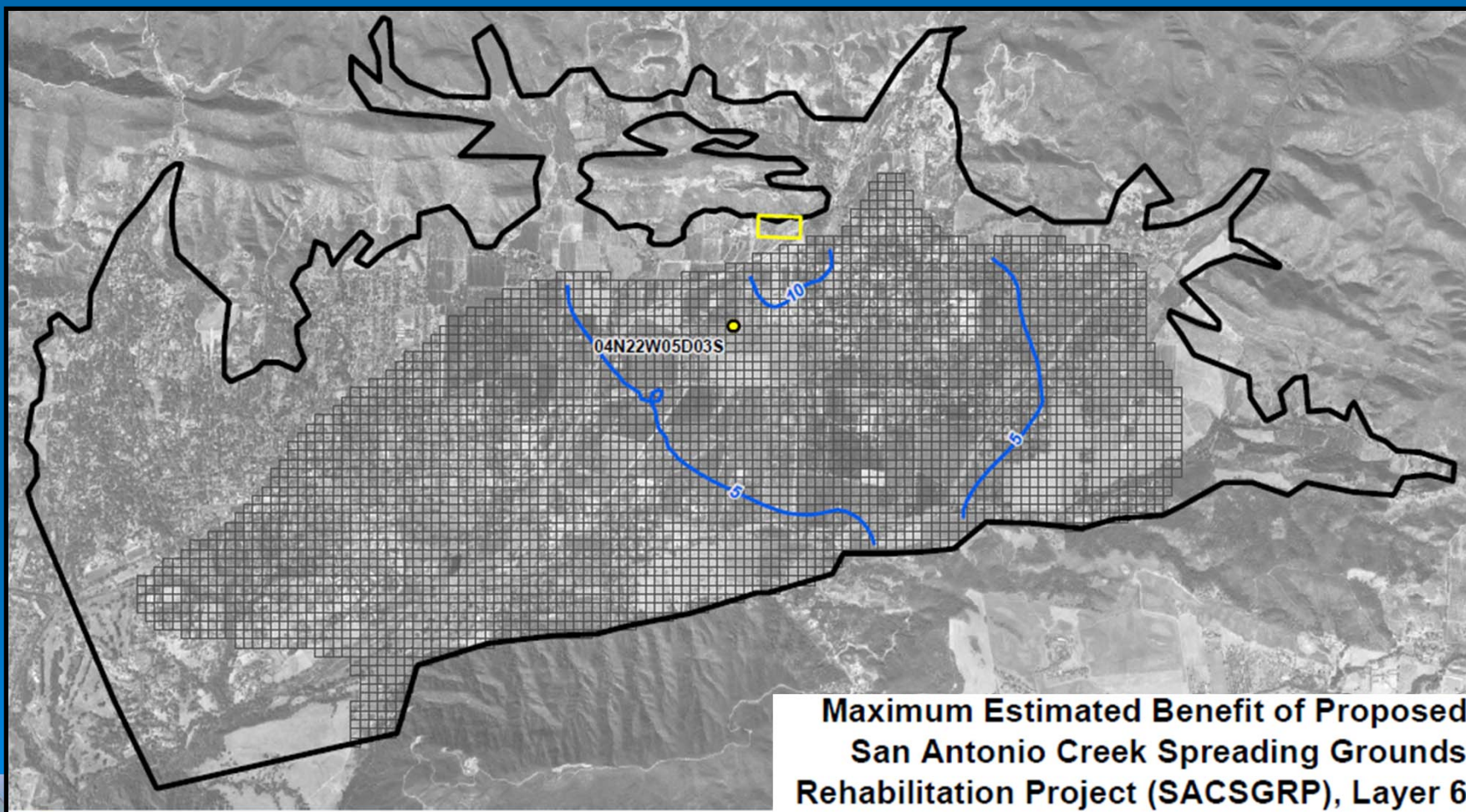
“Benefit” = Difference in Groundwater Elevation with Addition of SACSGRP Project





# *Ojai Groundwater Model: Basin Response to Proposed SACSGRP*

“Benefit” = Difference in Groundwater Elevation with Addition of SACSGRP Project



# *Ojai Groundwater Model: Additional Simulations*

- ◆ Basin Response to Extended Wet Period
- ◆ Basin Response to Increased Pumpage (120%, 144% of current levels)
- ◆ Analysis of discharge rates to San Antonio Creek
- ◆ Model sensitivity analyses



# *Ojai Groundwater Model: Summary/Conclusions*

- ◆ The Ojai Groundwater Model provides a state-of-the art technique for predicting groundwater levels in the Ojai Basin, and improves understanding of the Basin
- ◆ The primary groundwater input is recharge from precipitation; primary outputs are pumpage and discharge to creeks
- ◆ Current groundwater pumping levels are generally similar to 'safe yield' estimates, consistent with the observation of long-term stability in groundwater levels.
- ◆ In the case of a multi-year drought, current pumping levels will result in a significant decrease in groundwater levels in the basin

