UC WATER
Security and Sustainability Research Initiative

CONDITIONS FOR MAXIMIZING ON-FARM RECHARGE WITH FLOOD FLOWS

A CASE STUDY FOR THE SOUTH AMERICAN AND COSUMNES GROUNDWATER SUB-BASINS

R.M. Gailey, UC Davis

COLLABORATORS

- Erfan Goharian, UC Davis
- Stephen Maples, UC Davis
- Graham Fogg, UC Davis
- Jay Lund, UC Davis
- Josué Medellín-Azuara, UC Merced

PRESENTATION OUTLINE

- Summary of Recharge Operation Considerations
- Overview of Study Area
- Approach for Planning-Level Analysis
- Some Results
- Initial Conclusions

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RECHARGE OPERATION CONSIDERATIONS

- Source Water Options
  - Storm water runoff
  - Recycled water
  - Storm flows from streams
  - Reoperation of reservoirs on rivers
- Water Placement Options
  - Construct dedicated facilities (basins, dry wells)
  - Repurpose existing facilities (gravel pits)
  - Flow down disconnected or dry rivers and creeks
  - Crop lands

RECHARGE OPERATION CONSIDERATIONS

- Conveyance (routing, capacity, access)
- Recharge Site Infiltration Capacity
  - Soil/shallow geology
  - Deeper geology interconnectedness
- Storage Space (unsaturated zone thickness)
- Fate of Water Over Time
  - Local increased storage and use
  - Discharges to baseflow and flows across sub-basin boundaries

RECHARGE OPERATION CONSIDERATIONS

- Recharge Site Suitability
  - Location relative to conveyance and favorable hydrogeology
  - Timing of site availability relative to water available for recharge
  - Topography
    - Slope
    - Existing berms
  - Cost
    - Purchase
    - Rent
    - Options
    - Fees/rebates

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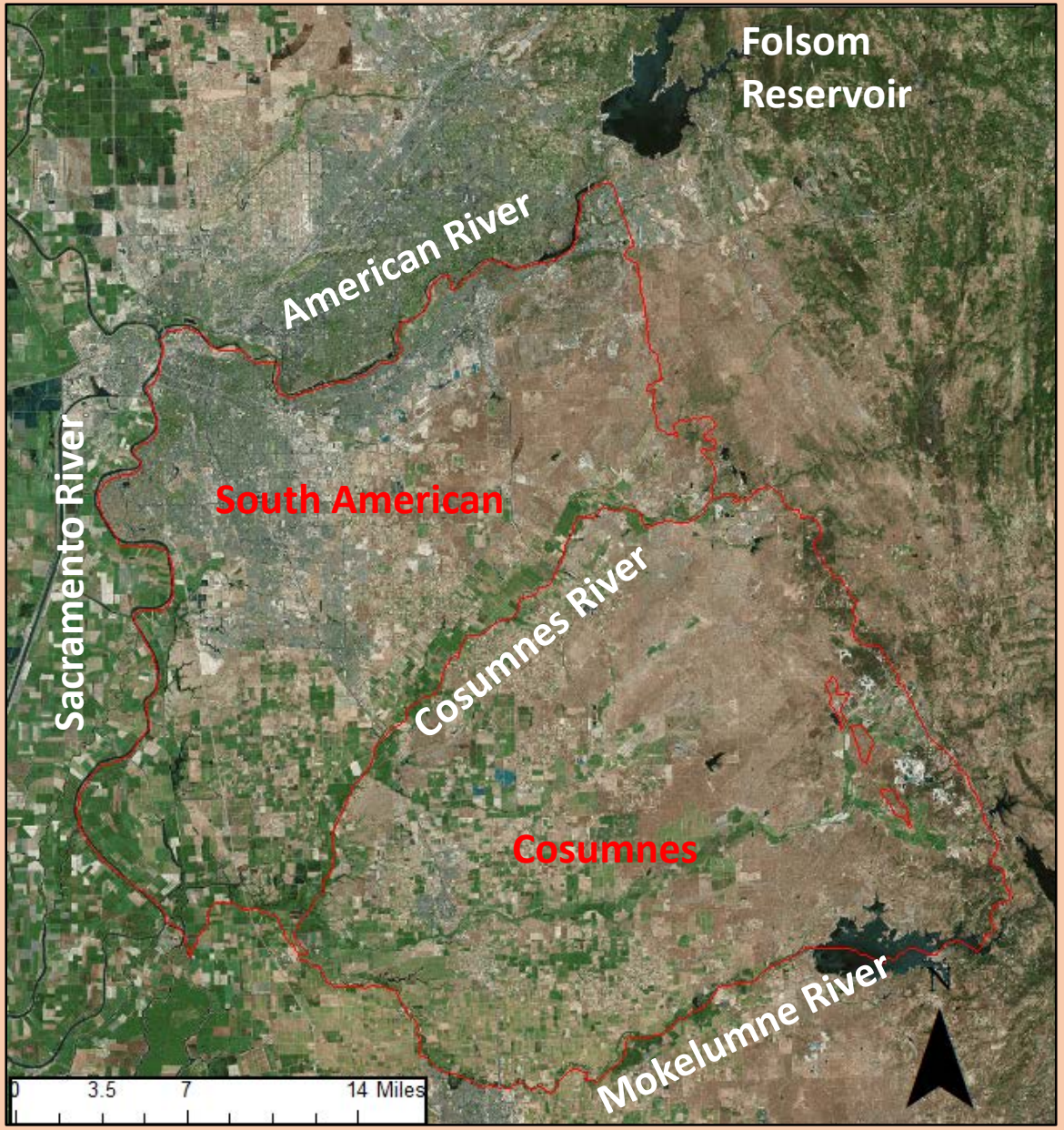
STUDY AREA

South American and Cosumnes Groundwater Sub-basins

STUDY AREA

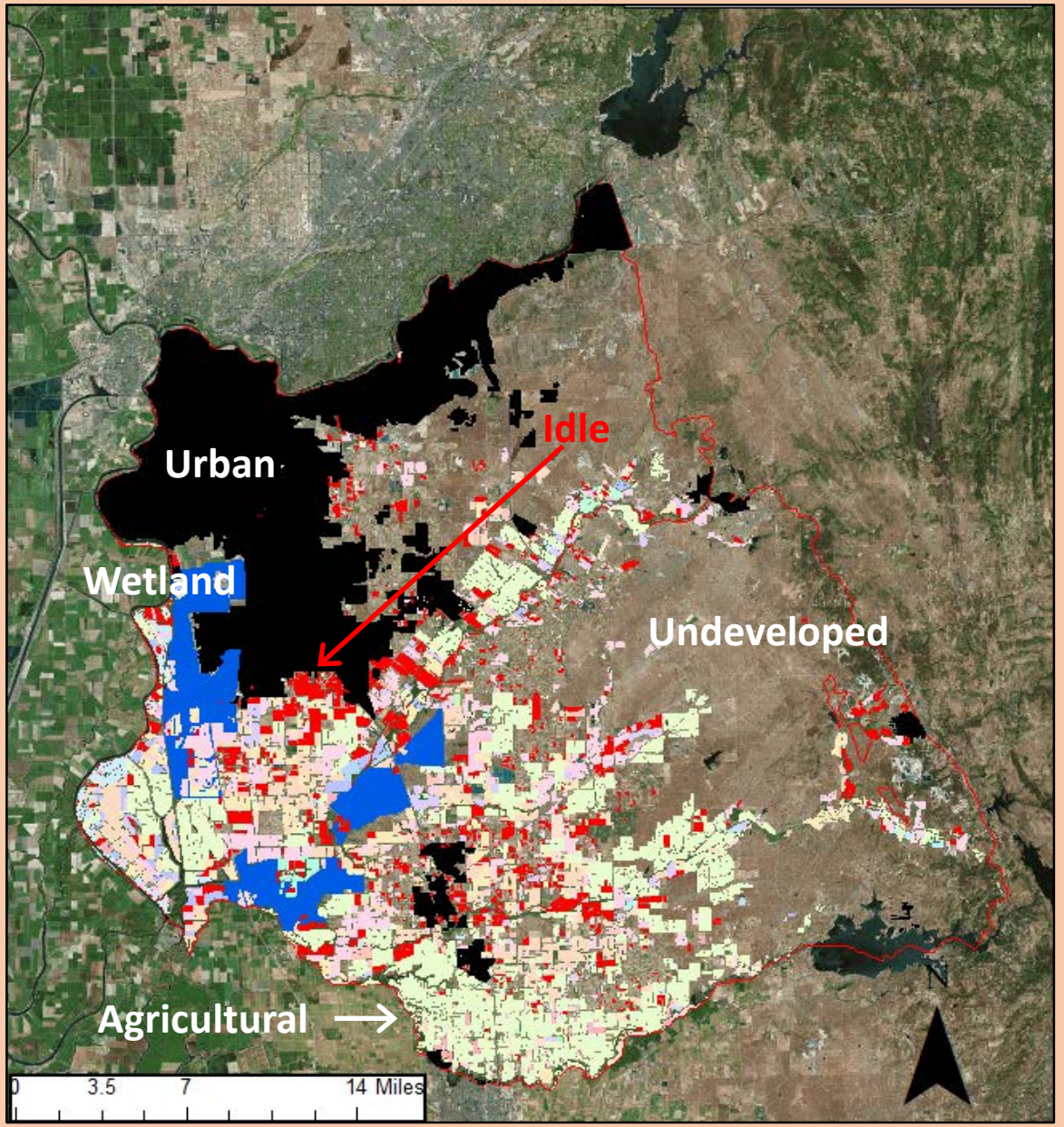
- South American and Cosumnes groundwater sub-basins
- Pre-adjustment southern boundary shown for Cosumnes
- Bounded by rivers and foothills



STUDY AREA

Total Acres: 525,000

- Urban: 95,000
- Agricultural: 140,000 (DWR 2014 data)
- Wetland: 21,000
- Undeveloped: 269,000

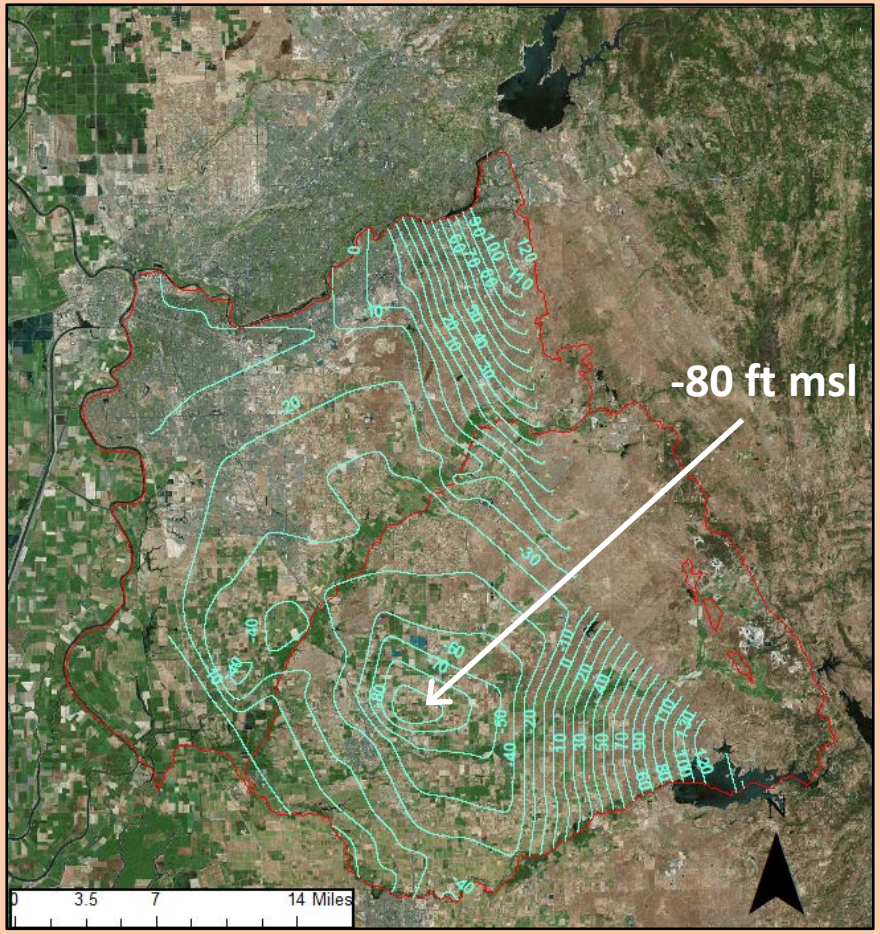


STUDY AREA

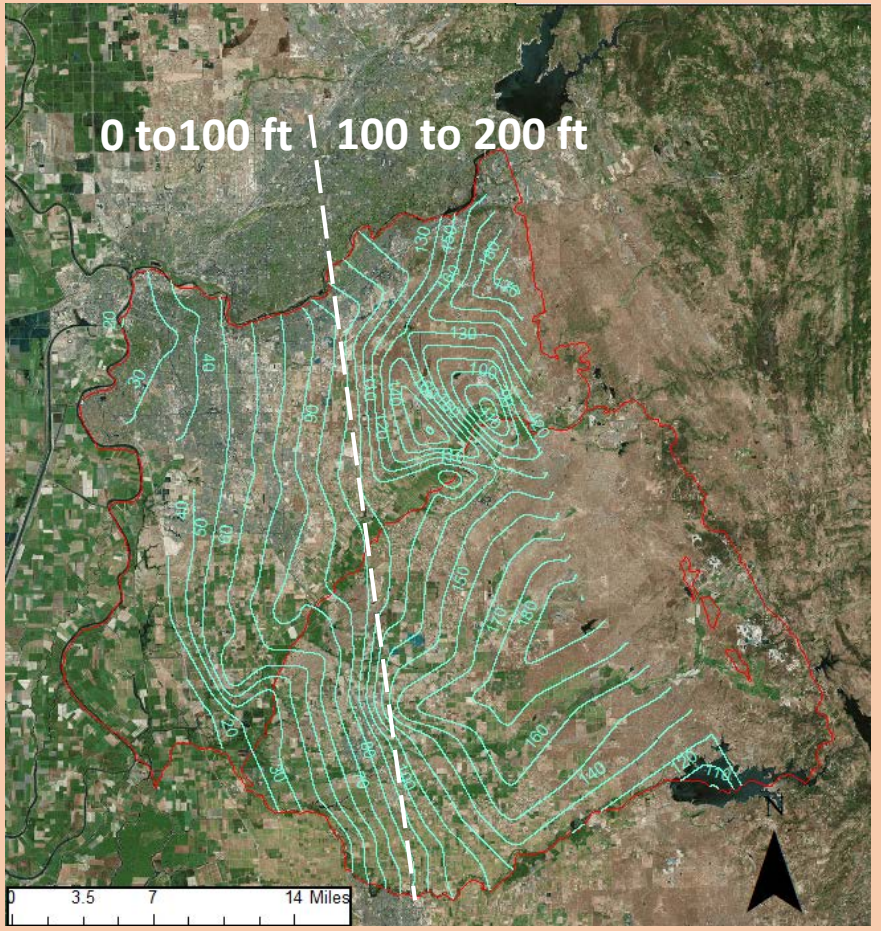
140,000 Acres
Agricultural Use

STUDY AREA

Fall 2016 Groundwater Elevations (ft MSL)



Fall 2016 Depths to Groundwater (ft)



STUDY AREA

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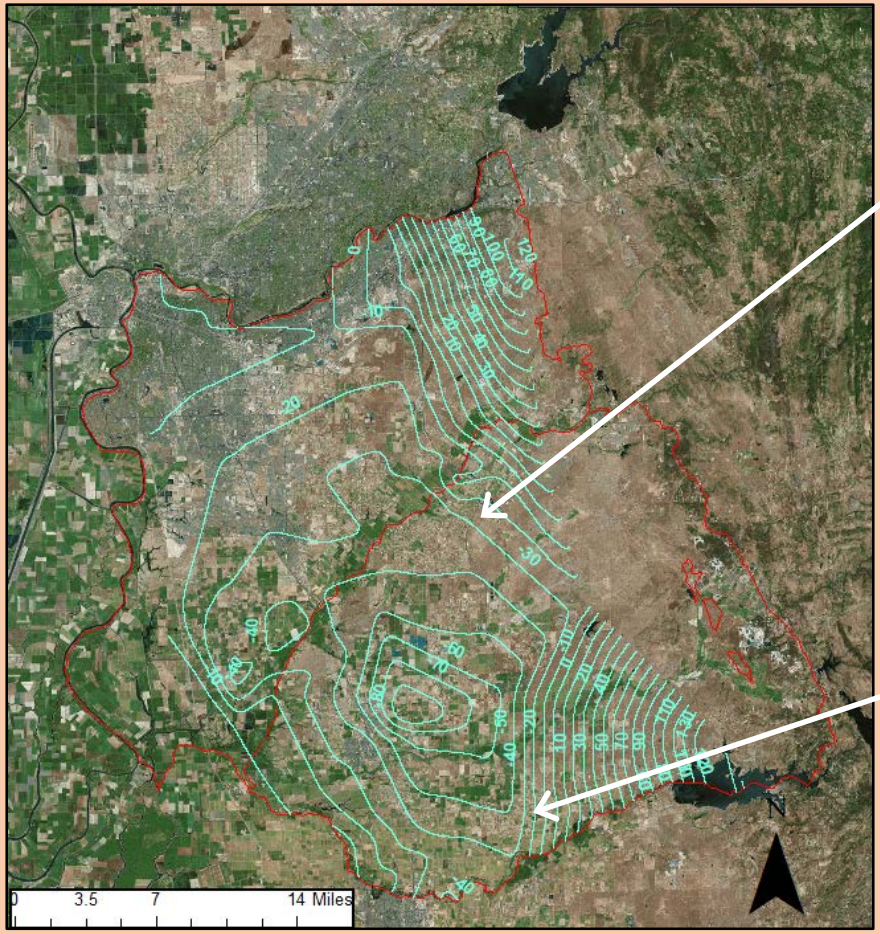

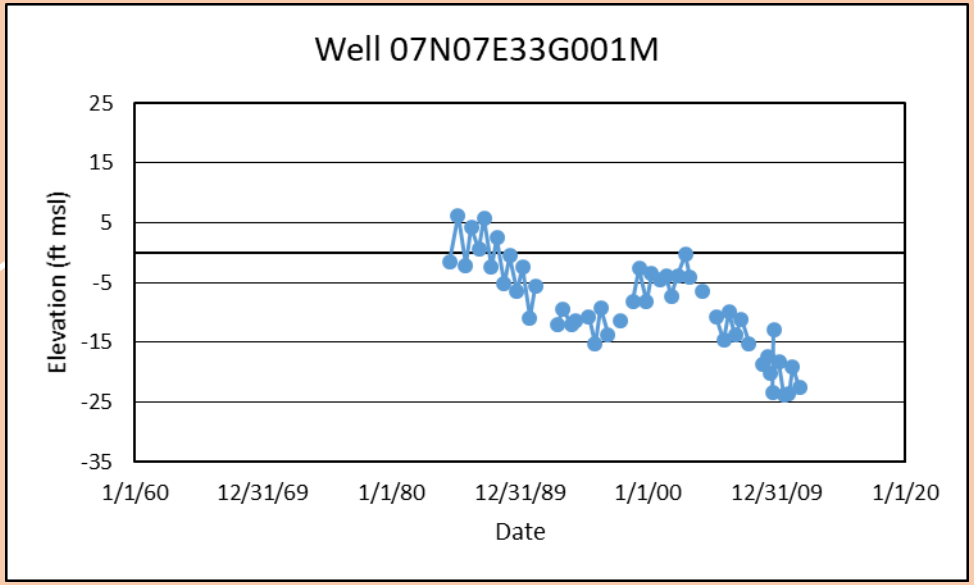

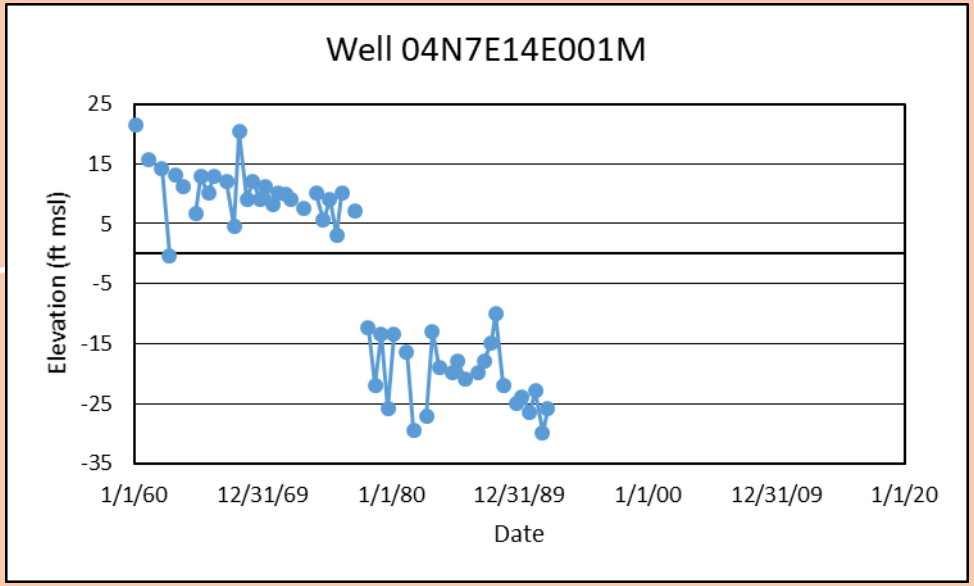

STUDY AREA

- SGMA Basin Priorities
  - S. American: High
  - Cosumnes: Medium
- SGMA Undesirable Result Considerations
  - Chronic lowering of water levels
  - Chronic depletion of storage
- Interest by some in improving support for surface water system

Reach of Cosumnes River in Dry Season

(Nature Conservancy)

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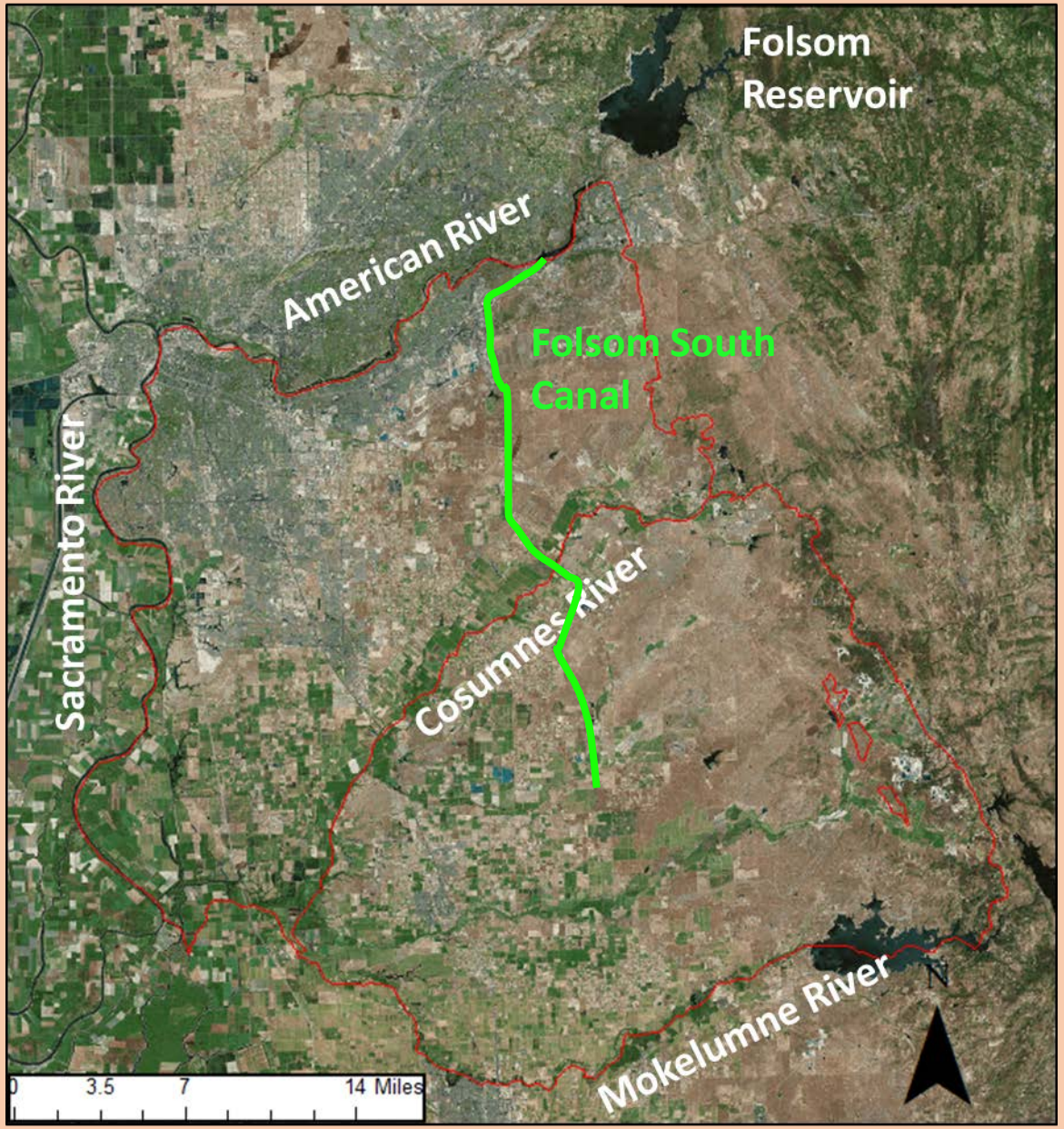
PLANNING-LEVEL ANALYSIS

- What might a managed aquifer recharge project look like for the study area?
- A portfolio of water sources and application approaches likely best
- UC Water considering combination of:
  - American River uplands watershed management
  - Folsom Reservoir reoperation
  - Application of water made available to croplands
- Looking at what might be possible without too much limitation regarding project funding at this point

PLANNING-LEVEL ANALYSIS

Concept is to move available water released from Folsom to sub-basins via Folsom South Canal

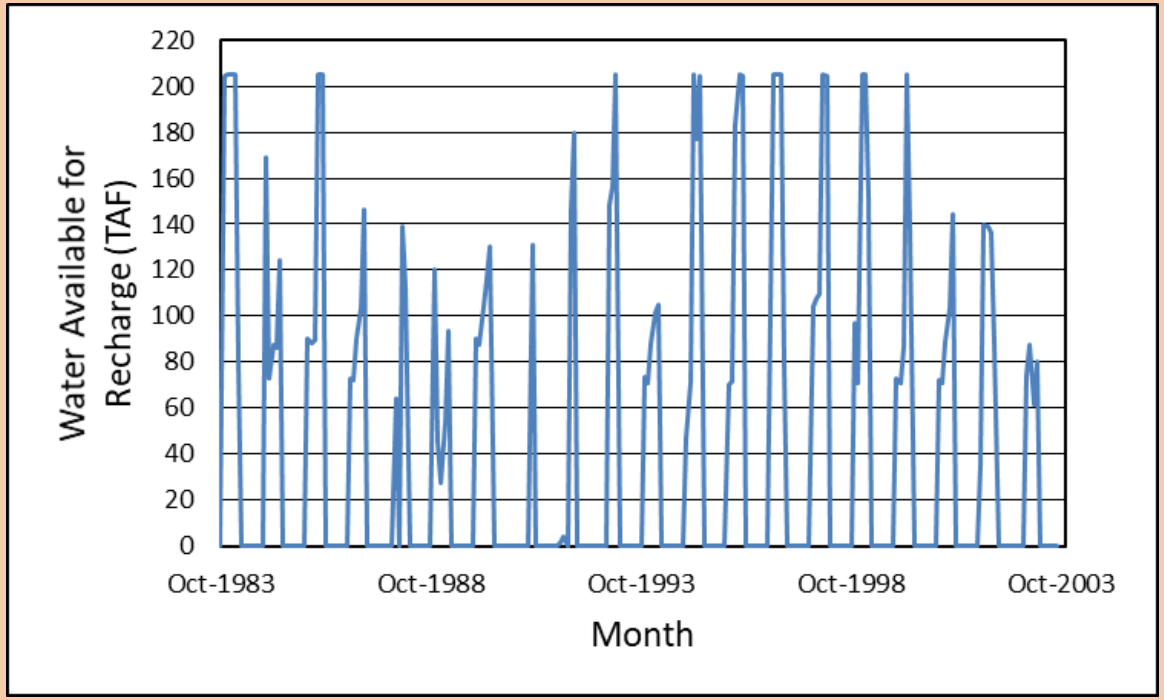


PLANNING-LEVEL ANALYSIS

- Initial work is one-way storage scenario
  - Recharge sub-basin to support ongoing water budget stresses (pumping, surface water baseflow, inter-basin flow)
  - No aquifer storage and recovery
- Perfect foresight approach provides upper bound on what is possible
- Beginning to look at total storage (surface water and groundwater)
  - Supports uses in sub-basin
  - Can extract stored water from basin for external uses
  - Flexibility to meet environmental flow and quality requirements downstream of Folsom without losing water

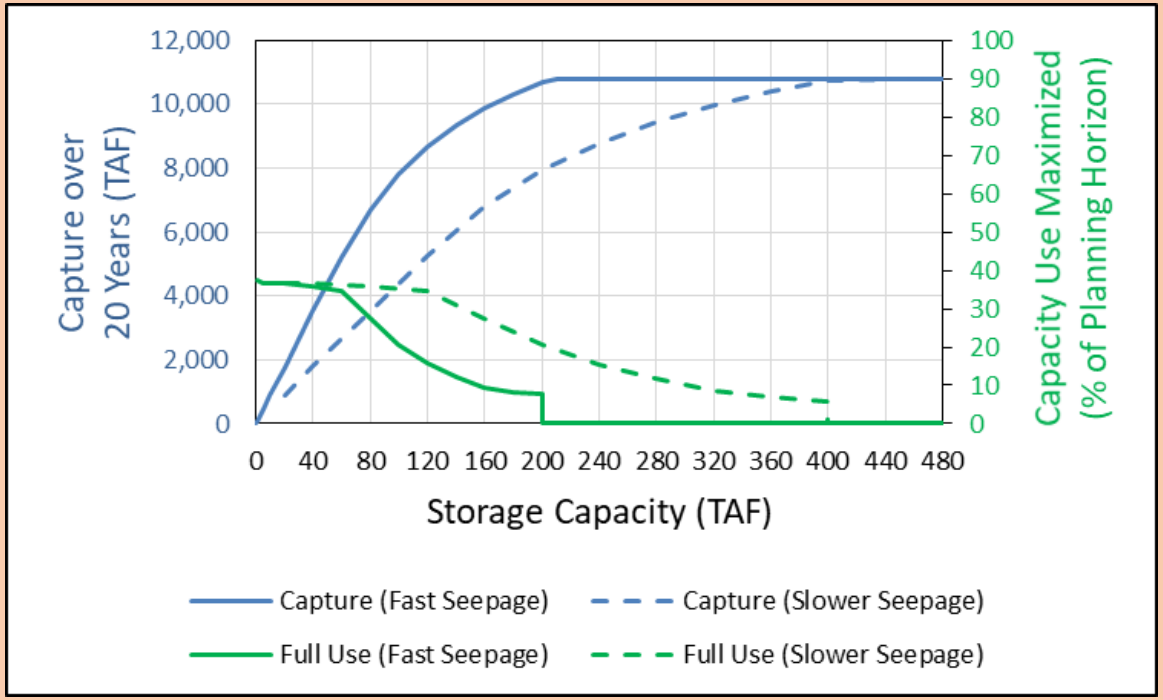
PLANNING-LEVEL ANALYSIS

Folsom Reoperation Scenario



(Erfan Goharian)

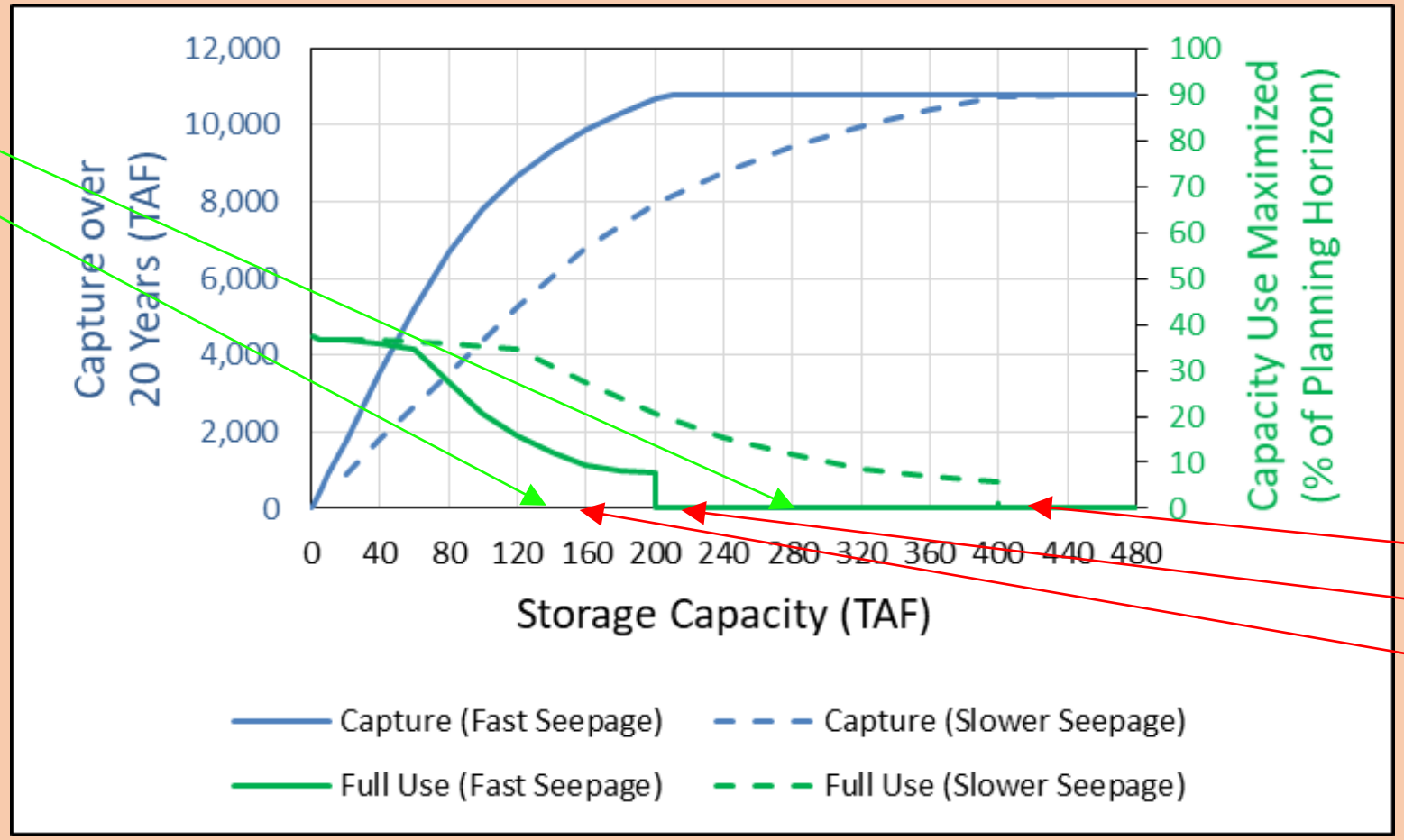
WAR Capture and Facility Utilization



- Large flows require significant total storage capacity across recharge sites
- Periodic occurrence of winter flows results in low facility utilization
- Is it always appropriate to build storage infrastructure?

PLANNING-LEVEL ANALYSIS

WAR Capture and Facility Utilization



All Cropland

2-foot berms

1-foot berms

Local Municipal Supply Reservoirs

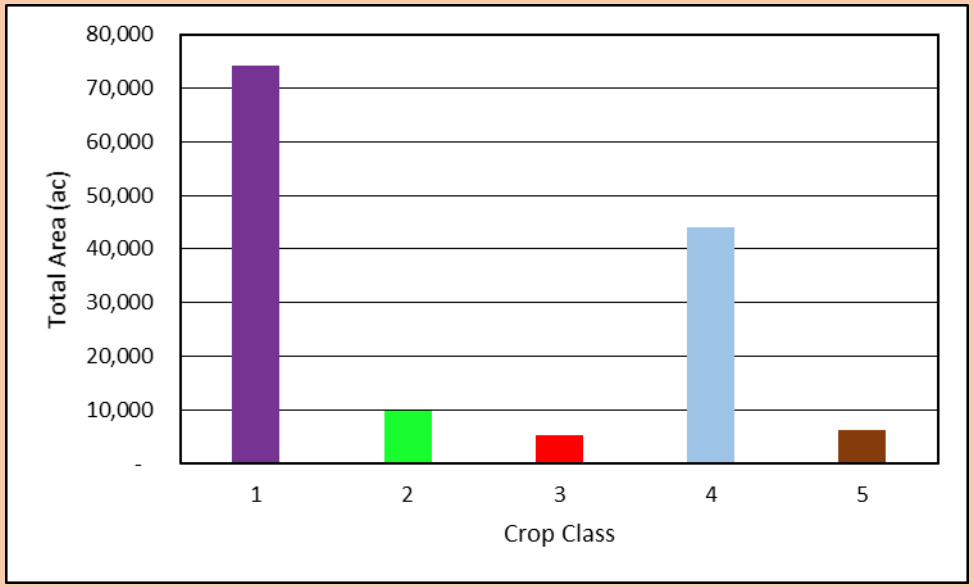
Camanche

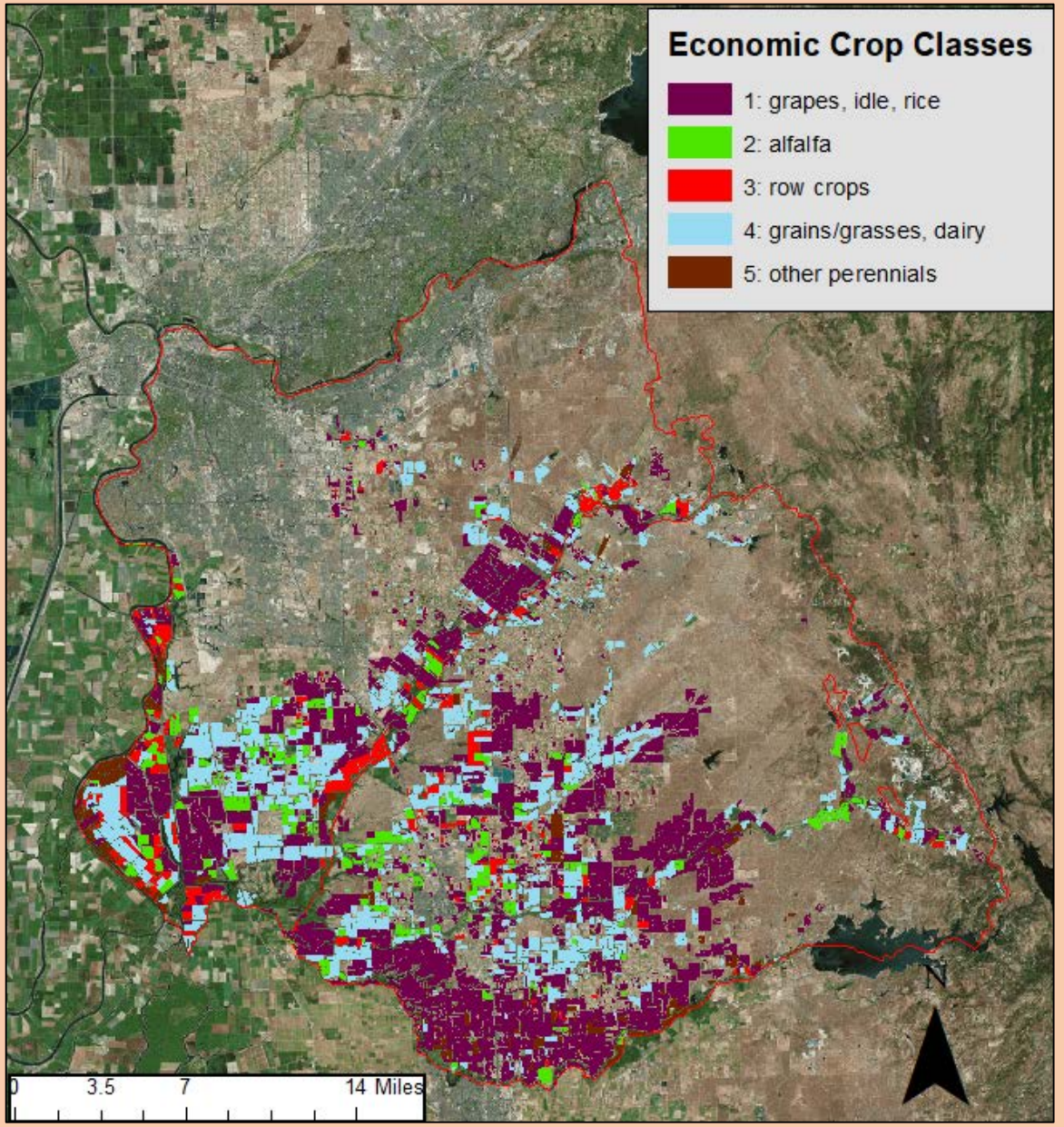
Pardee

Los Vaqueros

PLANNING-LEVEL ANALYSIS

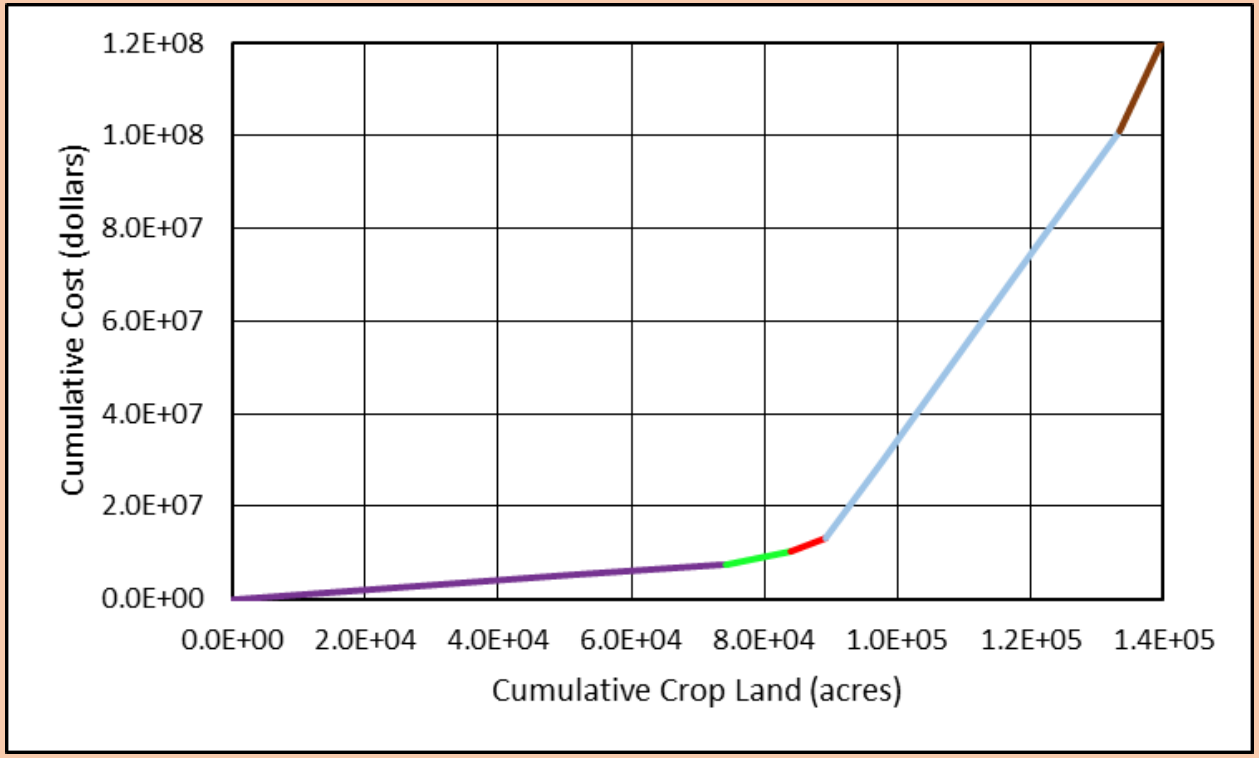
- How to encourage use of private lands for public good?
- Pay for annual option to flood land in winter





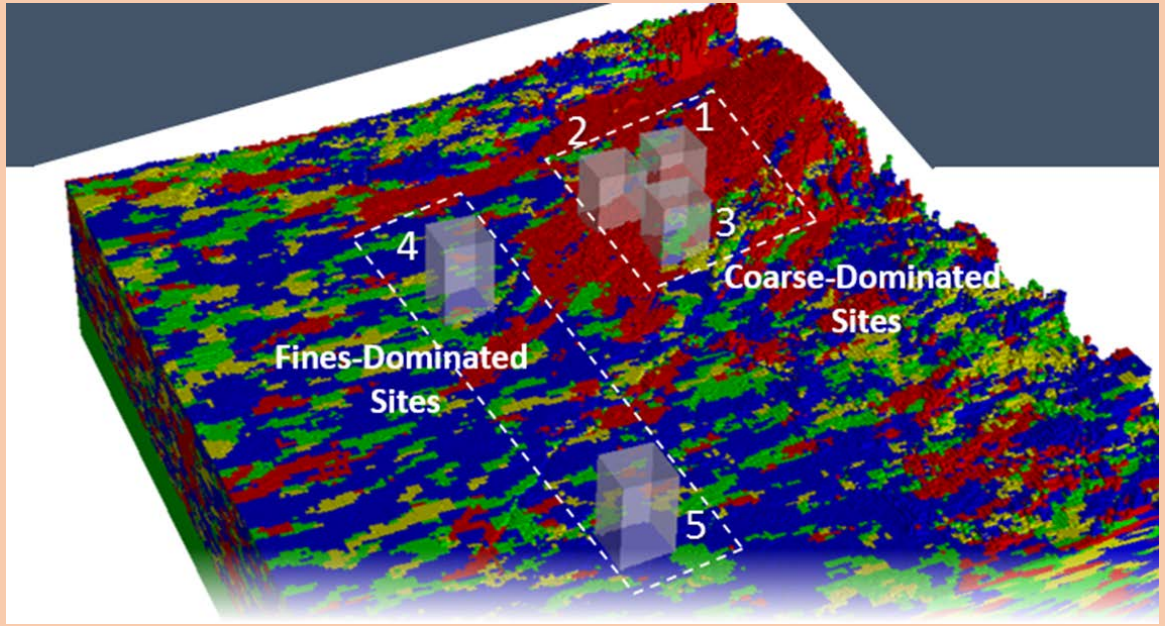
PLANNING-LEVEL ANALYSIS

- Base fees on reverse auction (assumed costs at present)
- Water deliveries limited by
  - Berm height
  - Seepage rate
  - Required draining time
- Pick suite of parcels that gets the most water in the ground with available funds



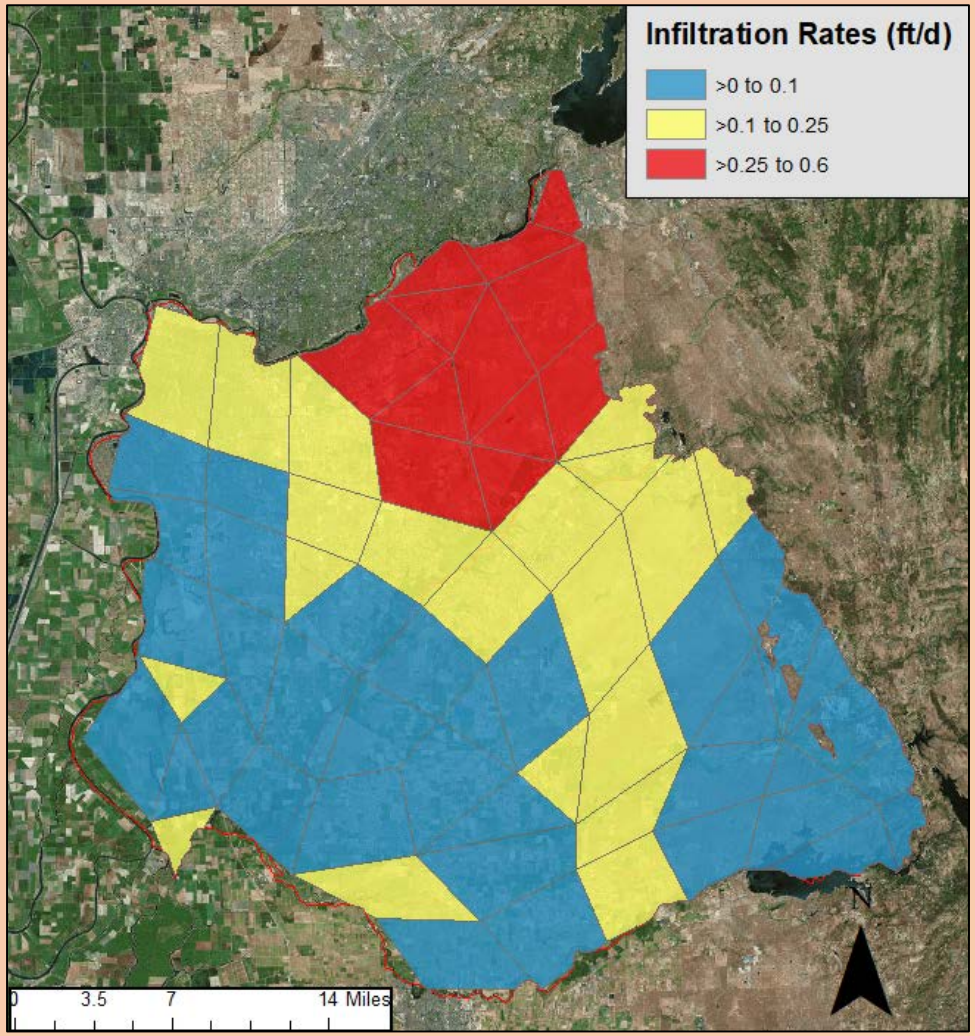
PLANNING-LEVEL ANALYSIS

ParFlow



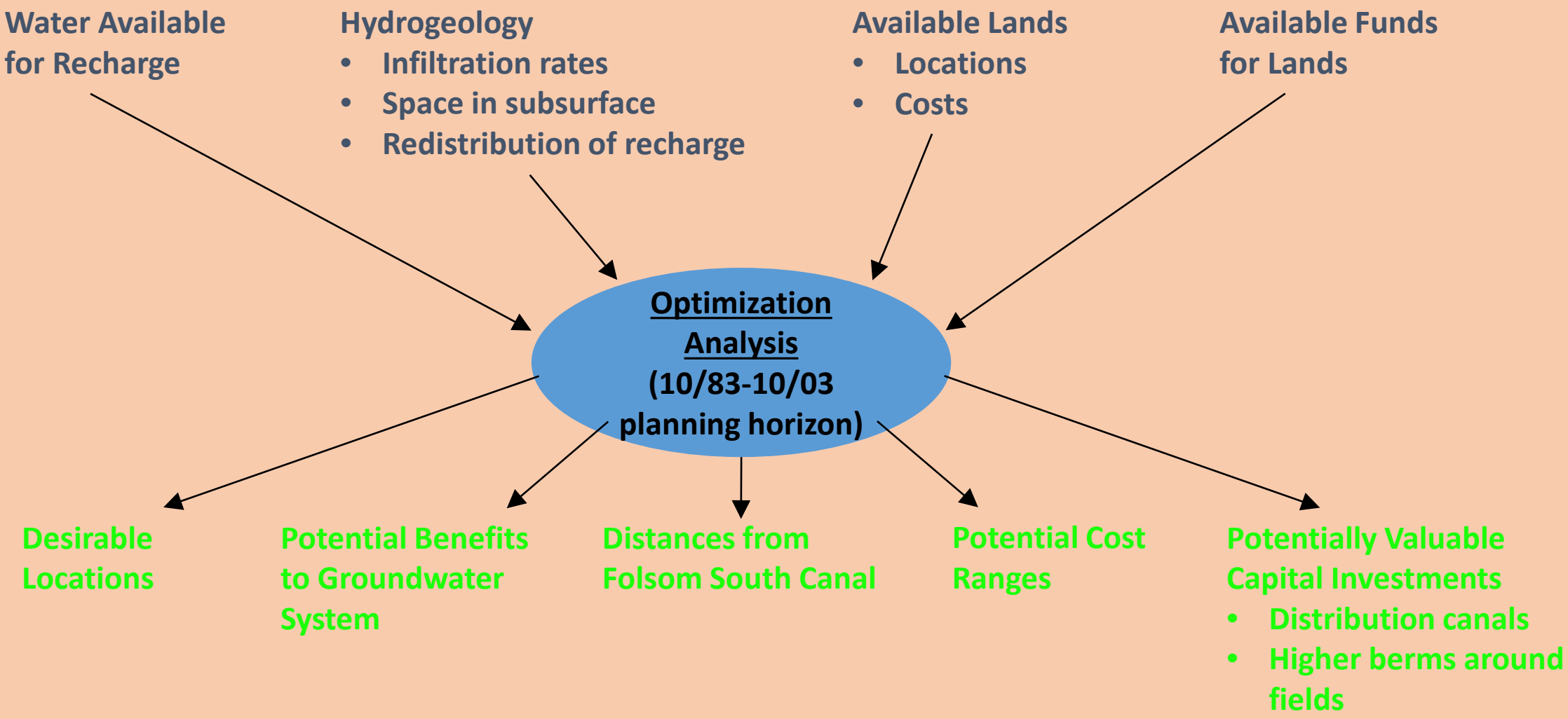
(Stephen Maples)

C2VSim



Geologic variability incorporated into infiltration rates

PLANNING-LEVEL ANALYSIS



PLANNING-LEVEL ANALYSIS

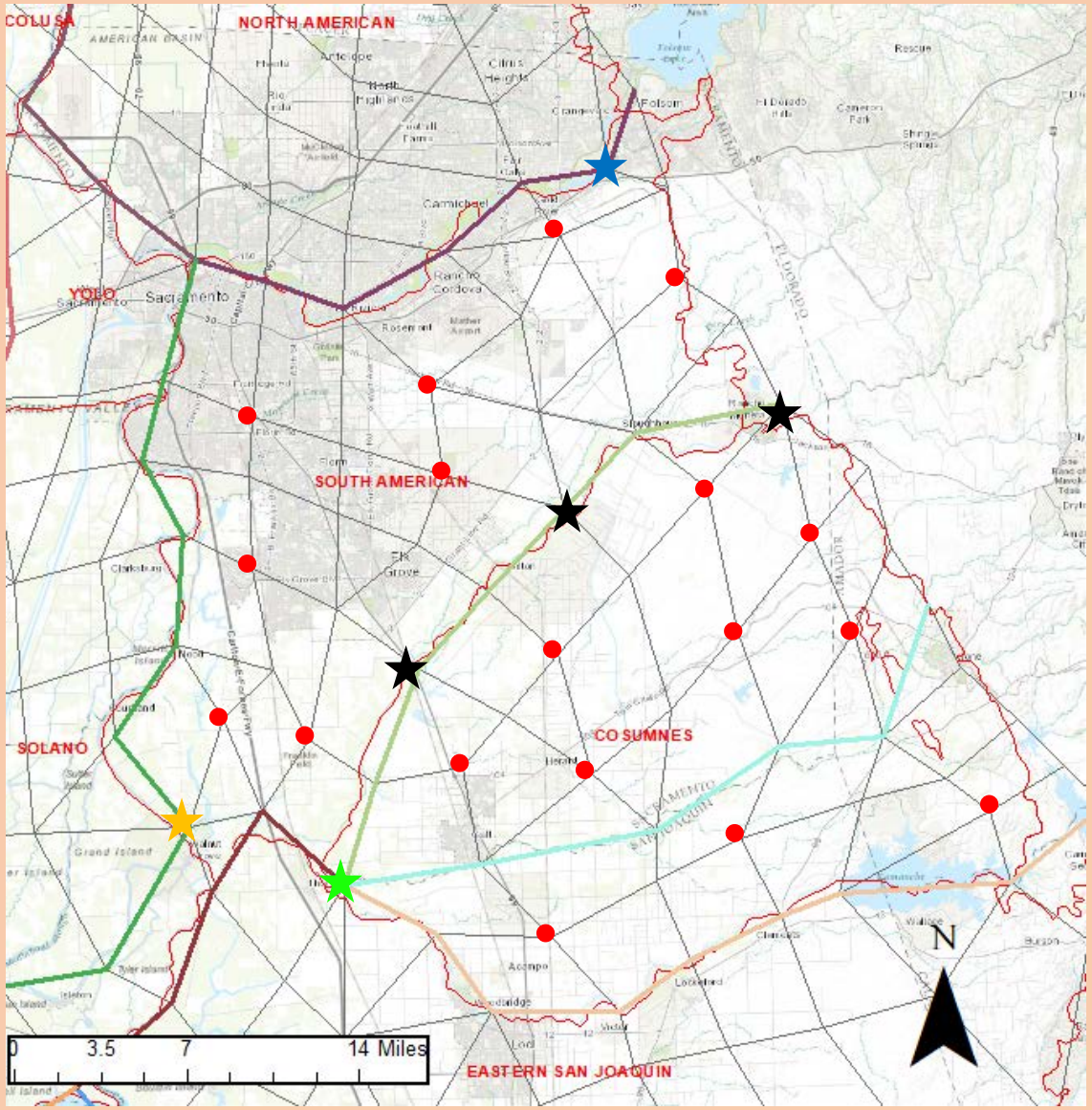
Evaluate Responses to Recharge (C2VSim)

Model observations

18 groundwater head observation locations

6 surface water flow observation locations

- Cosumnes River/upstream
- Dry Creek
- Mokelumne River
- Confluence
- American River
- Sacramento River



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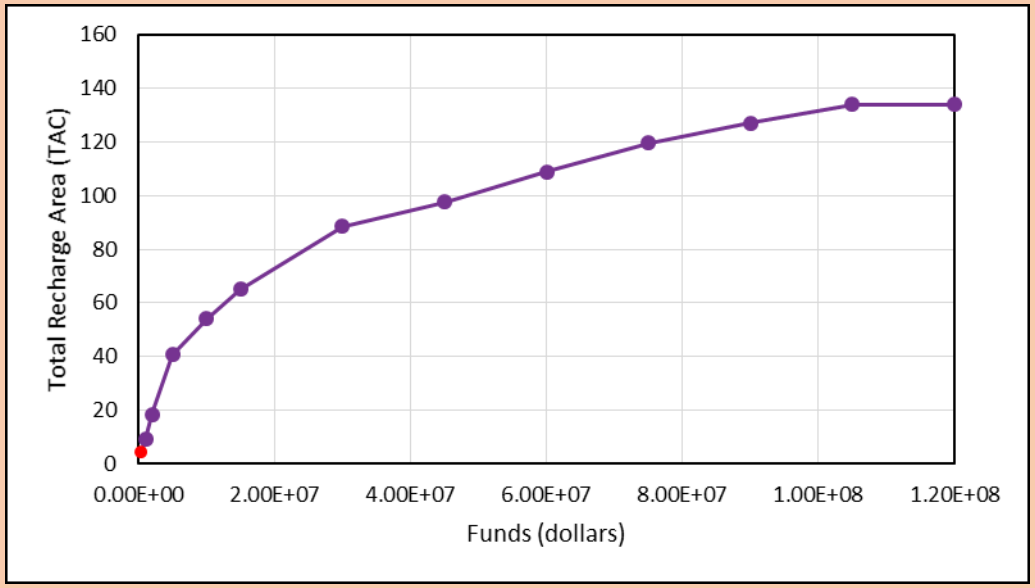
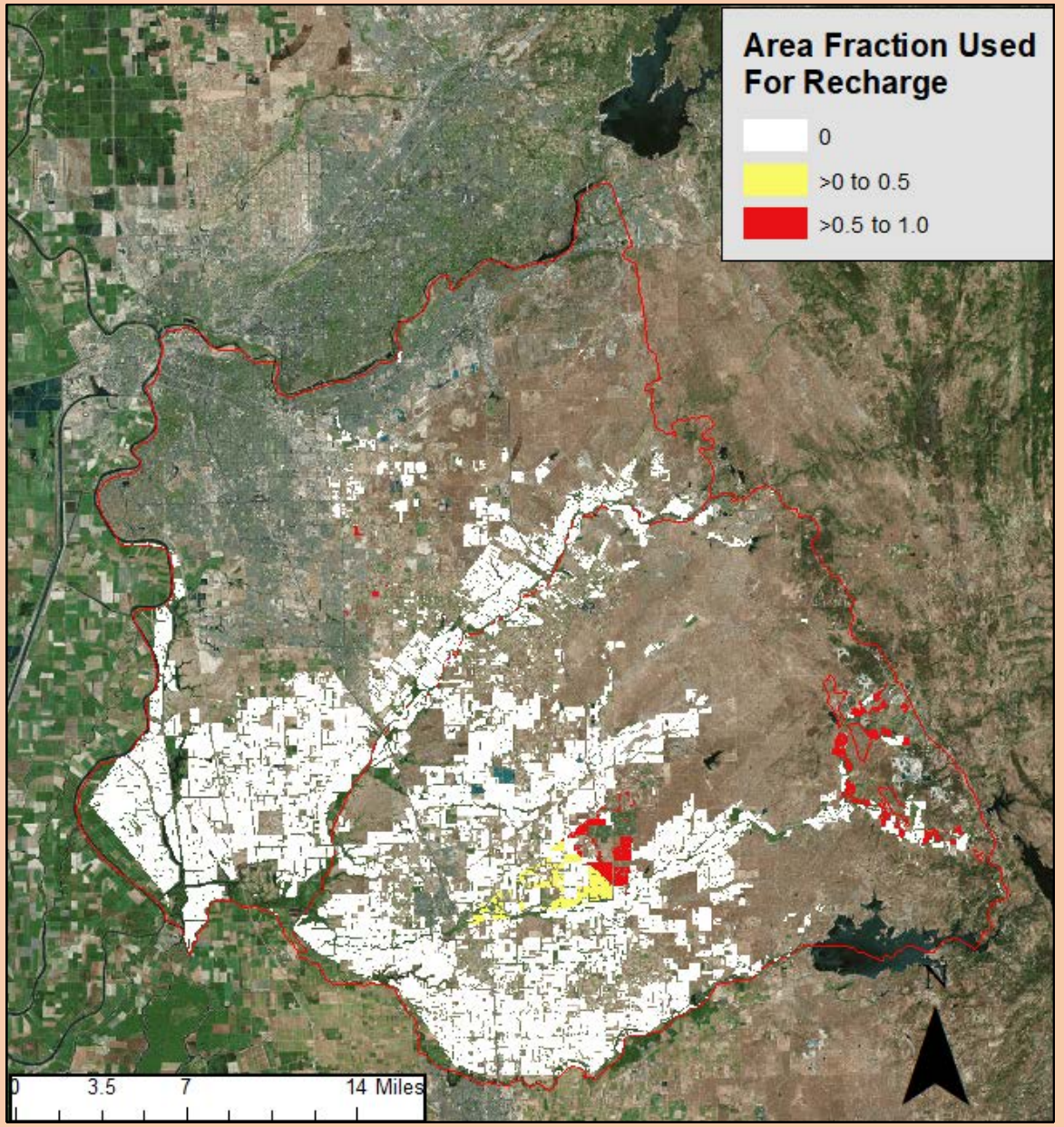
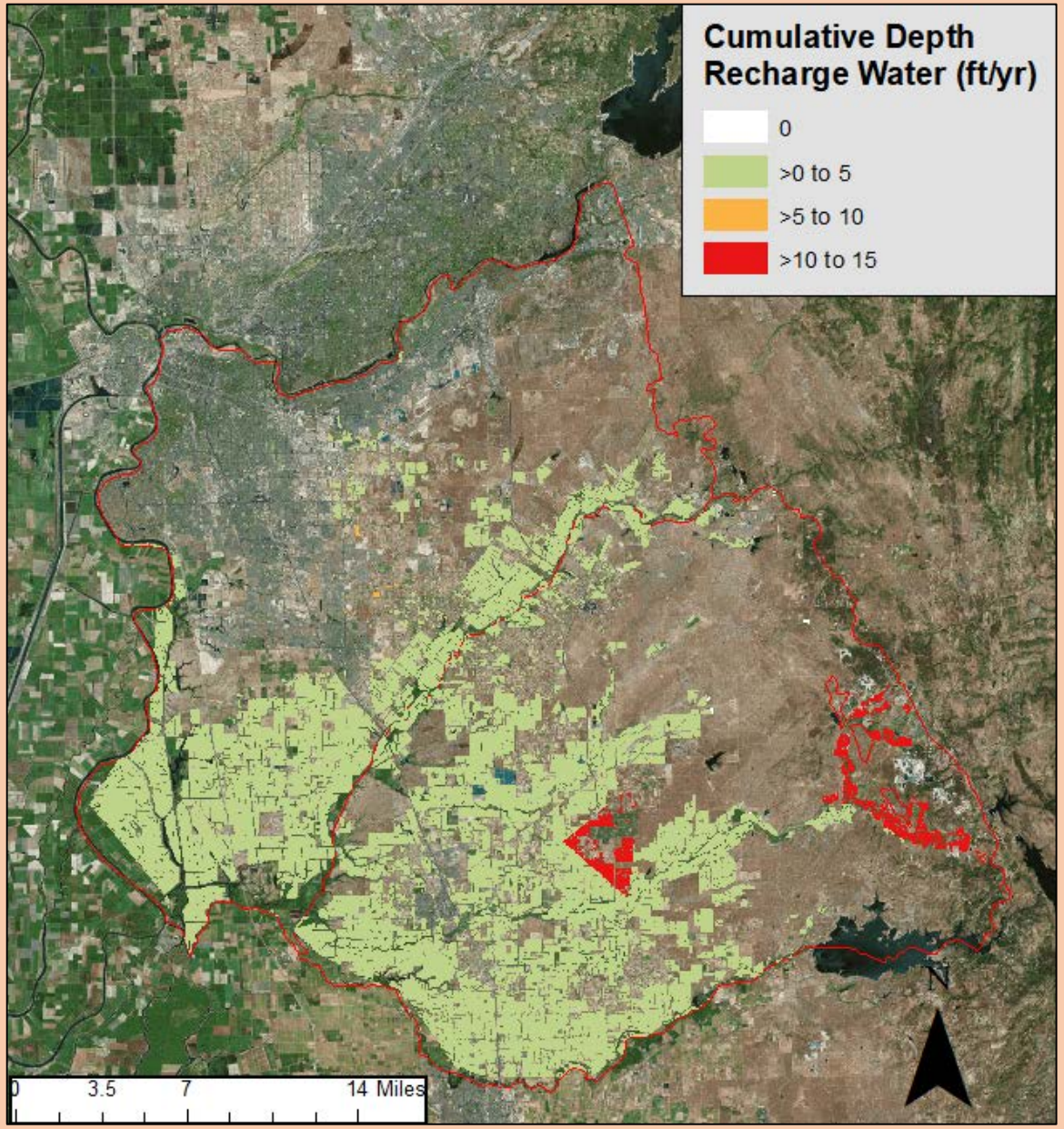
RESULTS


160
140
120
100
80
60
40
20
0
Total Recharge Area (TAC)
0.00E+00
2.00E+07
4.00E+07
6.00E+07
8.00E+07
1.00E+08
1.20E+08
Funds (dollars)


Area Fraction Used For Recharge
0
>0 to 0.5
>0.5 to 1.0
0
3.5
7
14 Miles
N

RESULTS

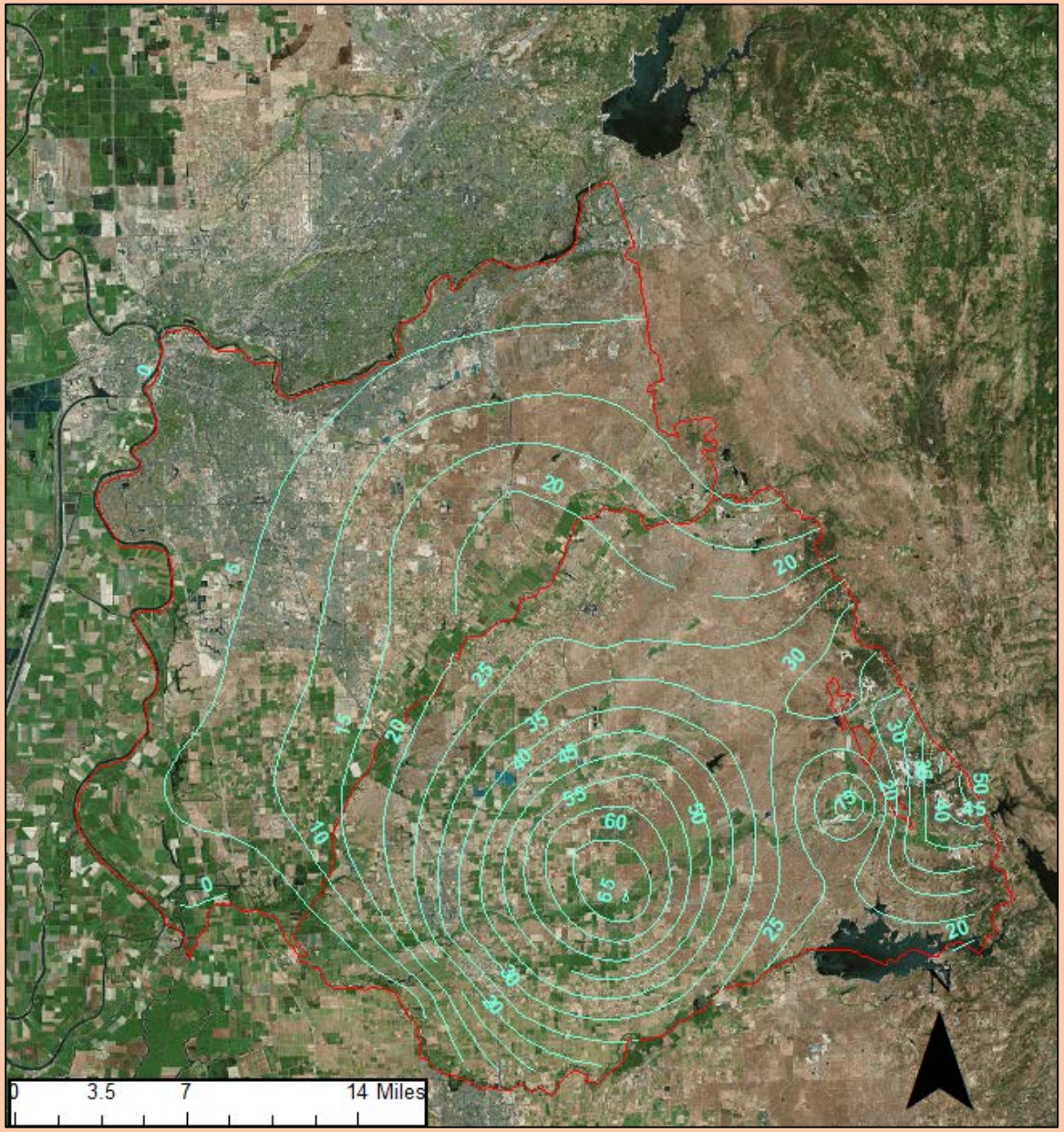
- Shown for greatest funding level
- Highest applications of recharge water in areas with favorable hydrogeology
  - High infiltration rate (west)
  - Thick unsaturated zone (east)
- Range of crop classes represented in high application areas



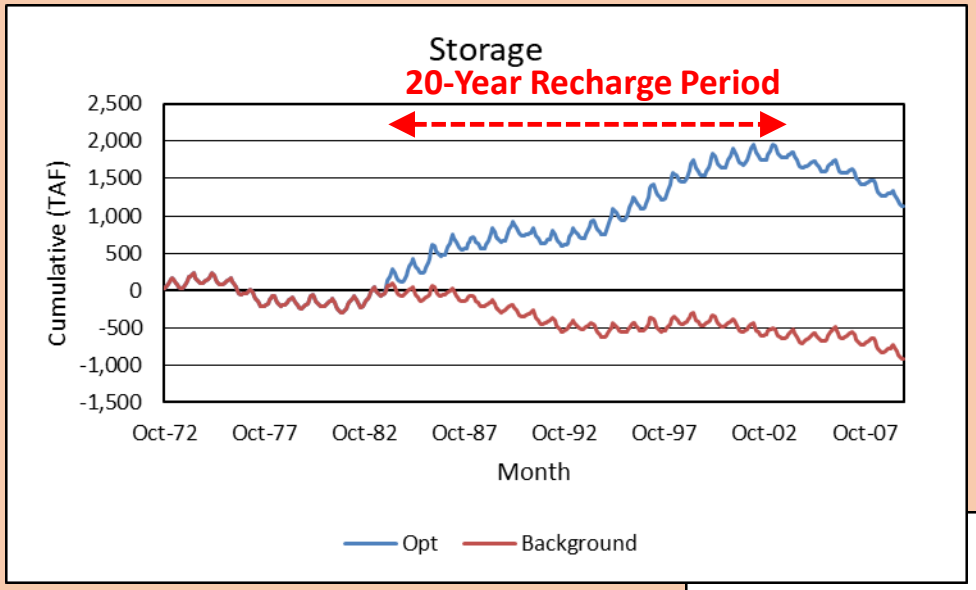
RESULTS

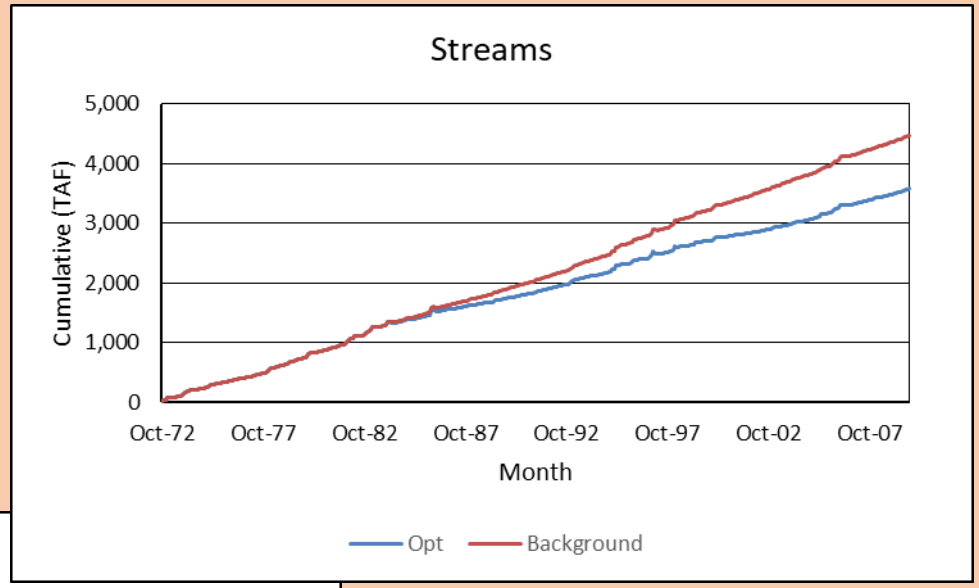
- Shown for
  - Greatest funding level
  - End of 20-year planning horizon
- Mounding centered on most intensively recharged areas

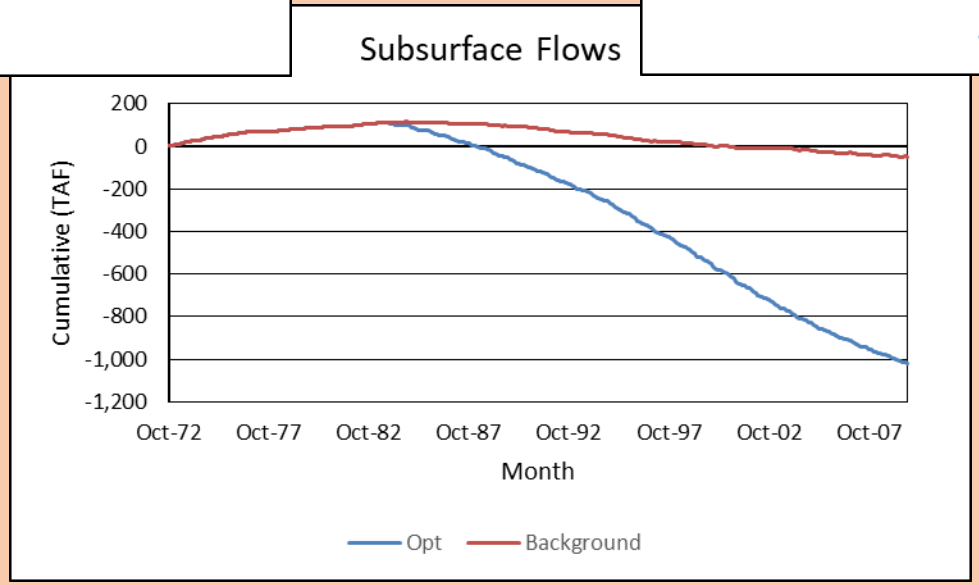
Change in Groundwater Elevations Over Base Case (ft)



RESULTS







36% WAR used

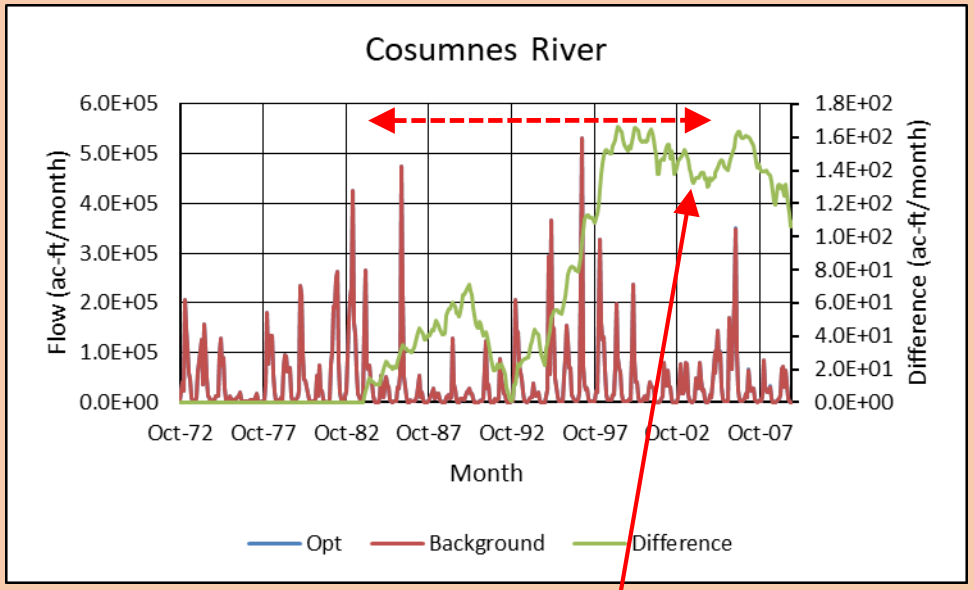
Recharged: 3, 901 TAF

Stored: 2,419 (62%)

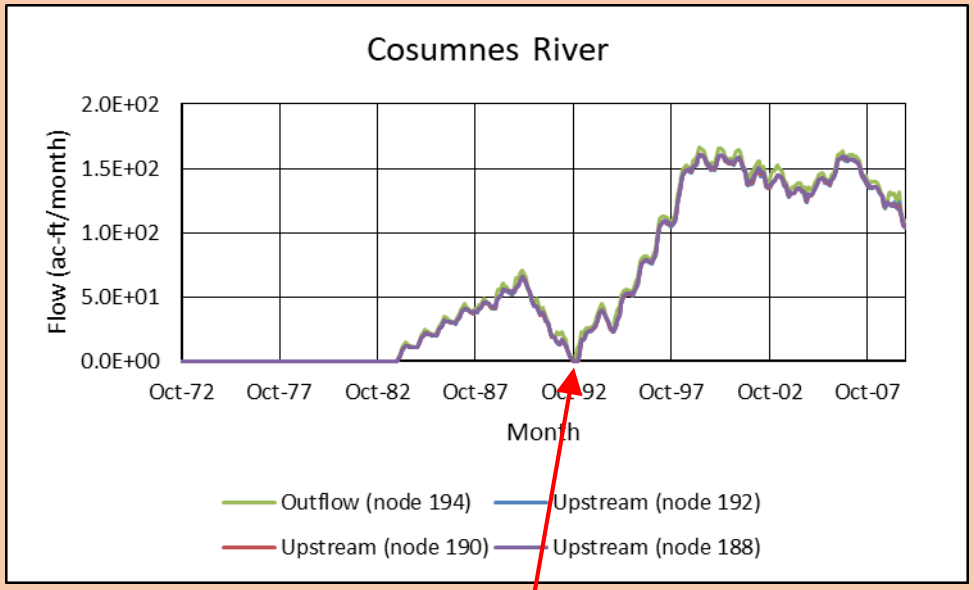
Streams: 718 (18%)

Other Basins: 764 (20%)

INITIAL RESULTS
WINTER EXTENDED AND ALL LAND

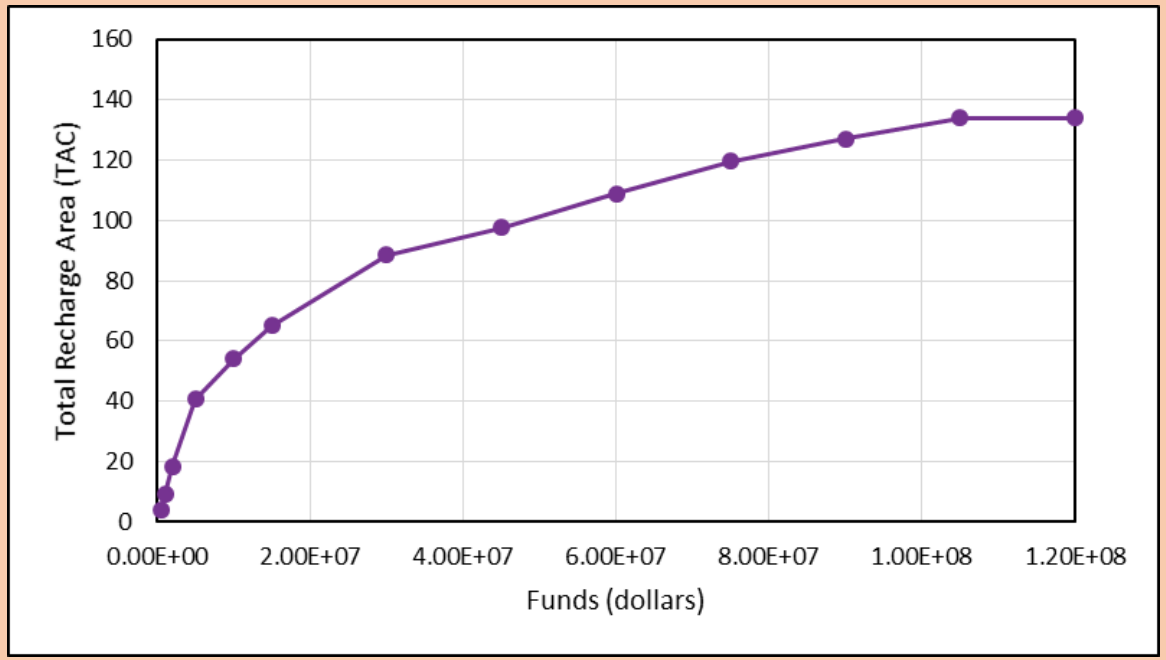


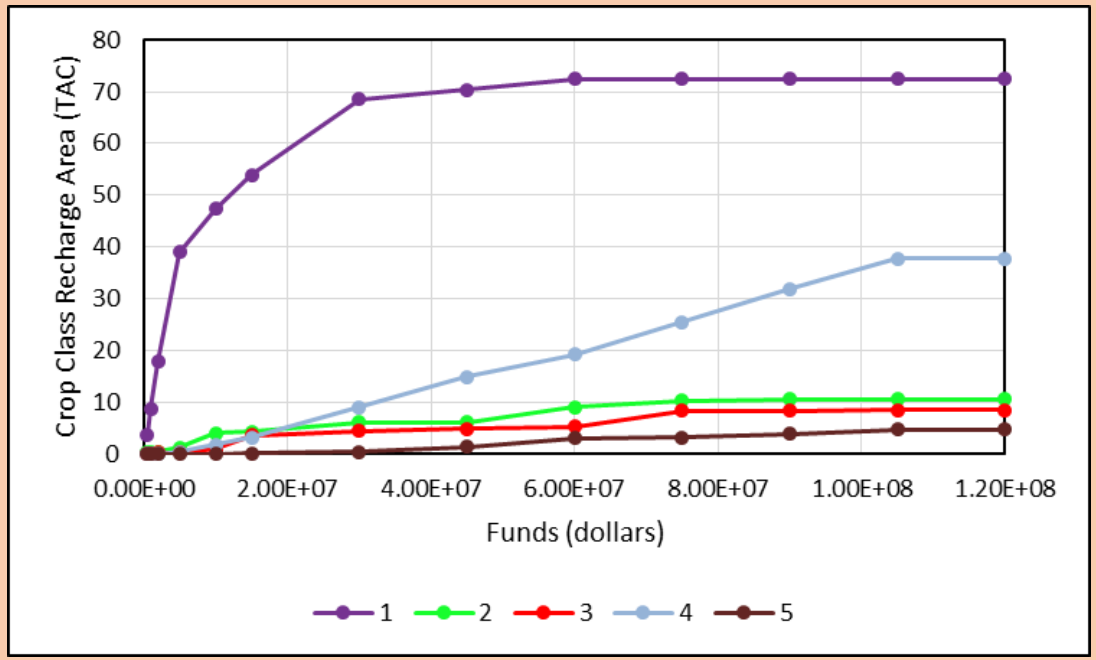
Added baseflow



Drought – no water available for recharge

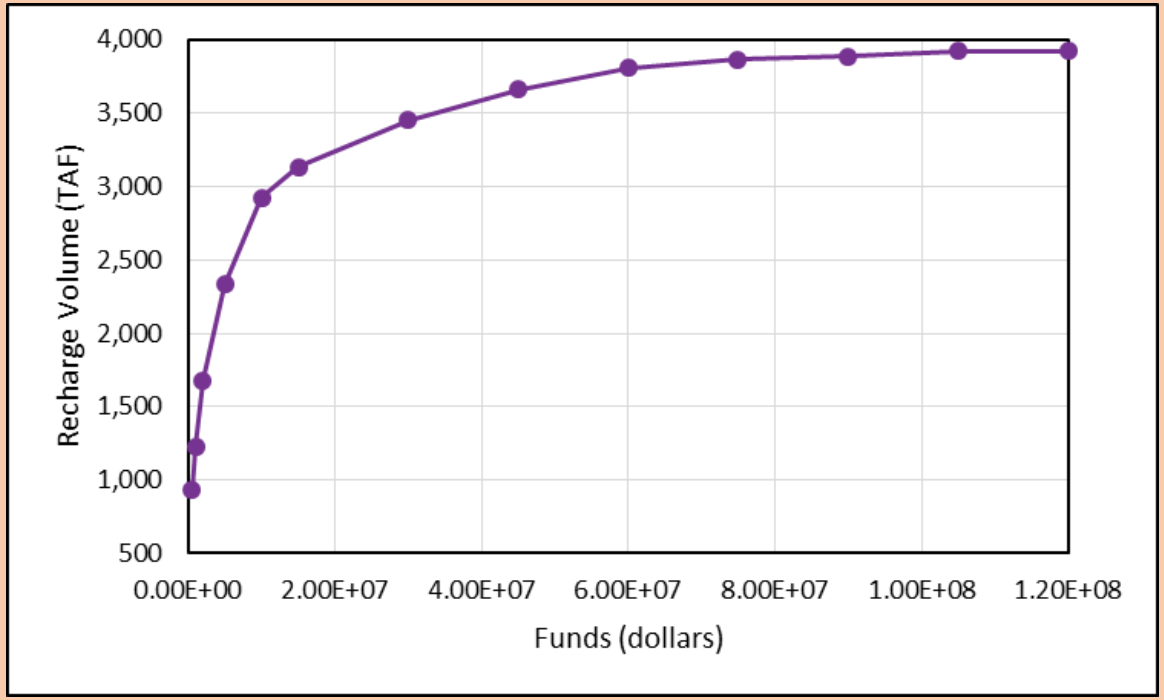
RESULTS

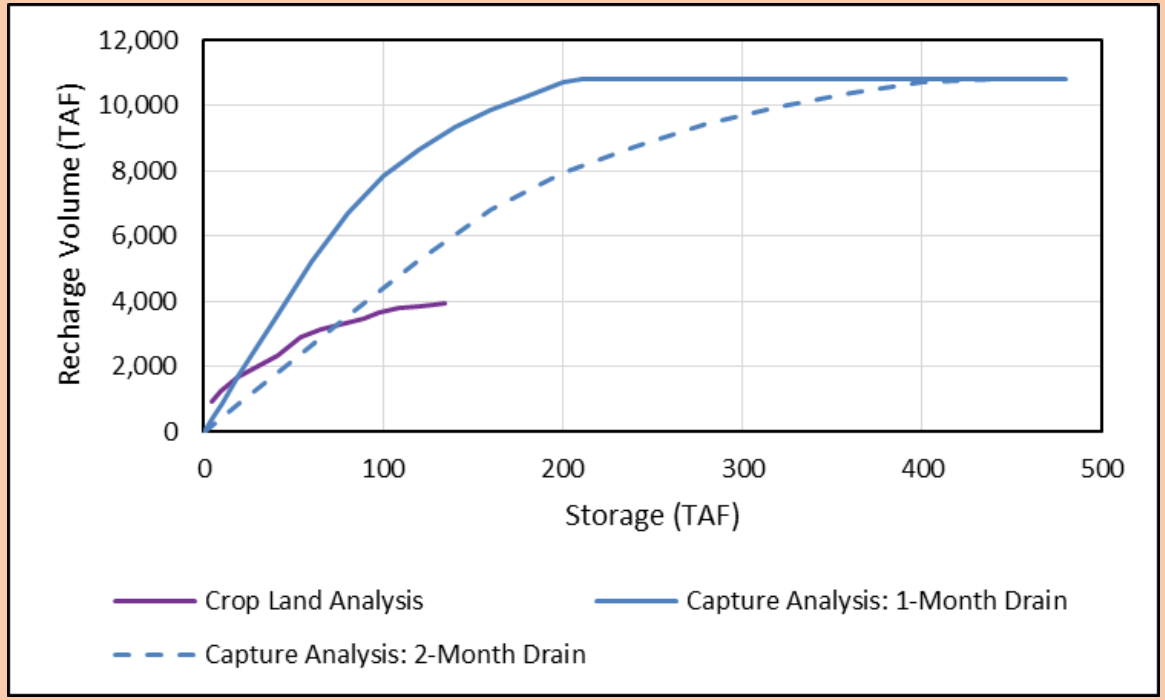




- Area for recharge increases with funding
- Diminishing returns to scale
- Not all cheapest land used first => Hydrogeology matters

RESULTS

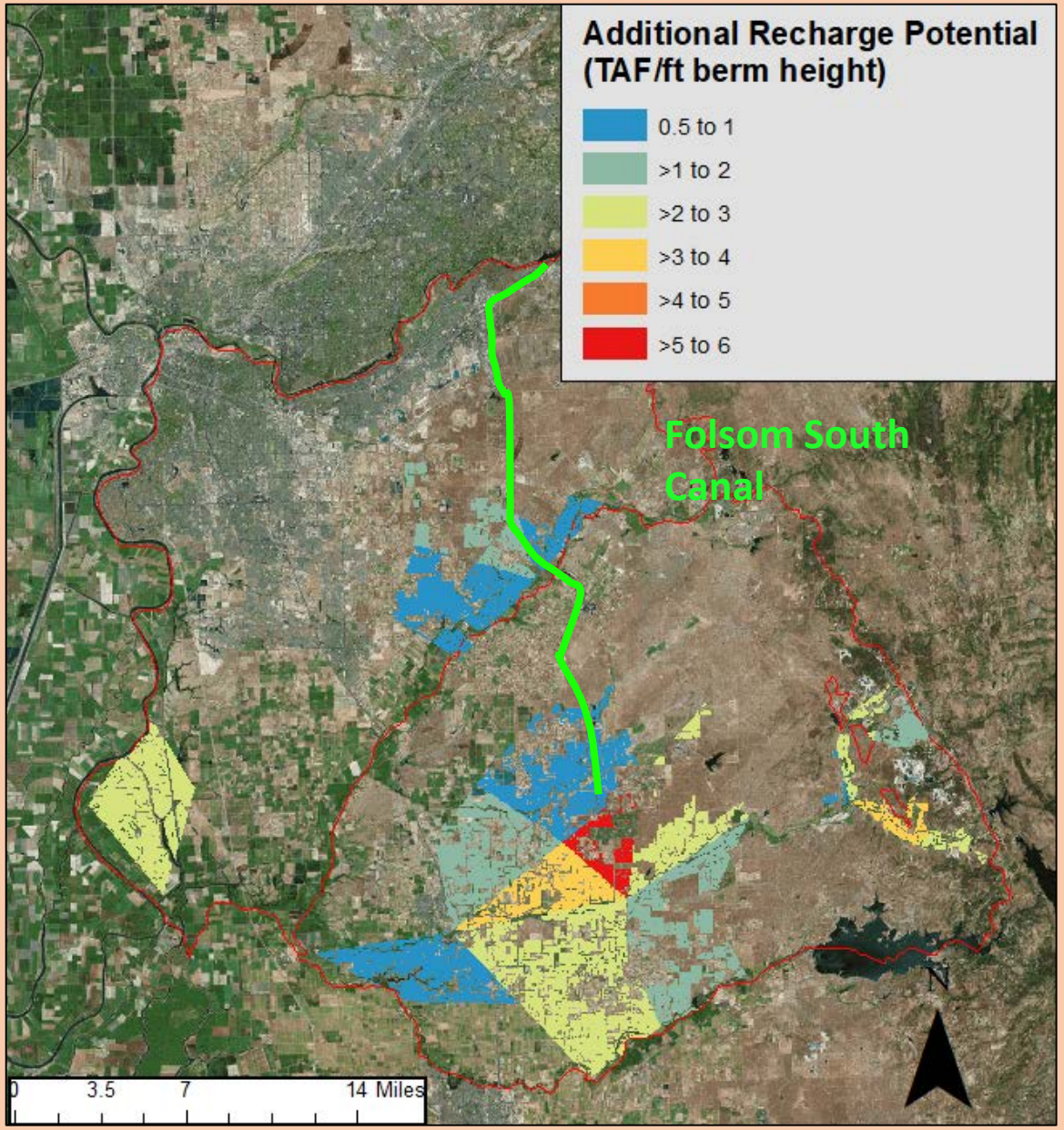




- Highest infiltration rates exceed that assumed in initial capture analysis
- Recharge capacity falls off pace fairly soon
- Limitation of assumed 1-foot berm height

RESULTS

- Highest for locations with high infiltration rate and available land
- Other locations with significant amounts of available land also favorable
- Note proximity to Folsom South Canal



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CONCLUSIONS

- Better decisions result from considering all available information
- Additional data needs
  - Soil infiltration variations
  - Detailed geology
  - Field tests of infiltration rates
- Future work
  - Additional details regarding crop tolerance and costs to use land
  - Proximity to Folsom South Canal
  - Range of cropland rental arrangements
  - Portfolios of recharge approaches