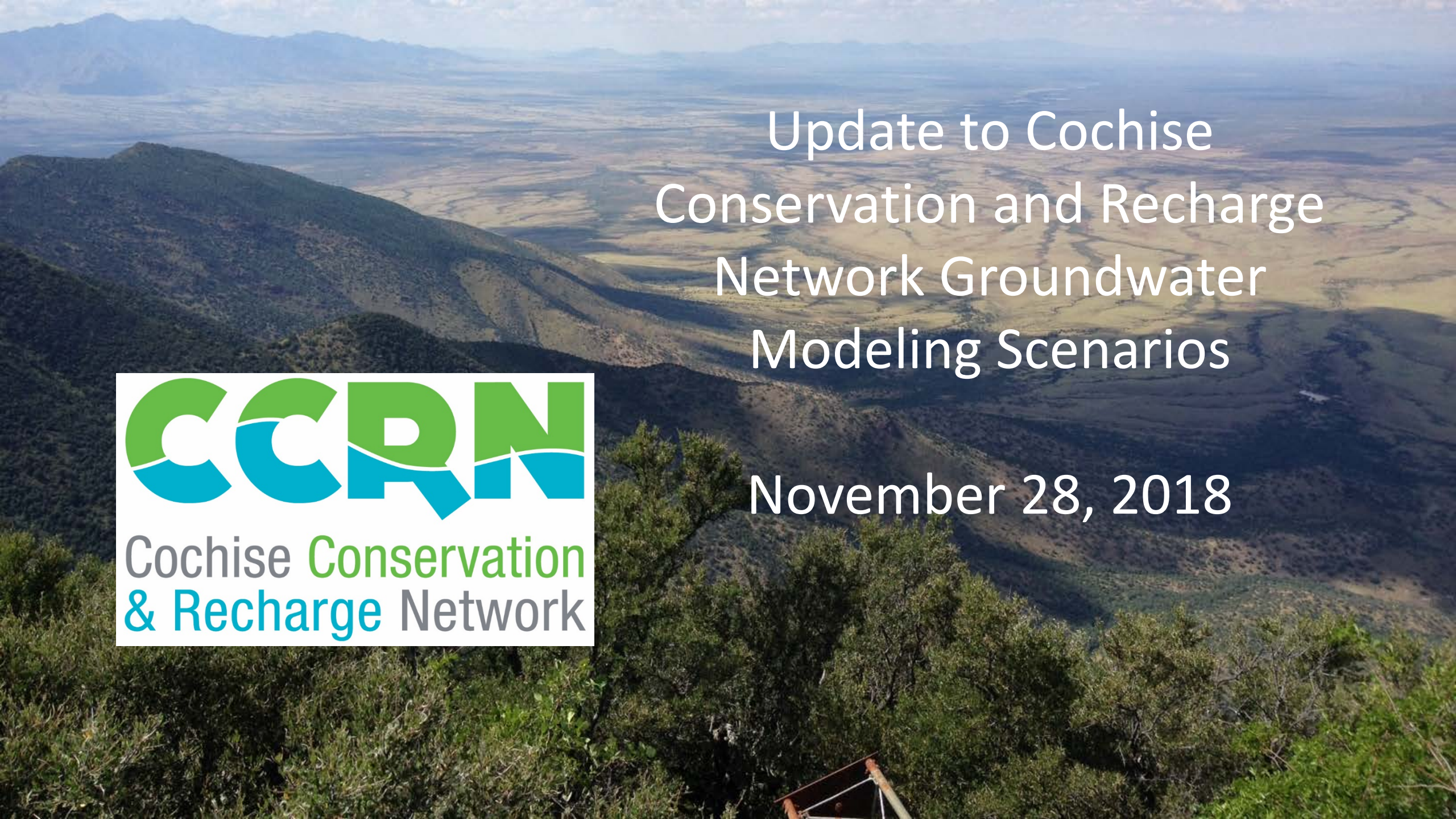


Update to Cochise Conservation and Recharge Network Groundwater Modeling Scenarios

November 28, 2018

CCRN

Cochise Conservation & Recharge Network

VERSION NOTES:

- This presentation has been edited in response to questions and clarifications requested at the 11/28/18 Tech Comm meeting.
- Additional background information about the model development has also been added for context.

Where we've come from

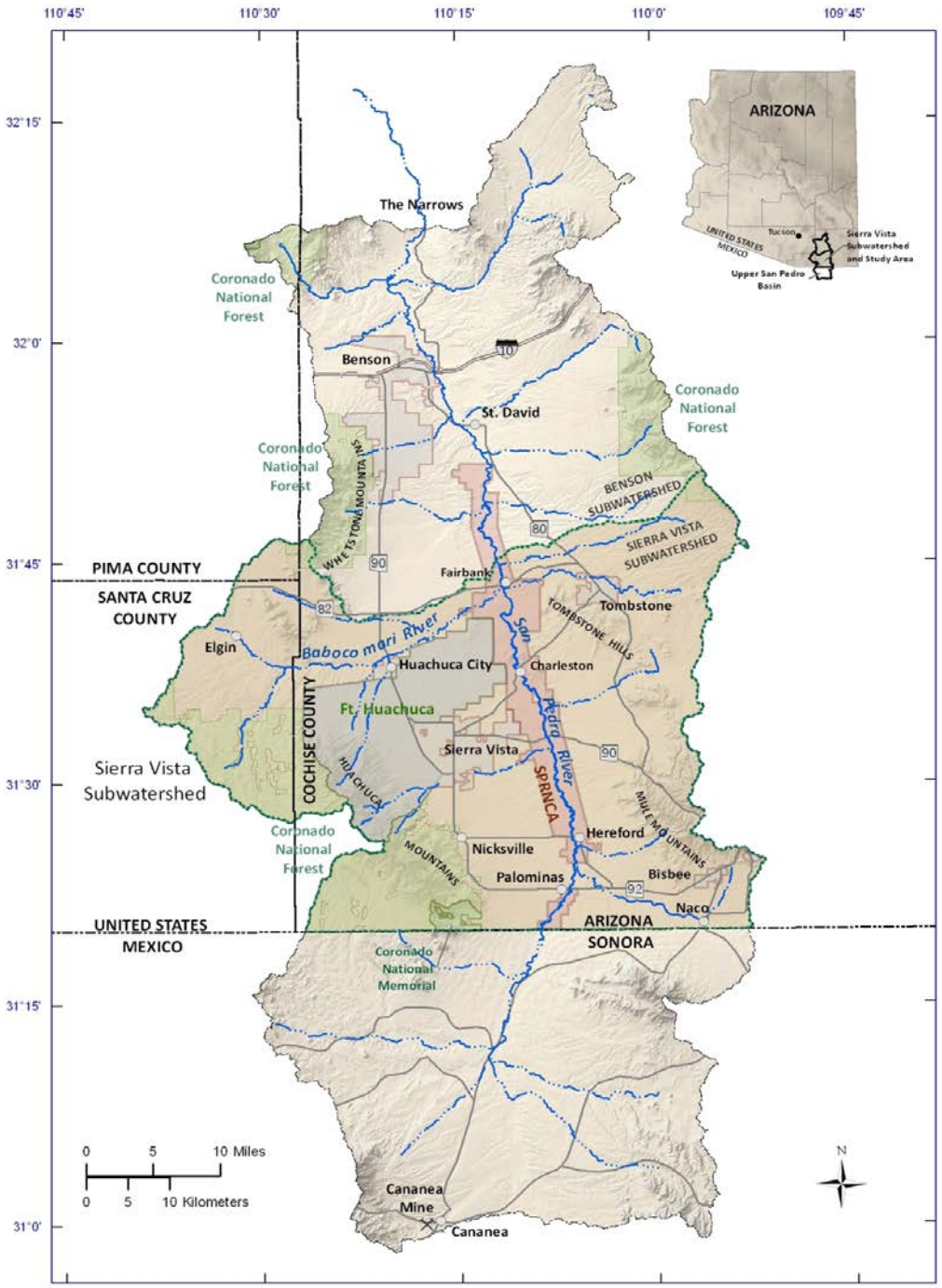
- ADWR's Rural Watershed Initiative fostered the establishment of the **Upper San Pedro Partnership in 1998**, with 21 local, state and federal member agencies (http://uppersanpedropartnership.org/)
- USGS was engaged as the honest broker for development of a shared groundwater model
- Sustainable yield was targeted as part of 2004 Defense Authorization Act, Section 321

The key question: What "no regrets" projects or policies could be implemented to not only reduce the existing annual deficit, but also address the ***cumulative impact*** of historic, current, and future pumping on the river?

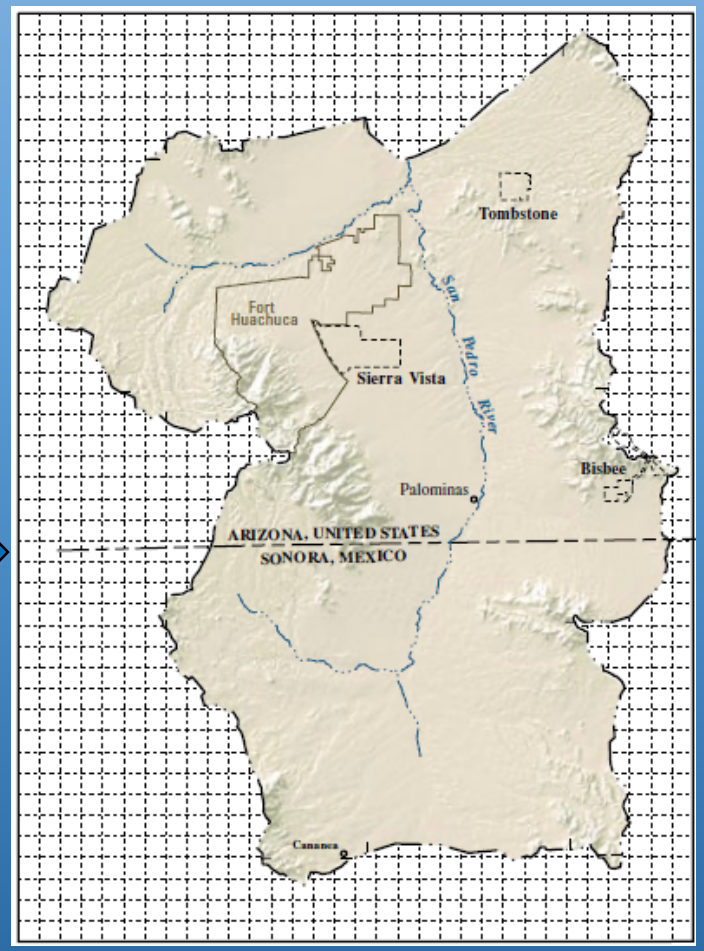
Ground-Water Flow Model of the Sierra Vista Subwatershed and Sonoran Portions of the Upper San Pedro Basin, Southeastern Arizona, United States, and Northern Sonora, Mexico

USGS Scientific Investigations Report 2006–5228
By D.R. Pool and Jesse E. Dickinson

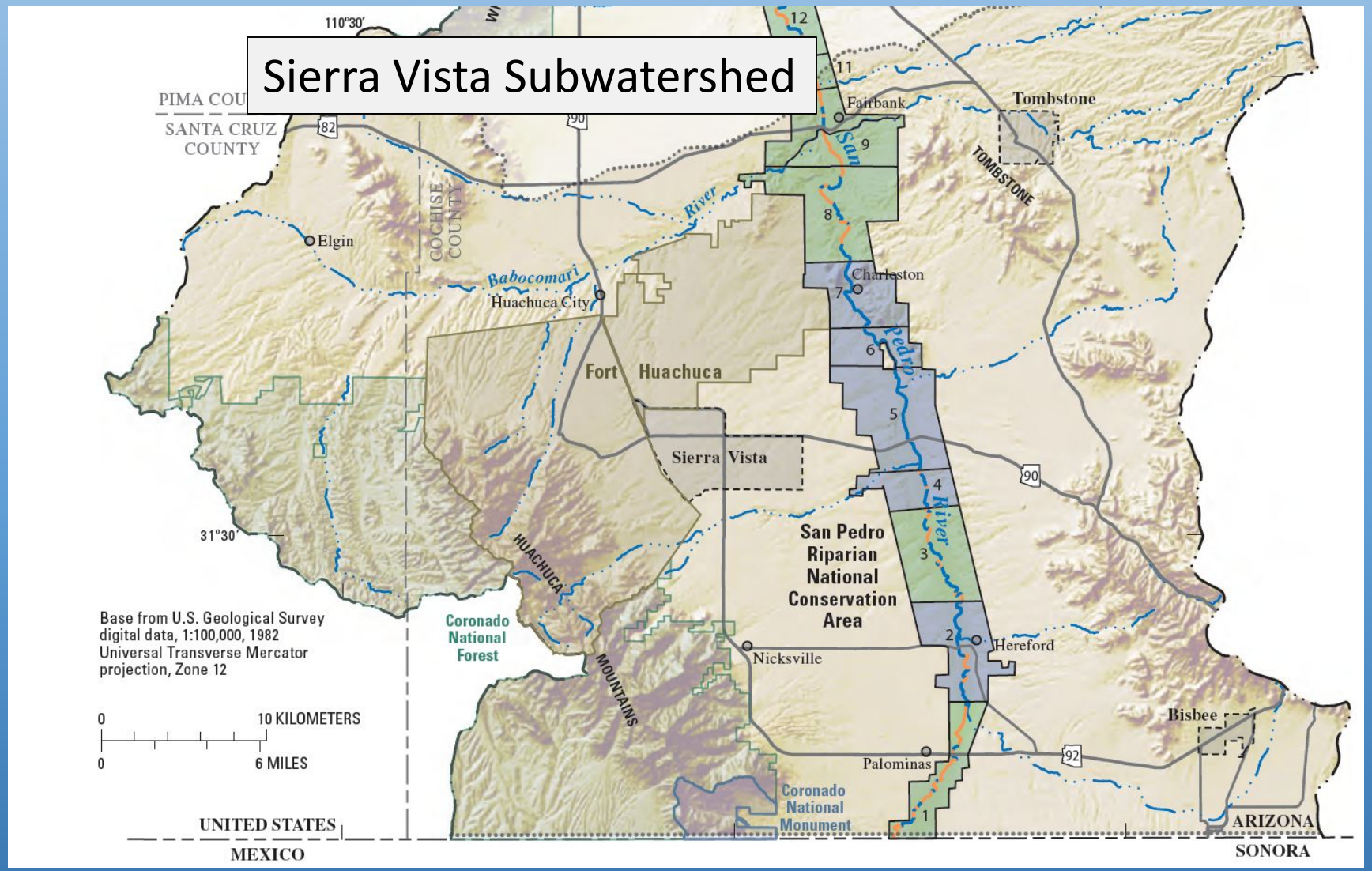
https://pubs.usgs.gov/sir/2006/5228/



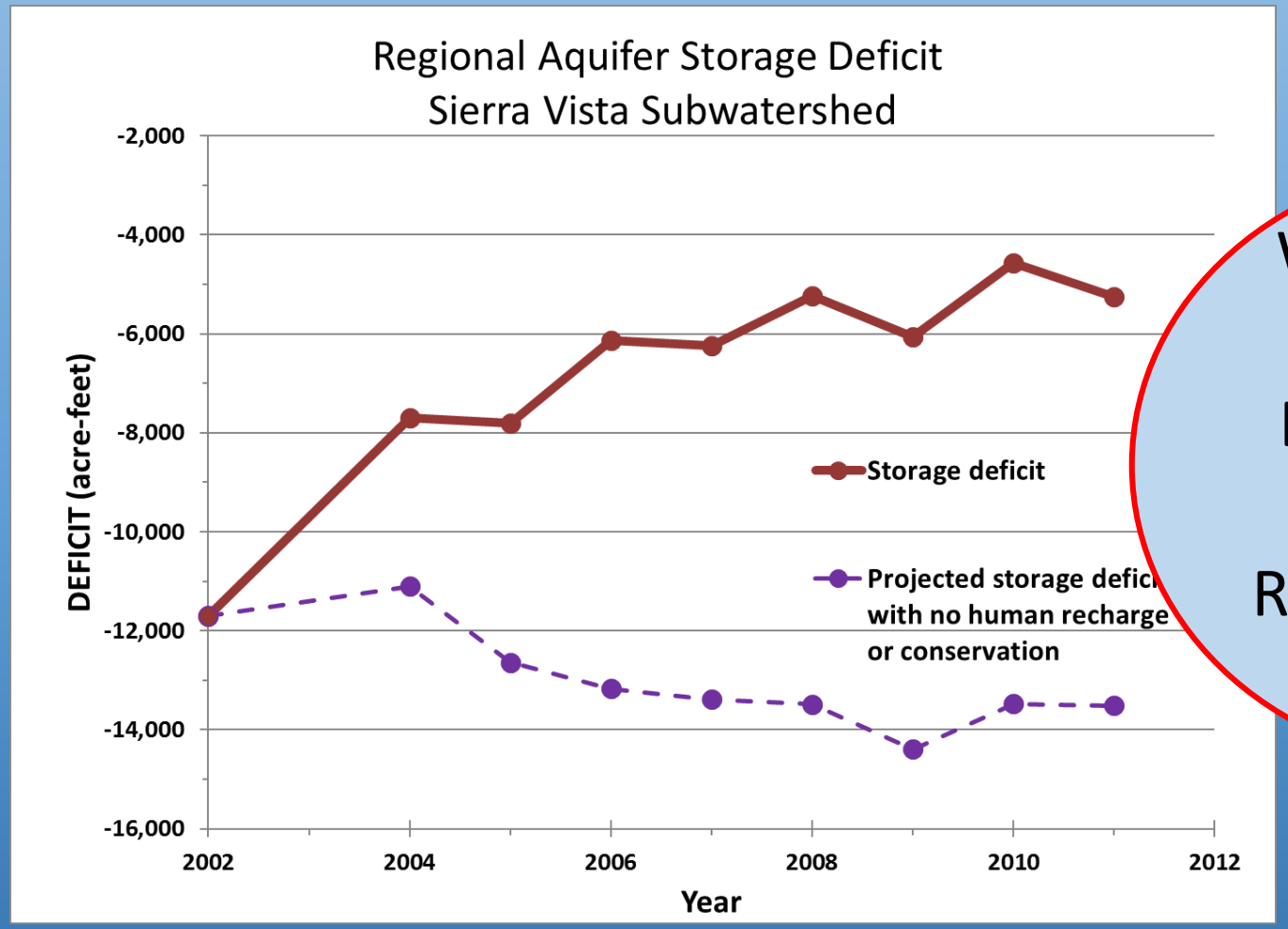
Courtesy of the USGS



Sierra Vista Subwatershed

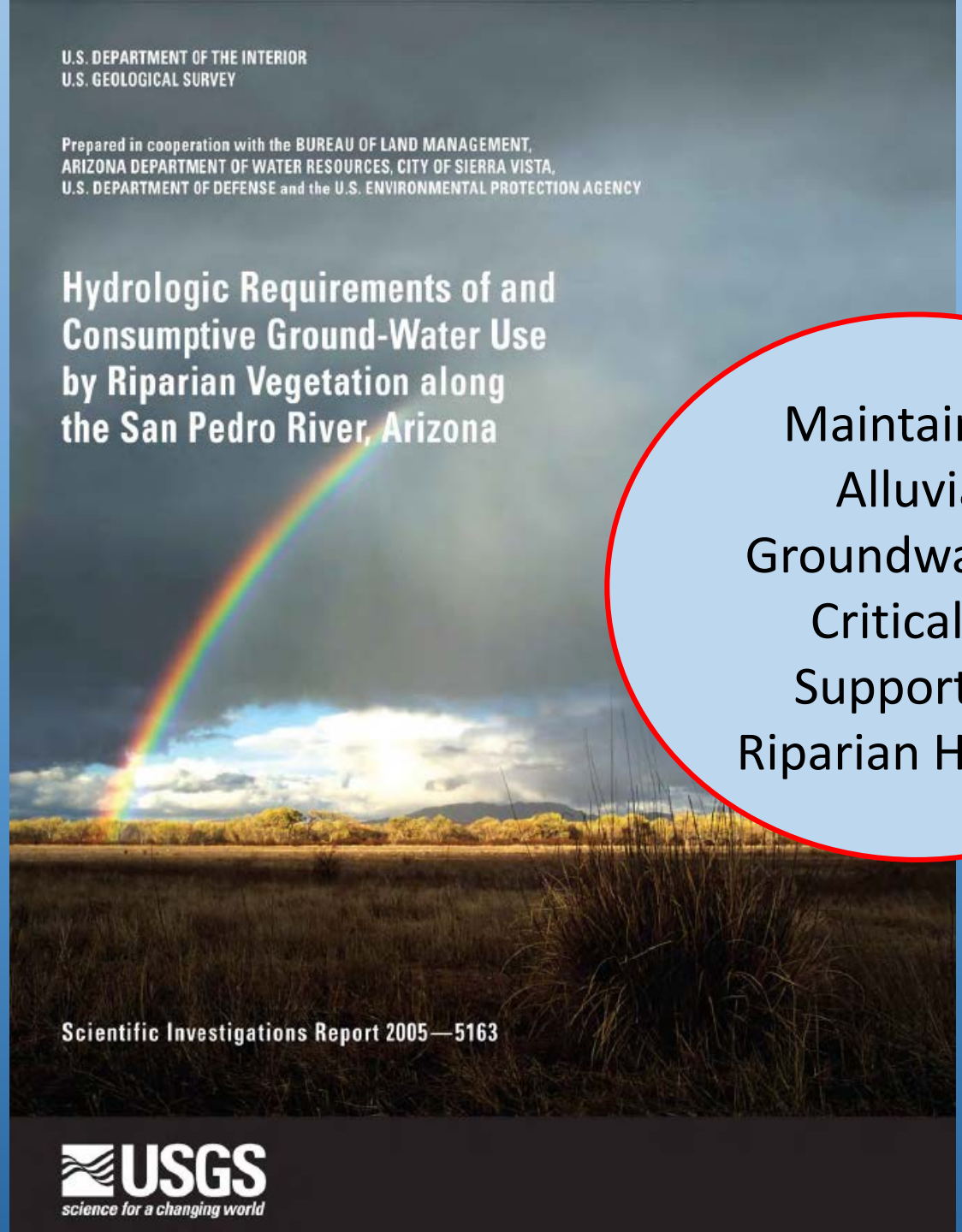


Demand Reduction Measures



Water Budget Approach Did Not Meet Spatially Relevant Needs of River

Source: Upper San Pedro Partnership, 2013, Water management of the regional aquifer in the Sierra Vista Subwatershed, Arizona—2011 report to Congress: Washington, D.C., U.S. Department of Interior, 16 p.
http://uppersanpedropartnership.org/wp-content/uploads/2017/10/2011321ReportDRAFT05-07-13.pdf



Maintaining Alluvial Groundwater is Critical to Supporting Riparian Habitat

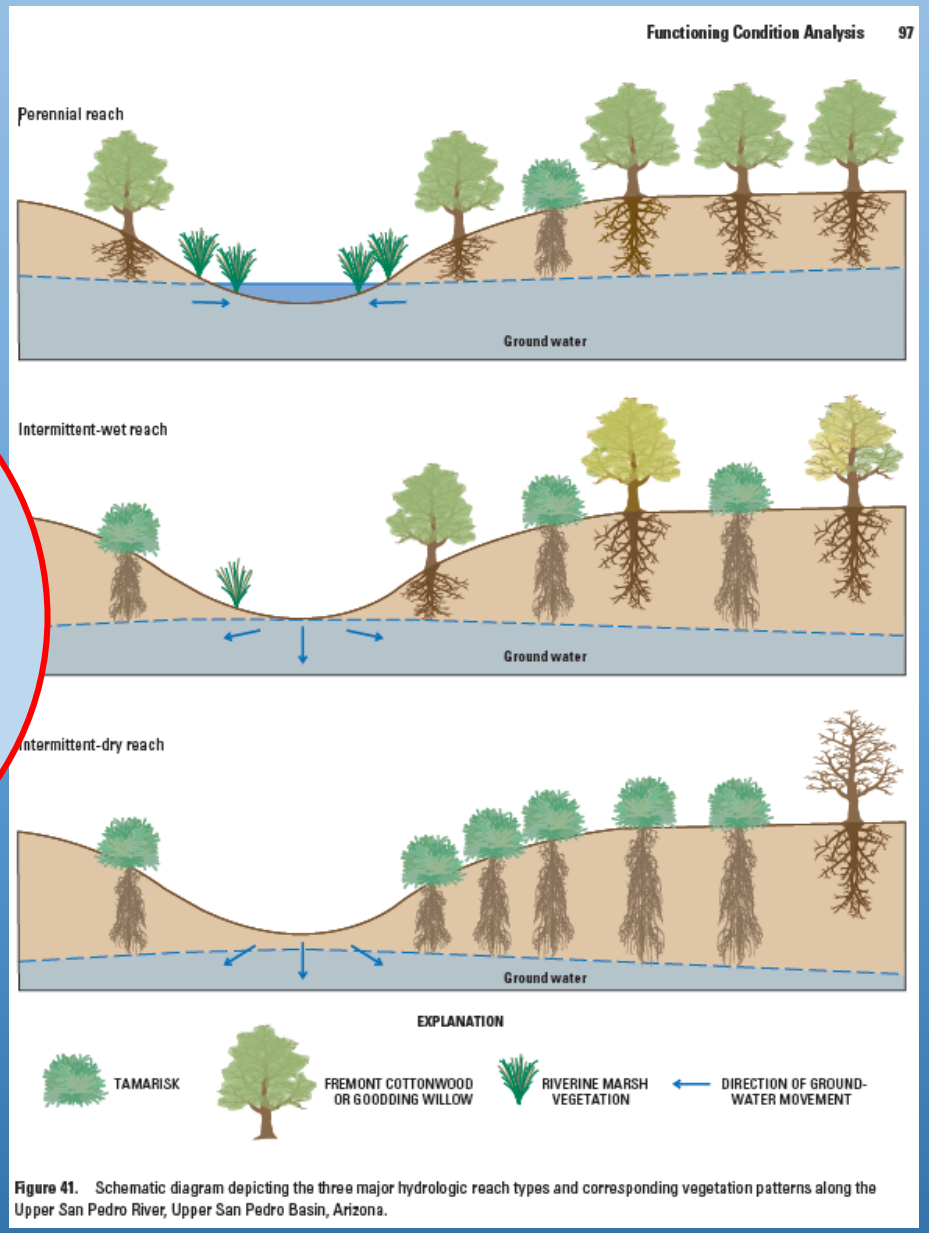


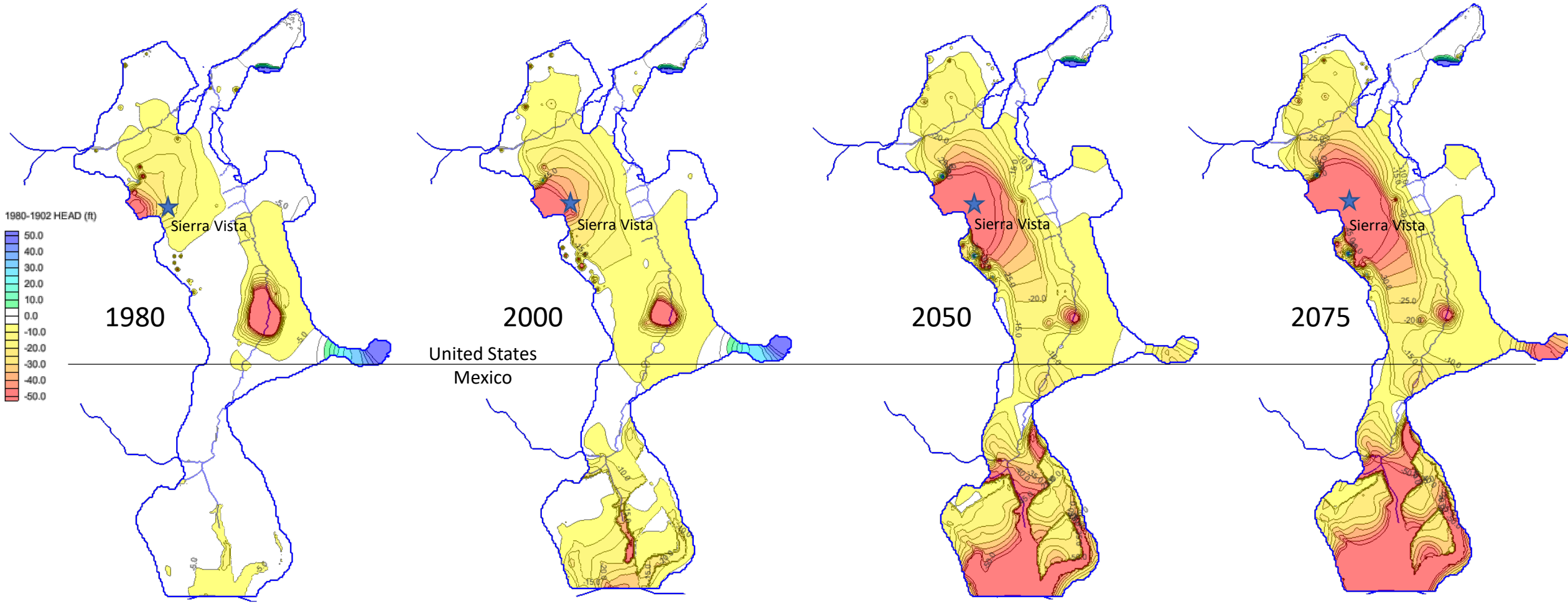
Figure 41. Schematic diagram depicting the three major hydrologic reach types and corresponding vegetation patterns along the Upper San Pedro River, Upper San Pedro Basin, Arizona.

https://pubs.usgs.gov/sir/2005/5163/


-Challenge & Vision
-Model Development
-Model Scenarios.

CCRN Challenge and Vision…

Simulated Drawdown in Regional Aquifer of Upper San Pedro Basin (ft)



Lacher Hydrological Consulting

CCRN Cochise Conservation & Recharge Network

WHO: Sierra Vista, Bisbee, Cochise County, Hereford Natural Resources Conservation District, The Nature Conservancy

WHAT: **Implement network of recharge projects to meet environmental, social, economic needs**

WHERE: 7 sites totaling 6,344 acres along 25 miles of the river

https://ccrnsanpedro.org/

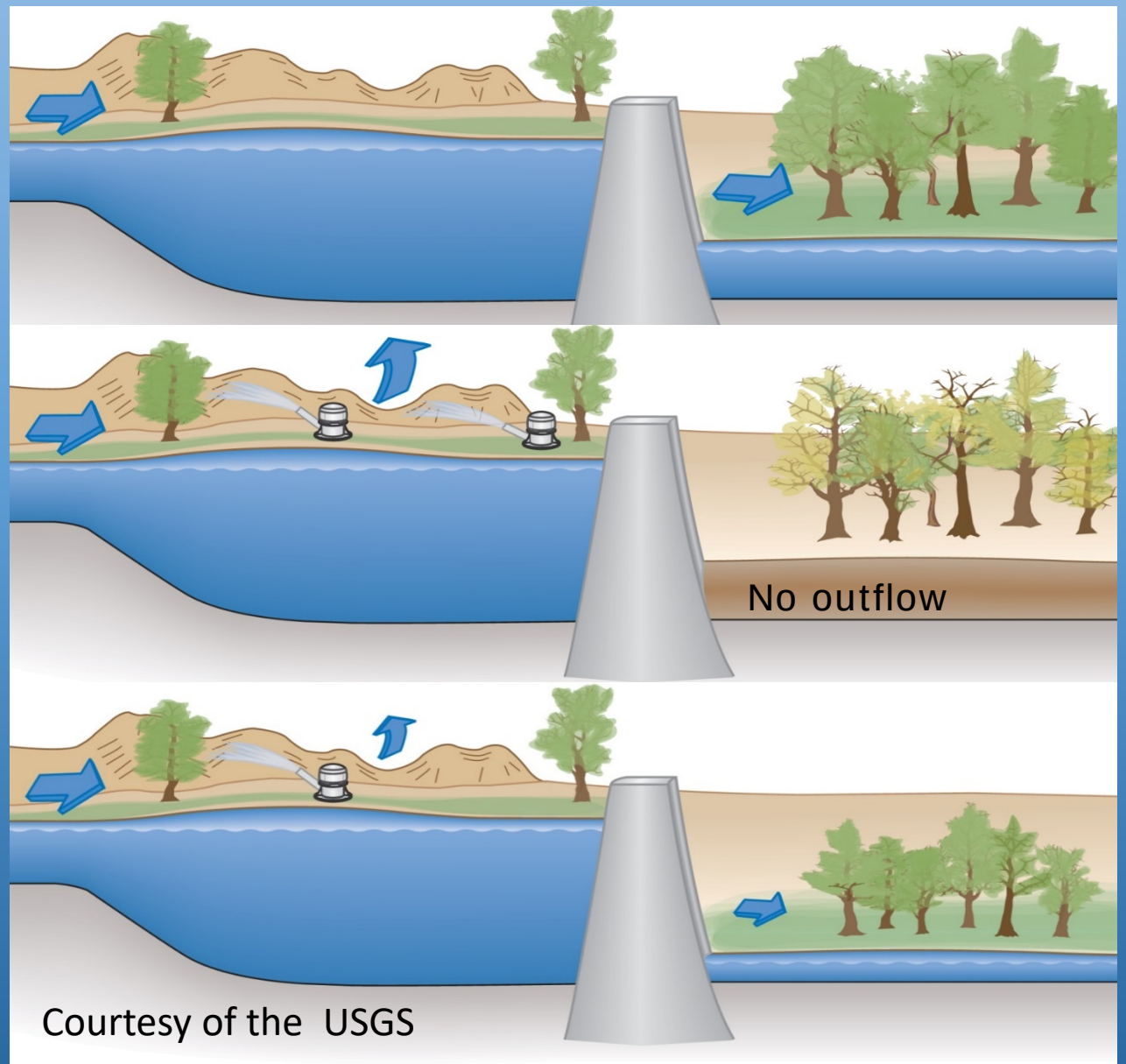
Sustainable Yield of Groundwater

Development and use of groundwater in a manner that can be maintained for an indefinite time without causing unacceptable environmental, economic, or social consequences

-U.S. Geological Survey, 1999

https://pubs.usgs.gov/circ/circ1186/pdf/circ1186.pdf

SUSTAINABLE YIELD



No Pumping

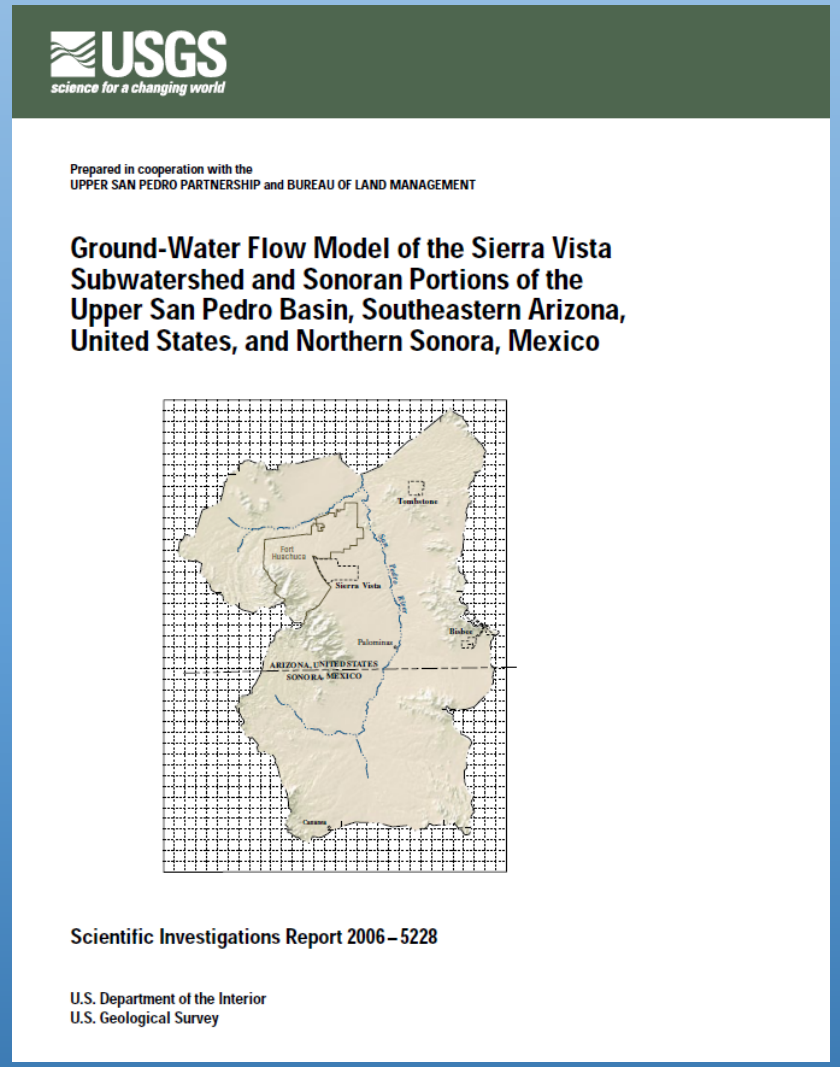
Safe Yield
(Pumping=Inflows)

Sustainable Yield assumes the consequences are acceptable

Model Development

Upper San Pedro Basin Model

- 250 m x 250 m grid size
- 5-layer MODFLOW model
- 1902-2003 Calibration period
- Published by USGS in 2007
- Updated by Lacher in 2011, 2017 to project pumping and recharge out to 2100.
- Other minor updates to improve EOP and Bisbee recharge representation and to extend Charleston wash into Bella Vista


USGS
science for a changing world

Prepared in cooperation with the
UPPER SAN PEDRO PARTNERSHIP and BUREAU OF LAND MANAGEMENT

Ground-Water Flow Model of the Sierra Vista Subwatershed and Sonoran Portions of the Upper San Pedro Basin, Southeastern Arizona, United States, and Northern Sonora, Mexico

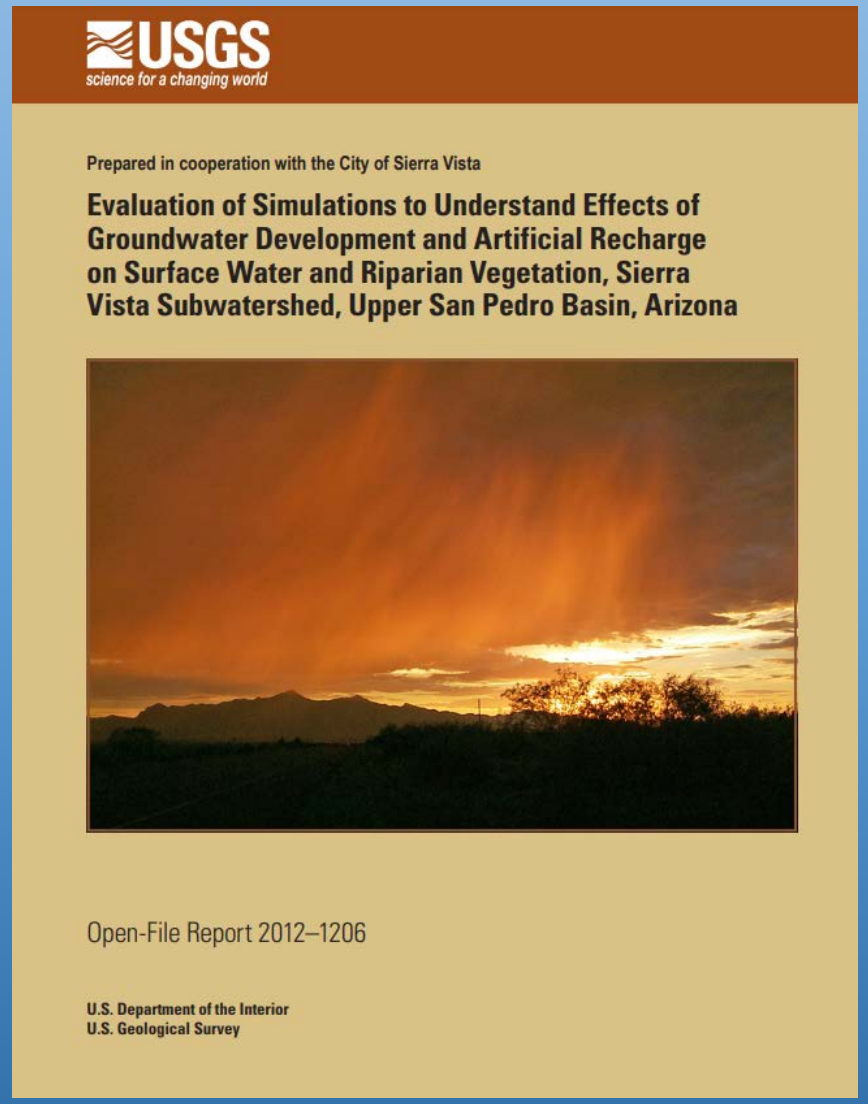
Scientific Investigations Report 2006–5228

U.S. Department of the Interior
U.S. Geological Survey

https://pubs.usgs.gov/sir/2006/5228/

USP Basin Model 2011 Update, USGS Review:

"Lacher made updates and a few corrections to the USGS groundwater flow model. In spite of concerns related to artificial boundary conditions, her applications constitute a reasonable use of the model for basin-wide evaluations of effects for groundwater pumping and artificial recharge."



https://pubs.usgs.gov/of/2012/1206/of2012-1206.pdf

Corrections to pre-2003 USGS model…

Wells Removed from USGS Model	AF (2002)
PUMPING	
Commercial-Industrial	0.00
Fort Huachuca	-43.73
Municipal	-322.95
Stock	0.00
Unused	-171.55
Total Pumping Removed	**-538.23**
RECHARGE	
Municipal	87.88
Stock	0.00
Unused	19.96
Domestic	-1453.92
Vineyard	0.00
Total Recharge Removed	**-1346.08**
Net Pumping Removed	-1884.31

Model files: http://uppersanpedropartnership.org/groundwater-model-dss/

Report: http://uppersanpedropartnership.org/wp-content/uploads/2018/03/Update-to-Pumping-Rates-in-Upper-San-Pedro-Basin-Groundwater-Model_Feb-2018.pdf

2017 Pumping Updates

Actual/Estimated Pumping:

- Reported Sierra Vista subwatershed (SVS) pumping 2003-2015 from water companies & utilities.
- Estimated unmetered-well pumping for exempt and non-exempt wells (2013).
- Projected Pumping:
- Based on latest (2015) population projections and per-capita water use rates.
  - Muni & domestic only

http://uppersanpedropartnership.org/groundwater-model-dss/

2017 Recharge Updates

- Incidental Recharge
  - Computed as a fraction of pumping
    - Septic systems (14% of pumping)
    - Irrigation excess water use
- Managed Aquifer Recharge
  - Wastewater treatment
    - EOP (Sierra Vista)
    - Greenbush Draw (Bisbee-Naco)
  - Storm-water
    - Palominas Recharge Project

http://uppersanpedropartnership.org/groundwater-model-dss/

Not Changed In 2011 or 2017 Updates

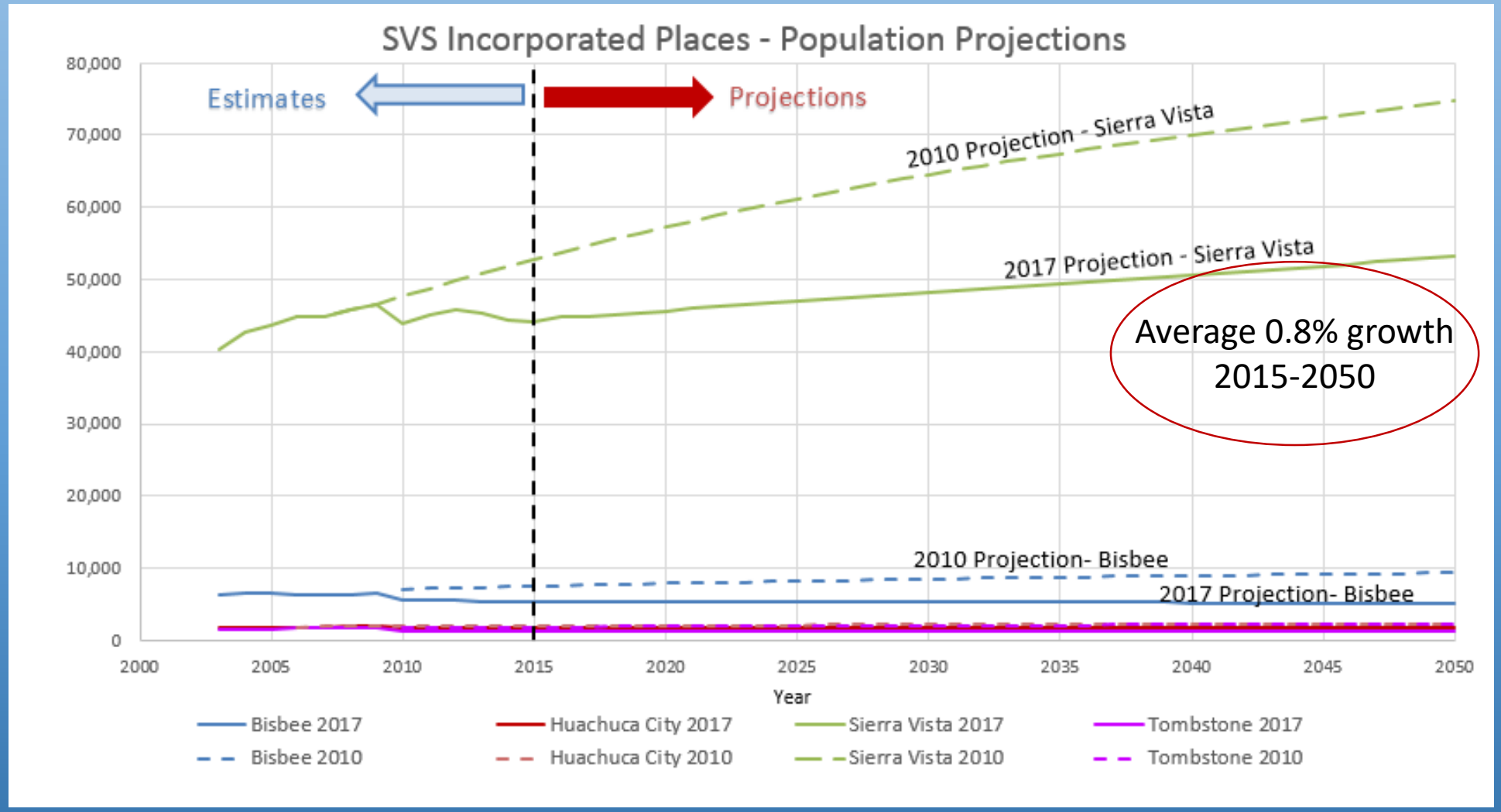
Pumping

- US Mining & Ag
- All Mexico

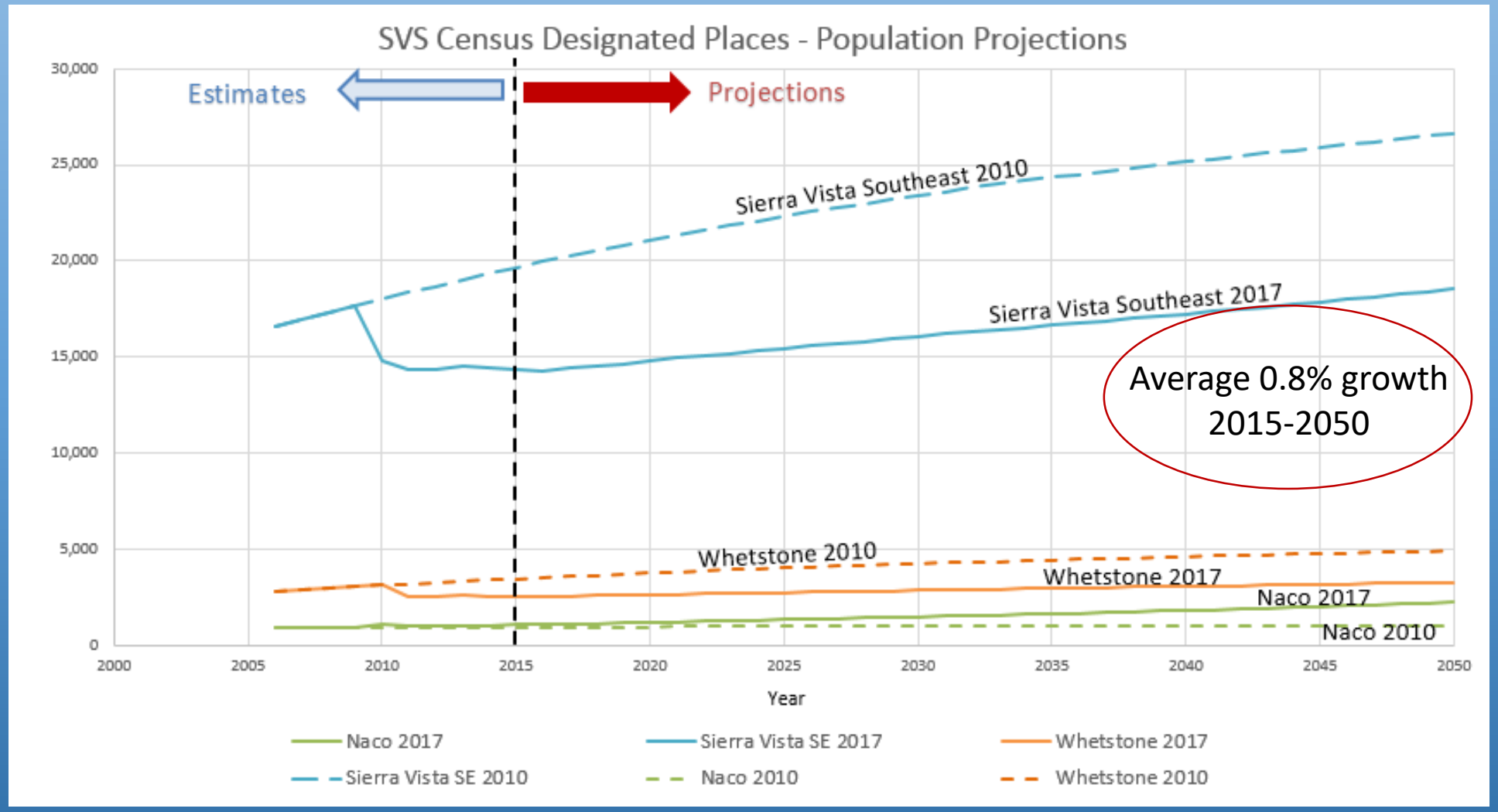
Recharge

- Natural (climate)
- Park areas

http://uppersanpedropartnership.org/groundwater-model-dss/



http://uppersanpedropartnership.org/groundwater-model-dss/



http://uppersanpedropartnership.org/groundwater-model-dss/

Comparison of Recent Simulated and Estimated Unmetered SVS Pumping (AF)

Unmetered Well Category	Pool & Dickinson (2007) Simulated 2002 Values	Plateau Resources (2013) Estimated 2012 Values[1]		Gungle, et. al (2016) Estimated 2012 Values		Mean of Estimated 2012 Values	Lacher (2017) Simulated 2012 Values
		mean	*range*	mean	*range*		
Domestic	1234[2]	1,250	*1135 to 1366*	1400[3]	*700 to 2100*	1,325	1,216
Commercial-Industrial (including golf courses)	1,388	1,056	*1065 to 1070*[4]	983[5]	*900 to 1500*[6]	1,026	1,301
Large Outdoor/Irrigation (excluding golf courses)[7]	413	505	*425 to 584*	50	*0 to 150*	317	414
Stock and Other Undefined	1,657	57[8]	n/a	57[9]	n/a	57	57
Subtotal	3,607	2,880	*1823.3 to 2042.5*	2,650	*1600 to 3750*	2,725	2,987
State Trust Land	171			n/a			171
Sand & Gravel	307			160			307

Notes:

1-All estimates from Plateau Resources (2013) except "Stock" value, which is from Hereford NRCD (Upper San Pedro Partnership Tech. Comm., Apr 2014)

2 - Pool & Dickinson (2007) value includes 1180 for "Domestic" and 53 AF of "Undetermined" category in ADWR Well Registry

3- Values include stock estimate of 12 AF

4- 1200 minus 57 for stock and 160 for sand & gravelIncludes all rural/exempt-well pumping (stock, comm-industrial, and other outdoor uses)

5- Turf (including golf courses)

6 - Range includes stock plus sand & gravel

7 - Pool & Dickinson (2007) value includes 265 for vineyards and 83 for other irrigation

8 - Plateau Res. (2013) figure is 12 AF for 1 cattle ranch with 900 head

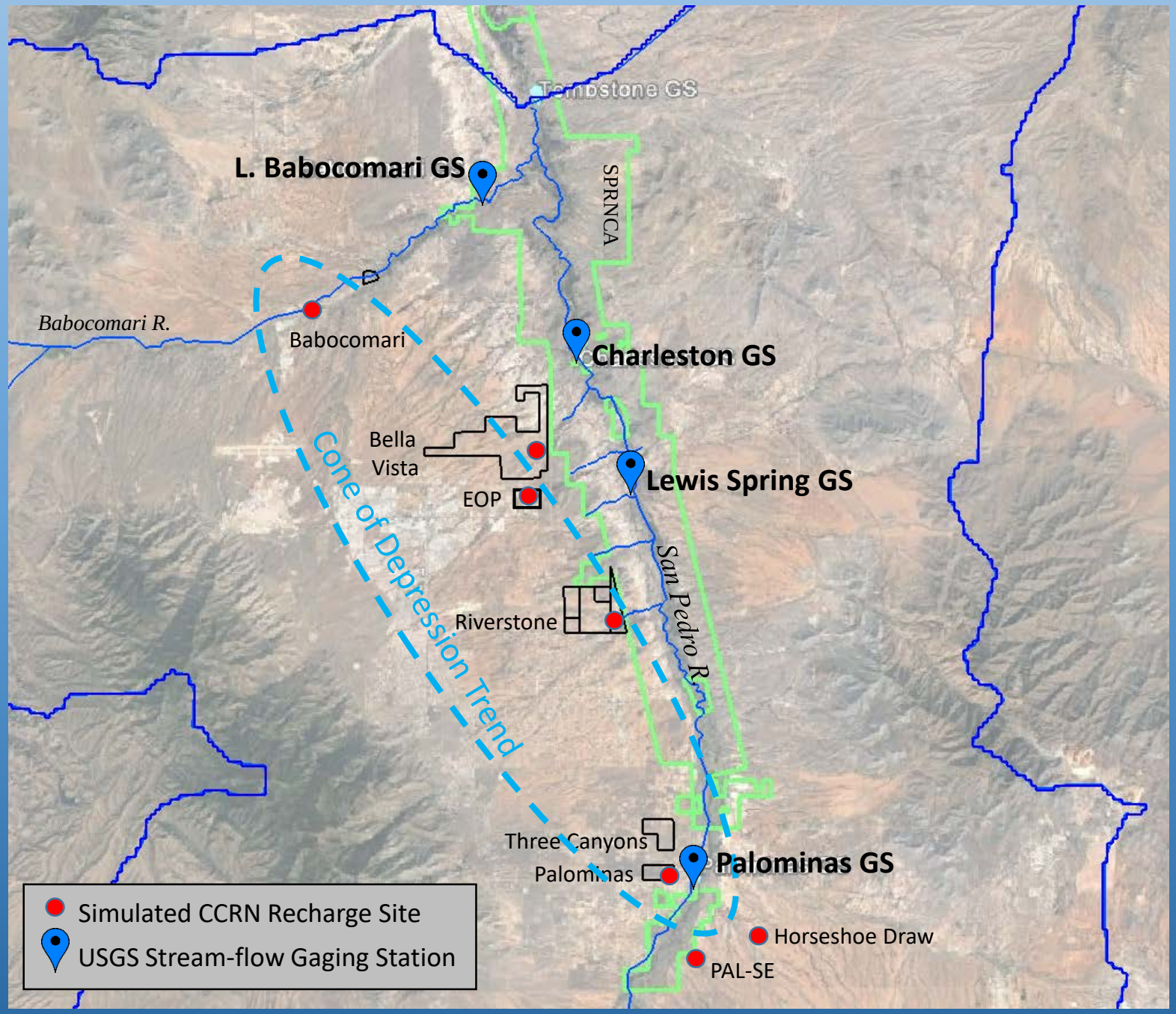
9 - Included in "Commercial-Industrial" in report.

n/a = not applicable

http://uppersanpedropartnership.org/groundwater-model-dss/

CCRN Model Scenario…

Simulated CCRN Sites and USGS Stream-flow Gaging Stations



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GOAL:
Maintain 2003
Baseflows
at Nearest USGS G.S.

Simulated Managed Aquifer Recharge (2015-2075)

Hypothetical Recharge Senario	Site	Recharge Rate (AF/yr)	Start	Stop
CCRN Recharge	Babocomari	500*	2020	2075
	EOP Basins	1938	2015	2075
	EOP Wetlands	805	2015	2075
	Bella Vista	500	2020	2075
	Riverstone	400	2025	**2040**
	Riverstone	800	**2040**	2075
	Palominas RP	40	2016	2075
	Horseshoe Draw	40	2017	2075
	Palominas SE	428*	2020	2075
Total CCRN Recharge 2020-2039		4651		
Total CCRN Recharge 2040-2075		5051		
No Pumping/No Recharge	EOP Basins	1938	2015	2020
	EOP Wetlands	805	2015	2020
	Horseshoe Draw	40	2017	2020
	Bisbee/Greenbush Draw	280	2015	2020
	Ft Huachuca	716	2015	2020
	Palominas RP	40	2016	2020
Total Recharge 2015-2020		3819		

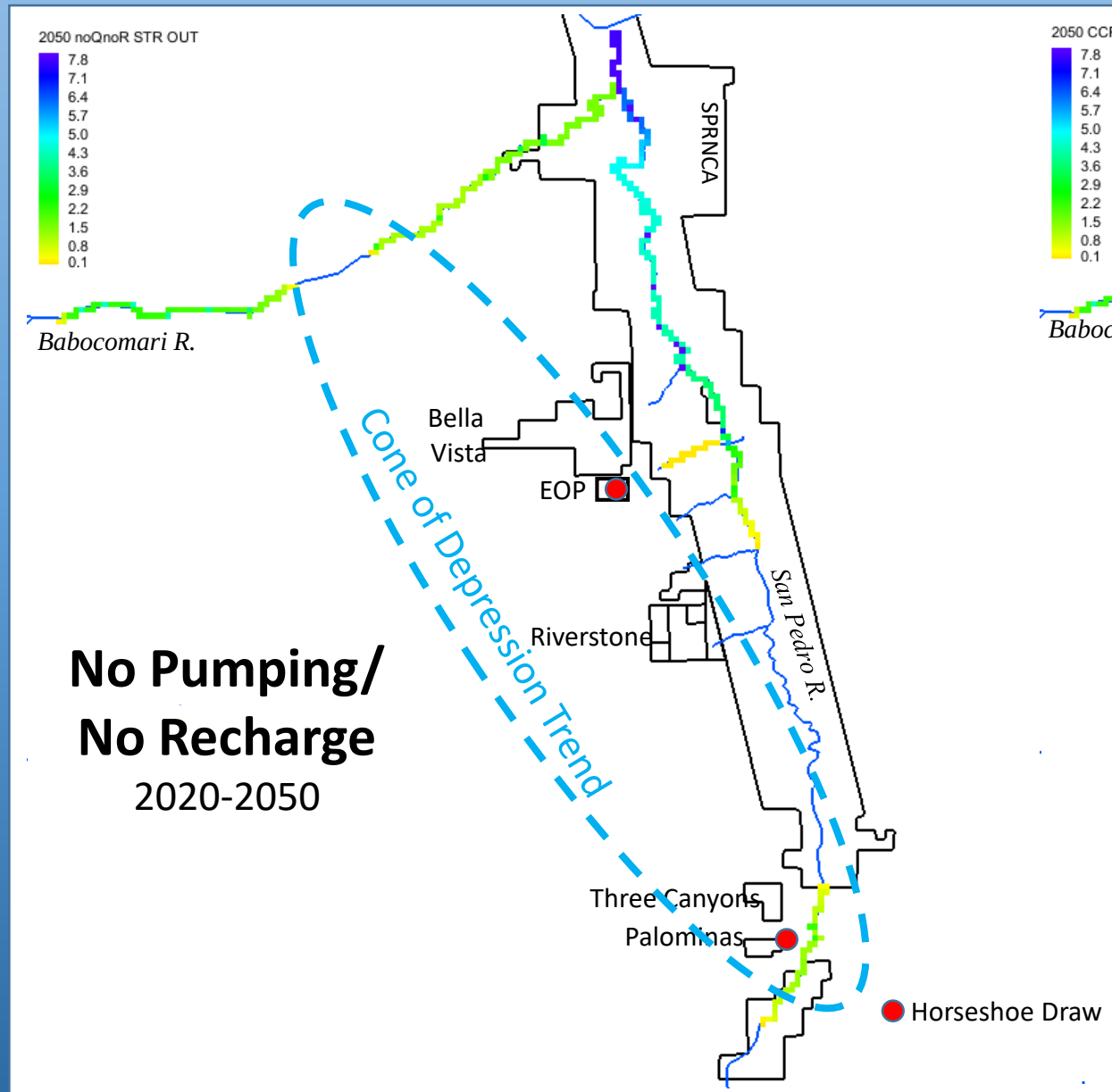
* Average of 2020-2075 stepped-up recharge rate

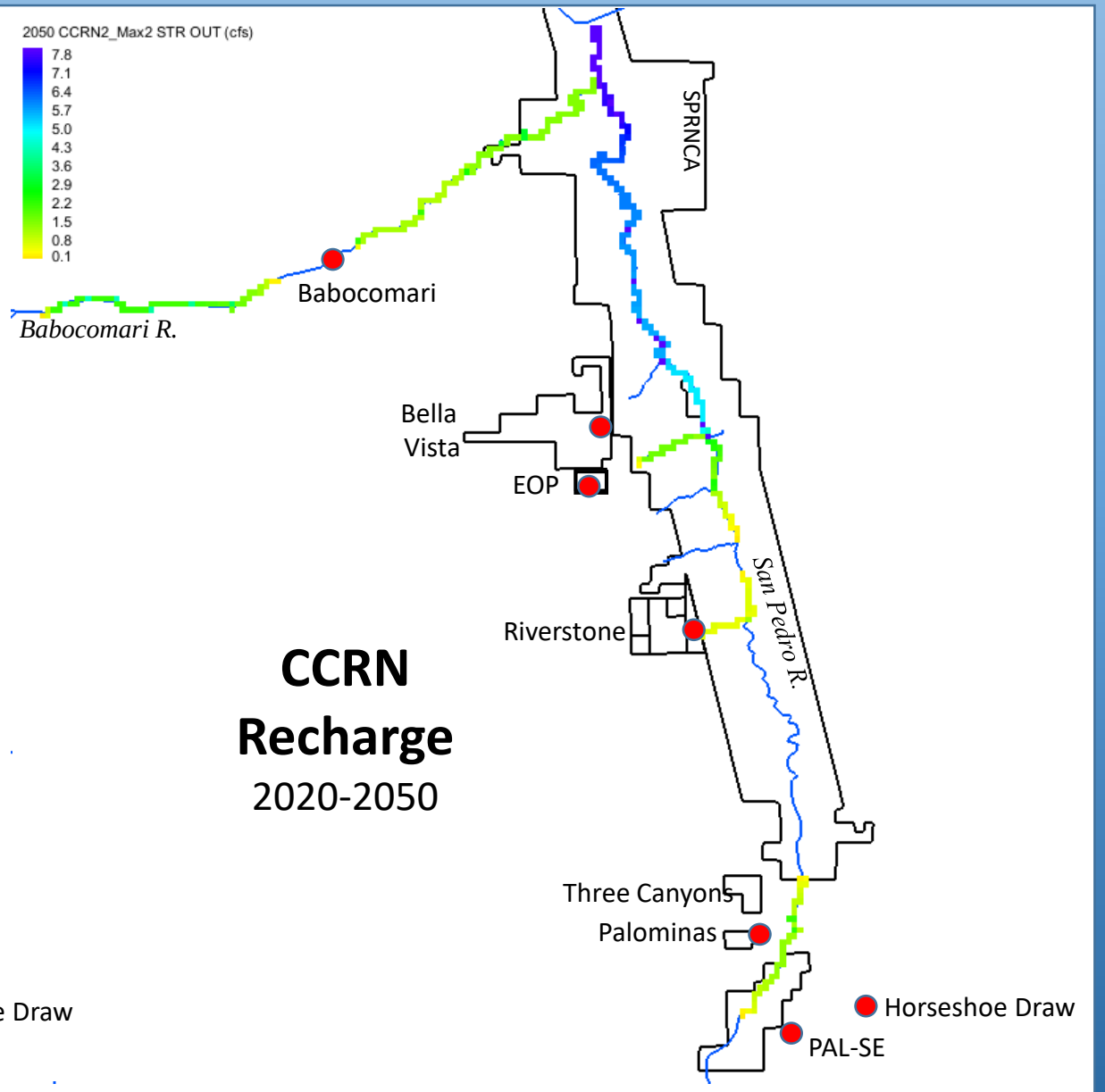
Simulation Results:

Spatial Patterns

Baseflow Trends

Simulated Baseflow in Sierra Vista Subwatershed in 2050 (cfs)





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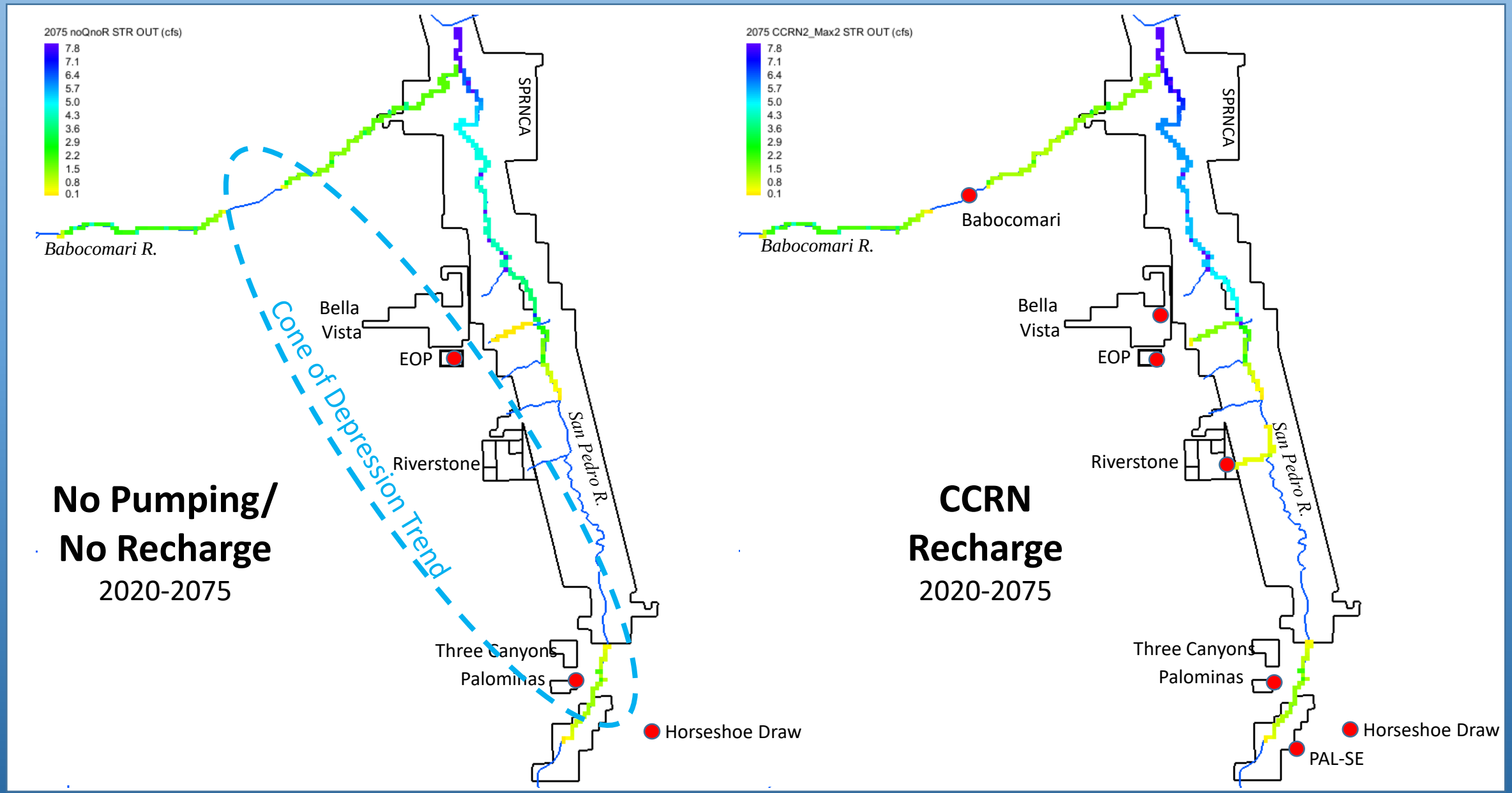
Simulated Baseflow in Sierra Vista Subwatershed in 2075 (cfs)



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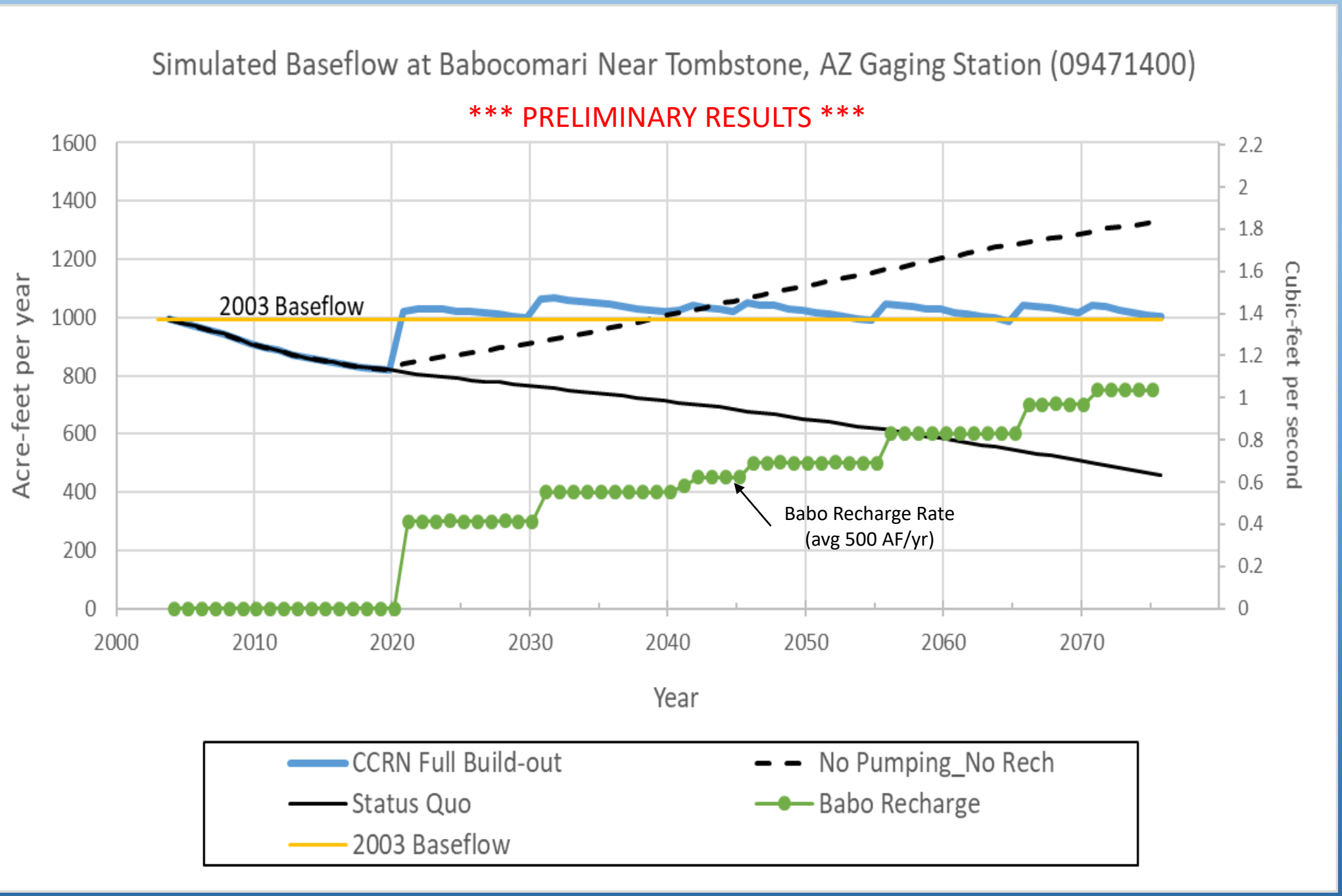
Simulation Results:

Baseflow at Gaging Stations



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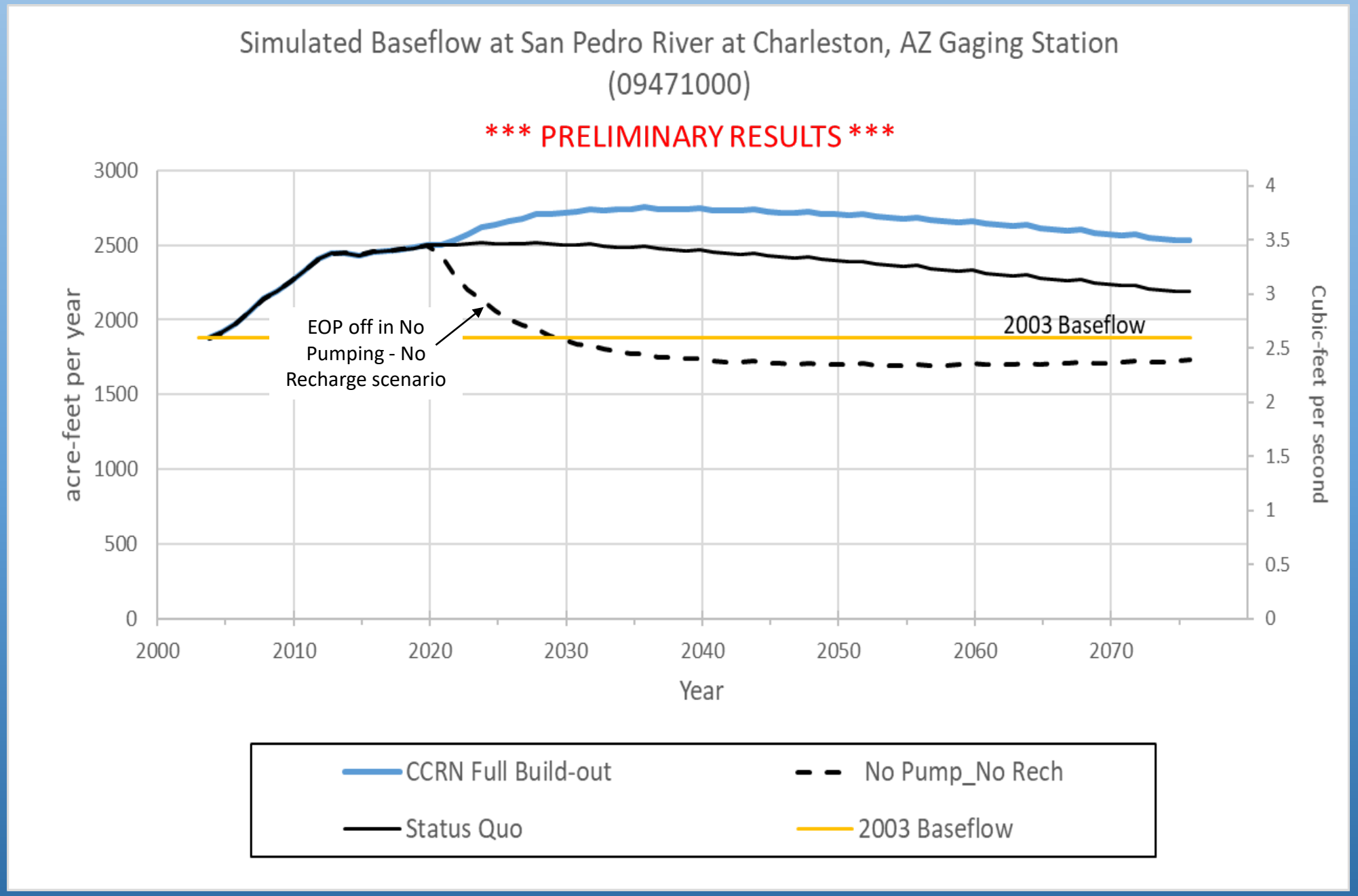

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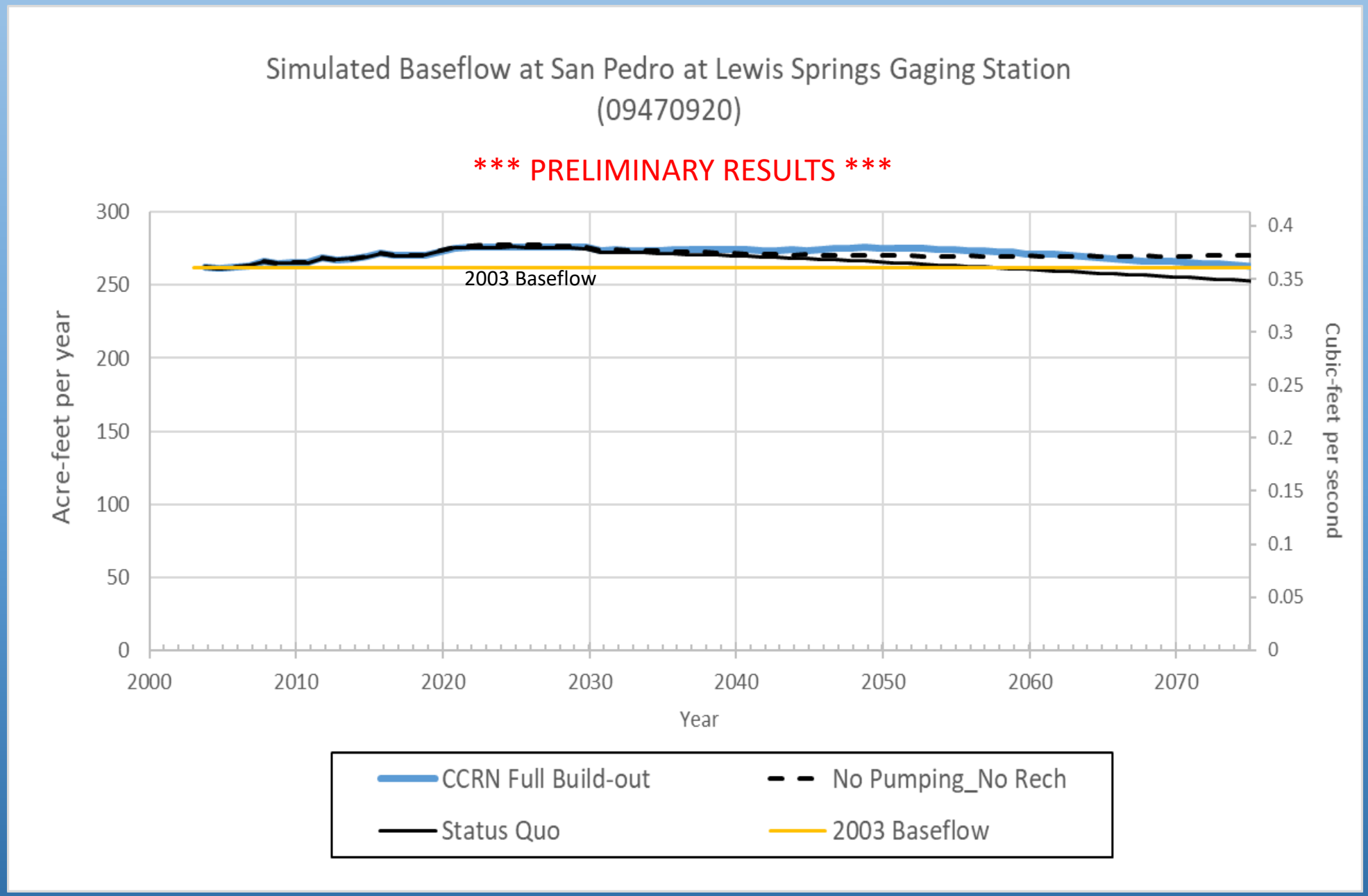
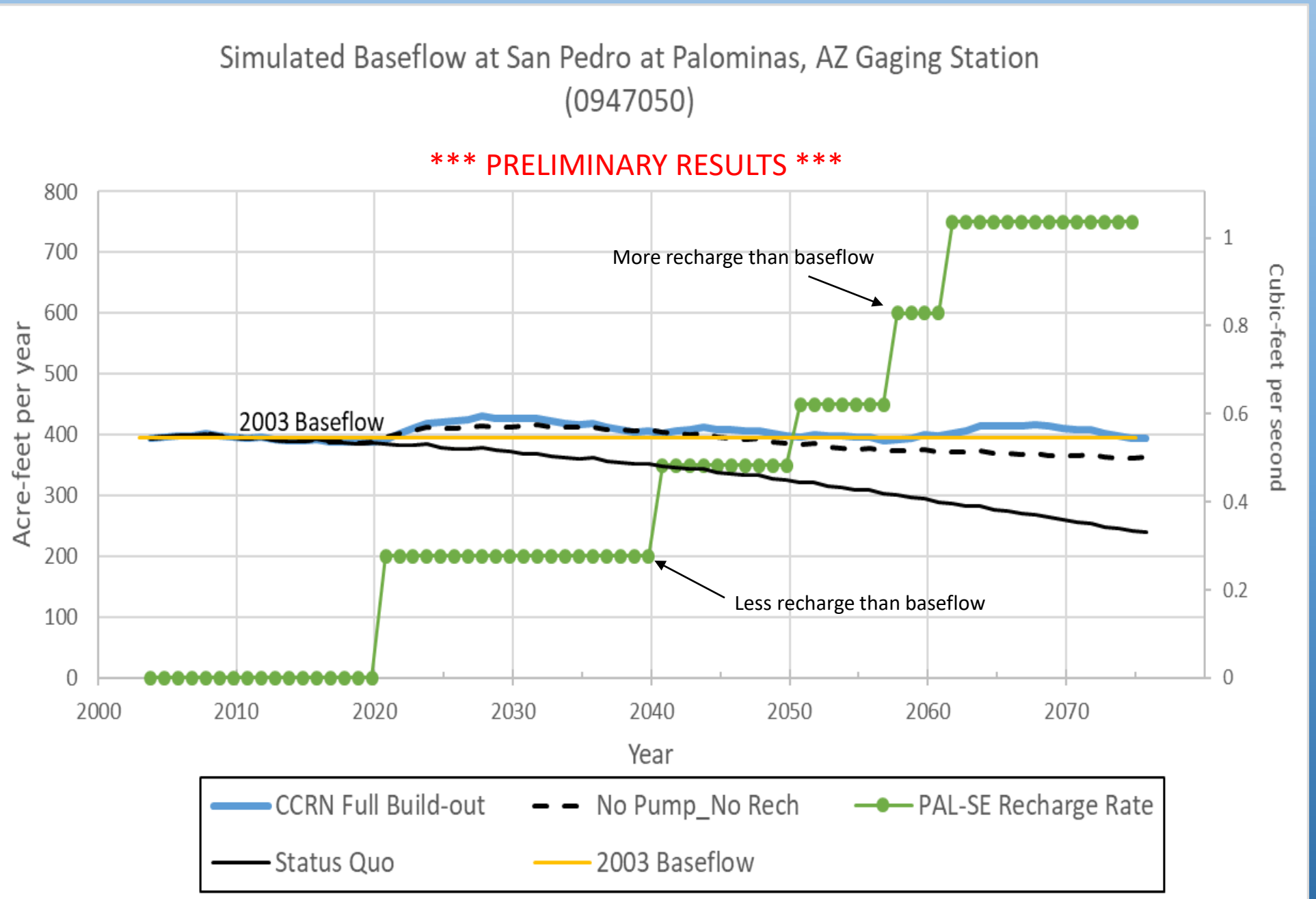

Simulated Baseflow at San Pedro at Lewis Springs Gaging Station
(09470920)
*** PRELIMINARY RESULTS ***
2003 Baseflow
Acre-feet per year
Cubic-feet per second
Year
300
250
200
150
100
50
0
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
2000
2010
2020
2030
2040
2050
2060
2070
CCRN Full Build-out
No Pumping_No Rech
Status Quo
2003 Baseflow



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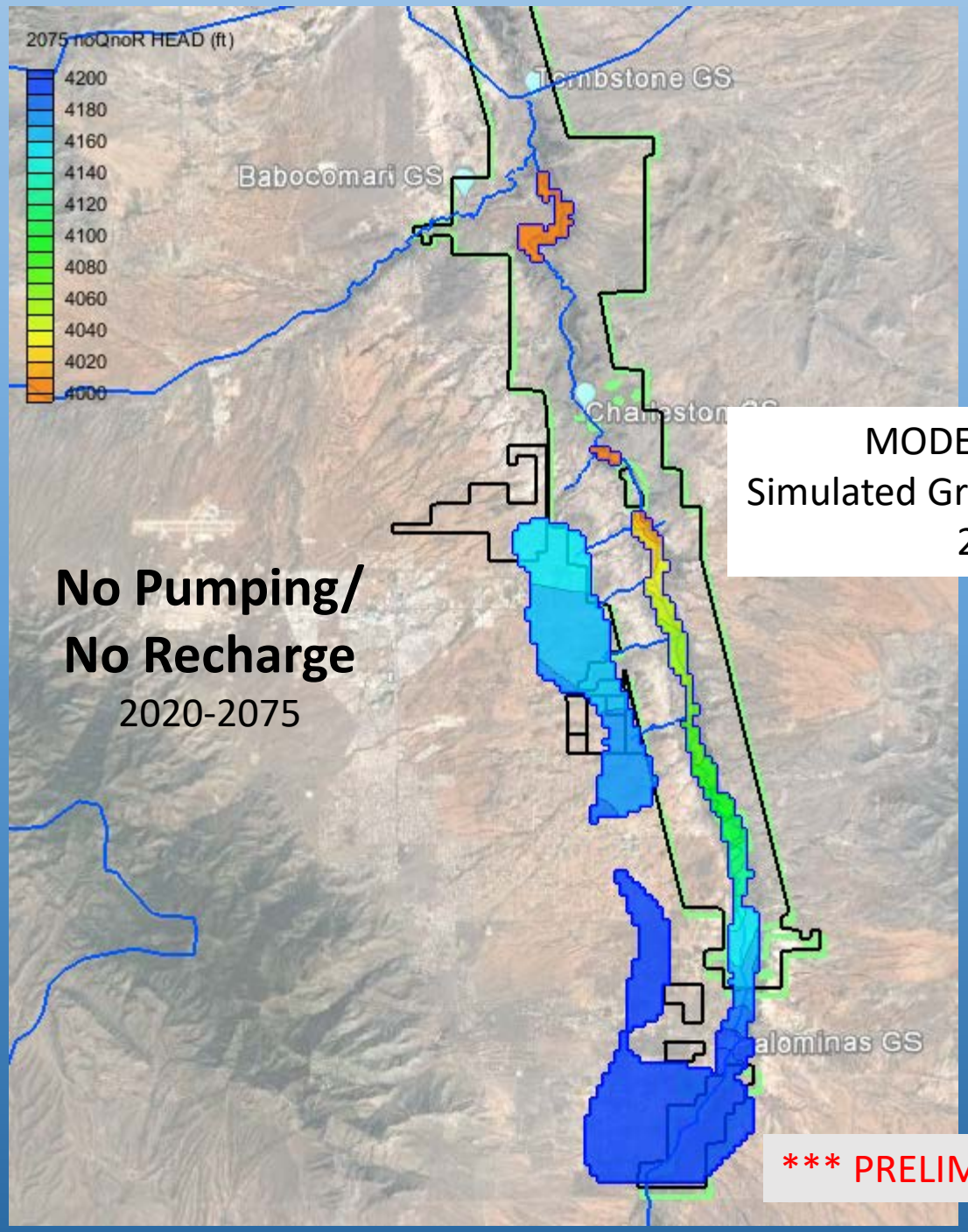
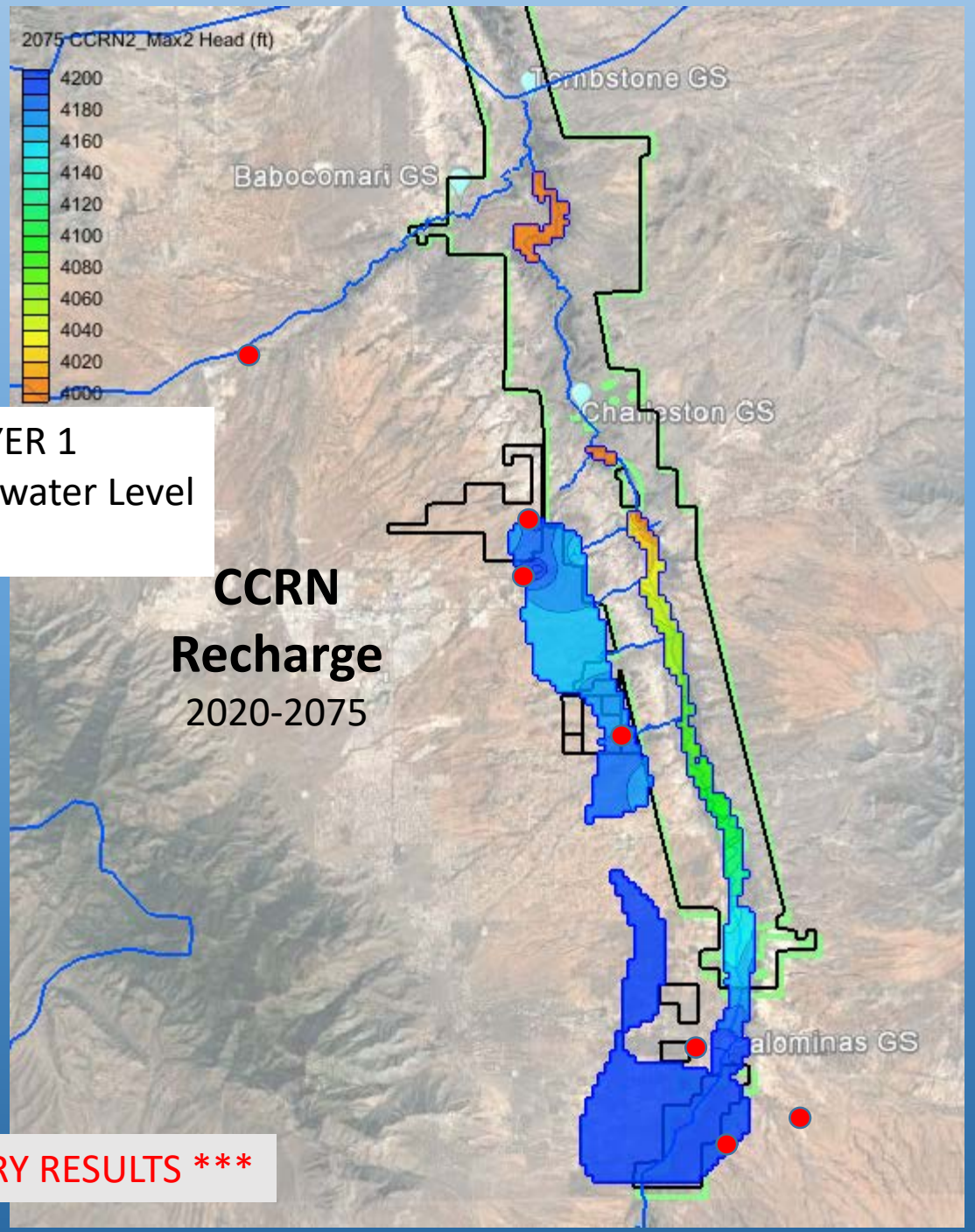
Simulation Results: Groundwater Levels (Head)





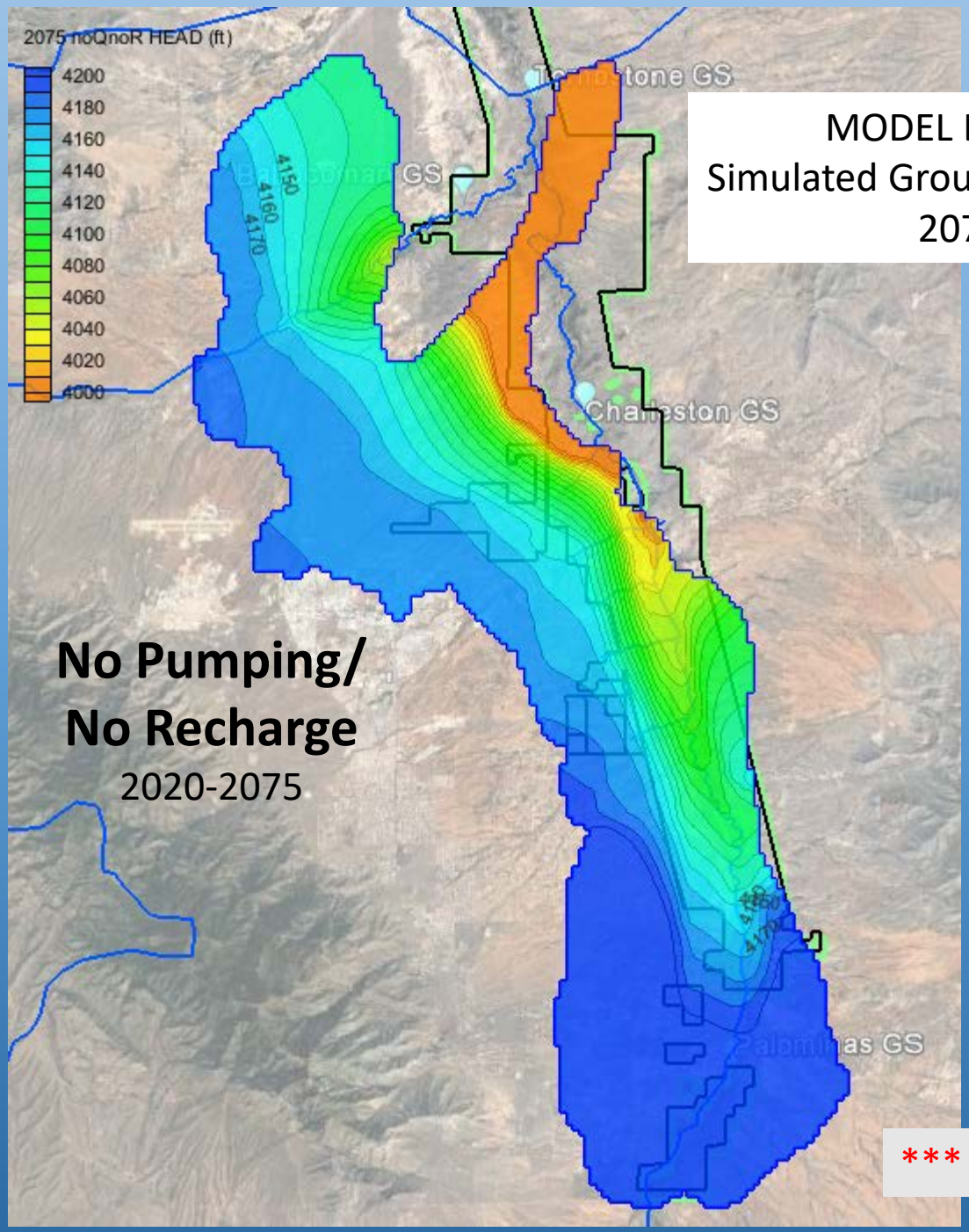
MODEL LAYER 1
Simulated Groundwater Level
2075

No Pumping/ No Recharge
2020-2075

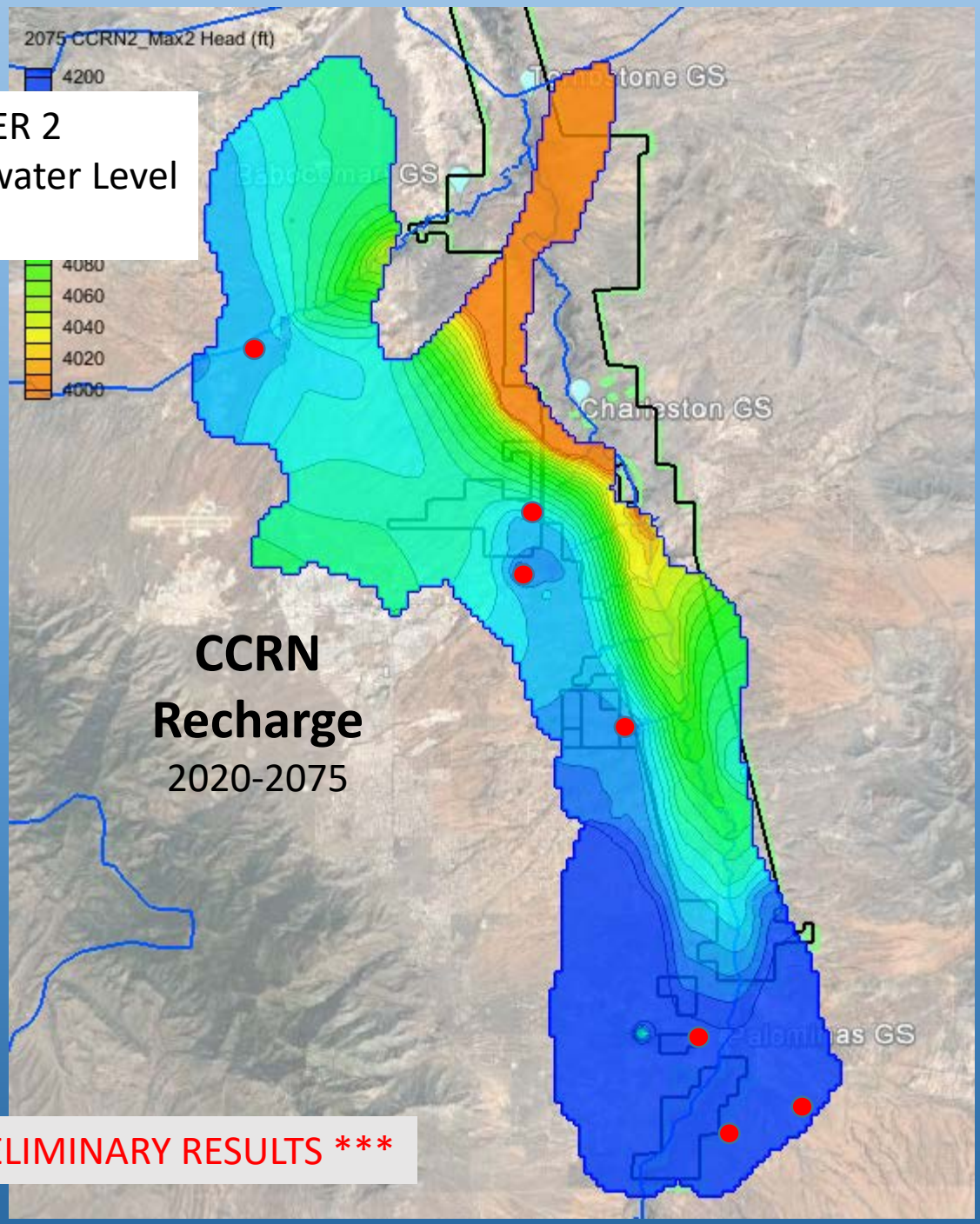
CCRN Recharge
2020-2075

*** PRELIMINARY RESULTS ***

Lacher Hydrological Consulting



MODEL LAYER 2
Simulated Groundwater Level
2075



*** PRELIMINARY RESULTS ***

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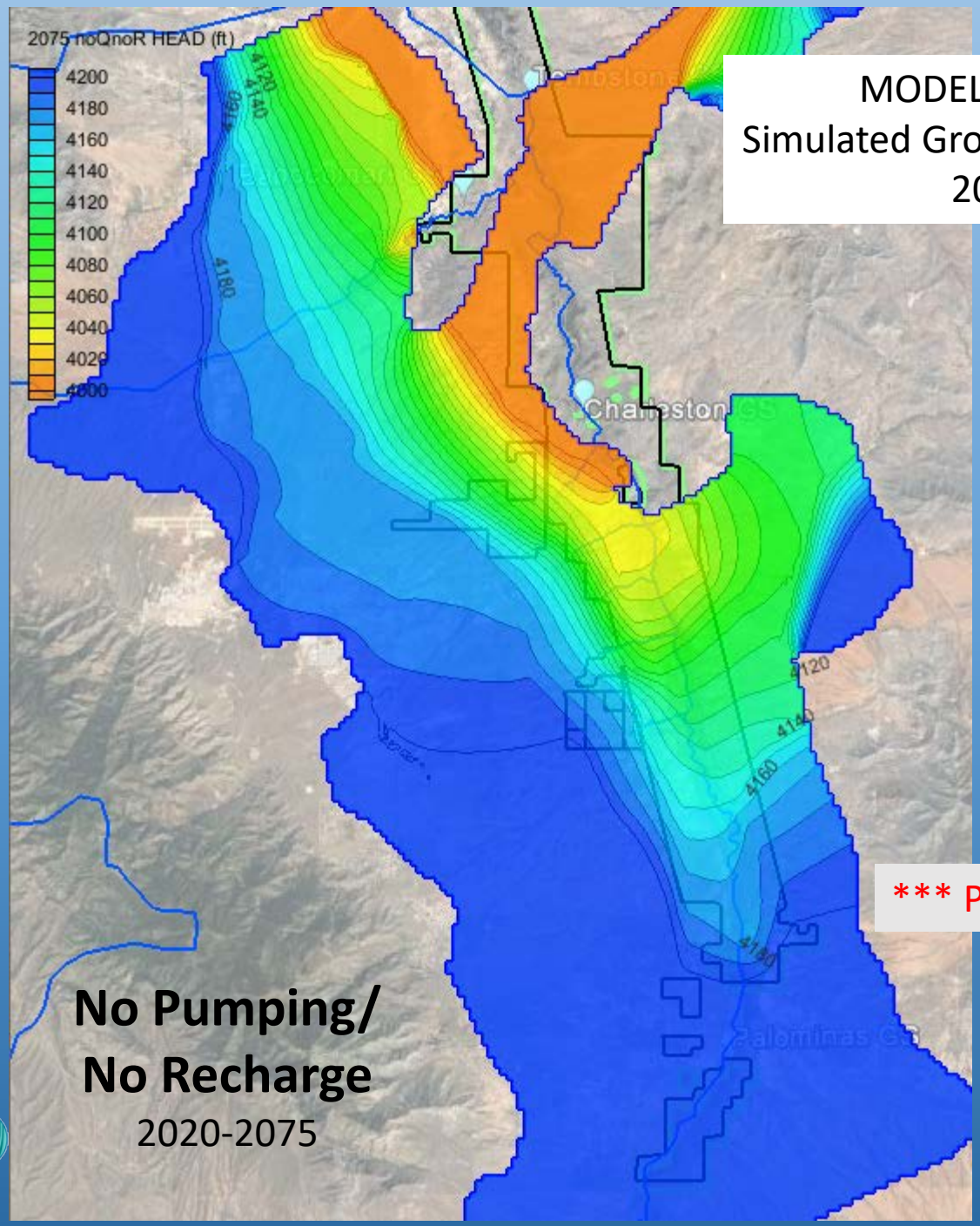
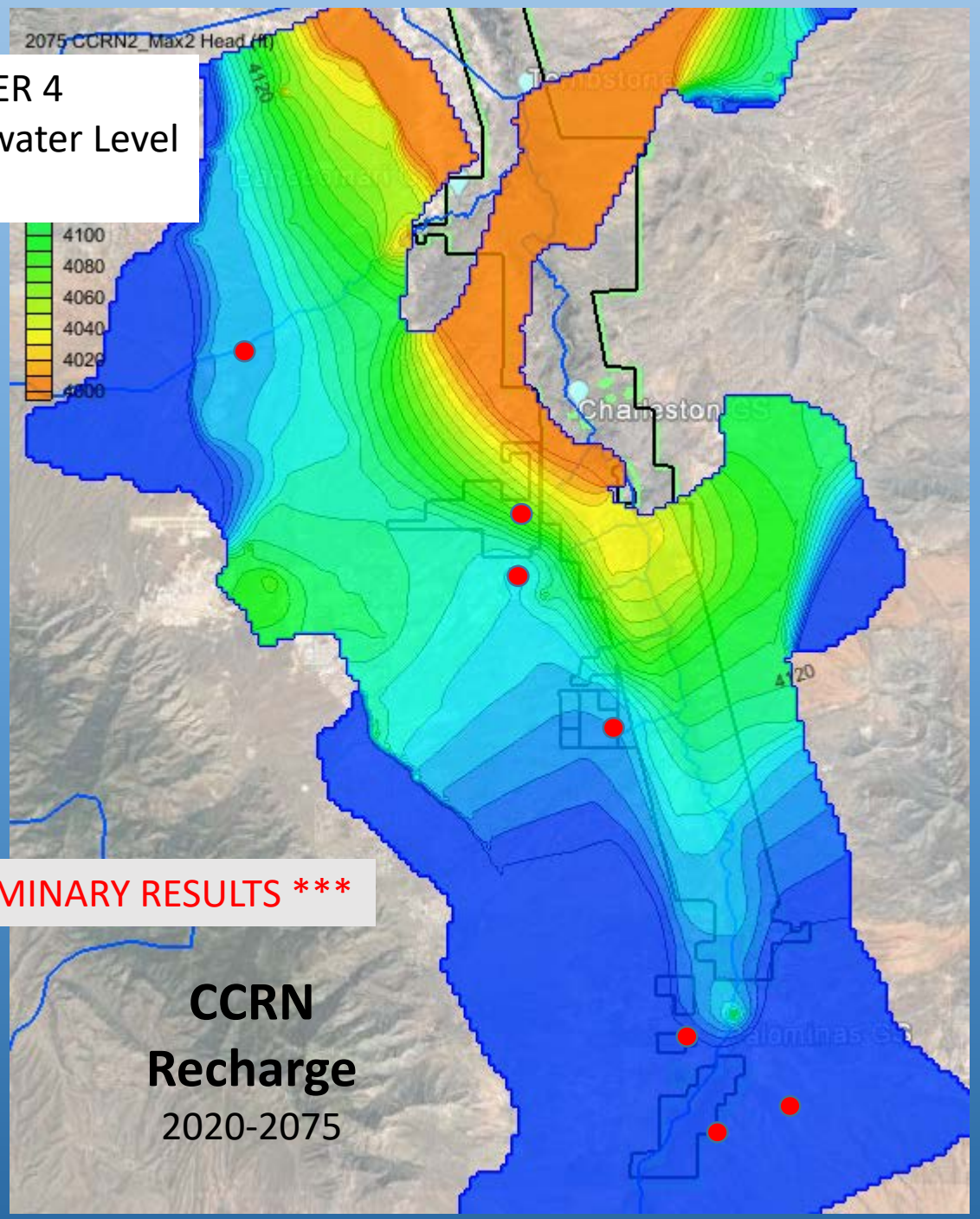


MODEL LAYER 4
Simulated Groundwater Level
2075



*** PRELIMINARY RESULTS ***

No Pumping/ No Recharge
2020-2075

CCRN Recharge
2020-2075

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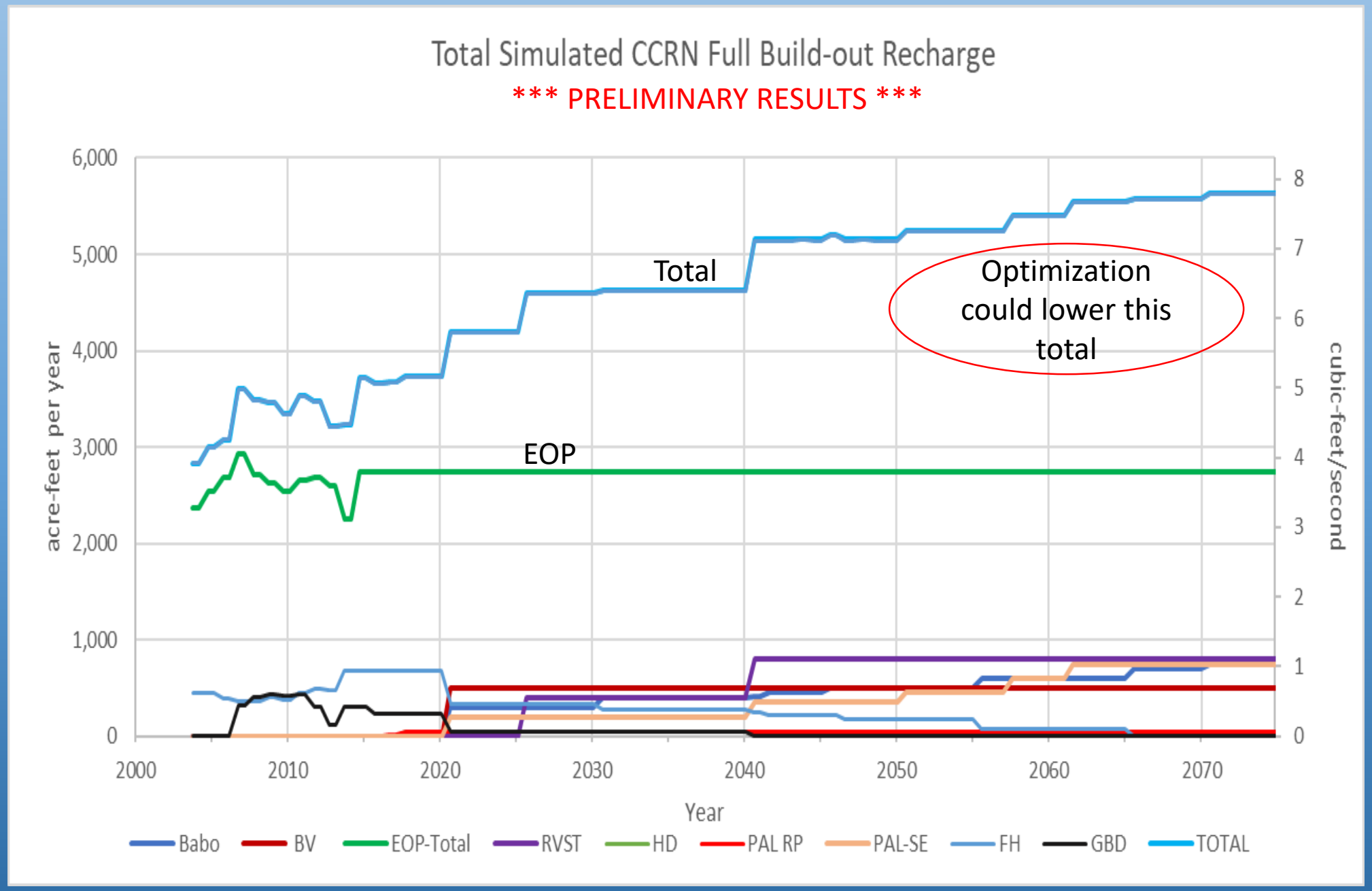
Simulation Summary


Total Simulated CCRN Full Build-out Recharge
*** PRELIMINARY RESULTS ***
Total
EOP
Optimization could lower this total
acre-feet per year
cubic-feet/second
6,000
5,000
4,000
3,000
2,000
1,000
0
8
7
6
5
4
3
2
1
0
2000
2010
2020
2030
2040
2050
2060
2070
Year
Babo
BV
EOP-Total
RVST
HD
PAL RP
PAL-SE
FH
GBD
TOTAL

Simulation Summary
CCRN Full Build Out vs. No Pumping/No Recharge 2020-2075:

CCRN Full Build Out

- Maintains baseflows at or above 2003 levels on San Pedro mainstem and Lower Babocomari through 2075.
- Buffers alluvial aquifer from cone of depression.

No Pumping/No Recharge

- Significant recovery of regional aquifer within SV/FH cone of depression.
- UNDER performs compared to CCRN in terms of alluvial groundwater levels and baseflows, except at Lower Babo (2043-2075).

Holly Richter, PhD
AZ Water Projects Director
Hrichter@tnc.org

Laurel Lacher, PhD, RG
Lacher Hydrological Consulting
LLacher1@msn.com