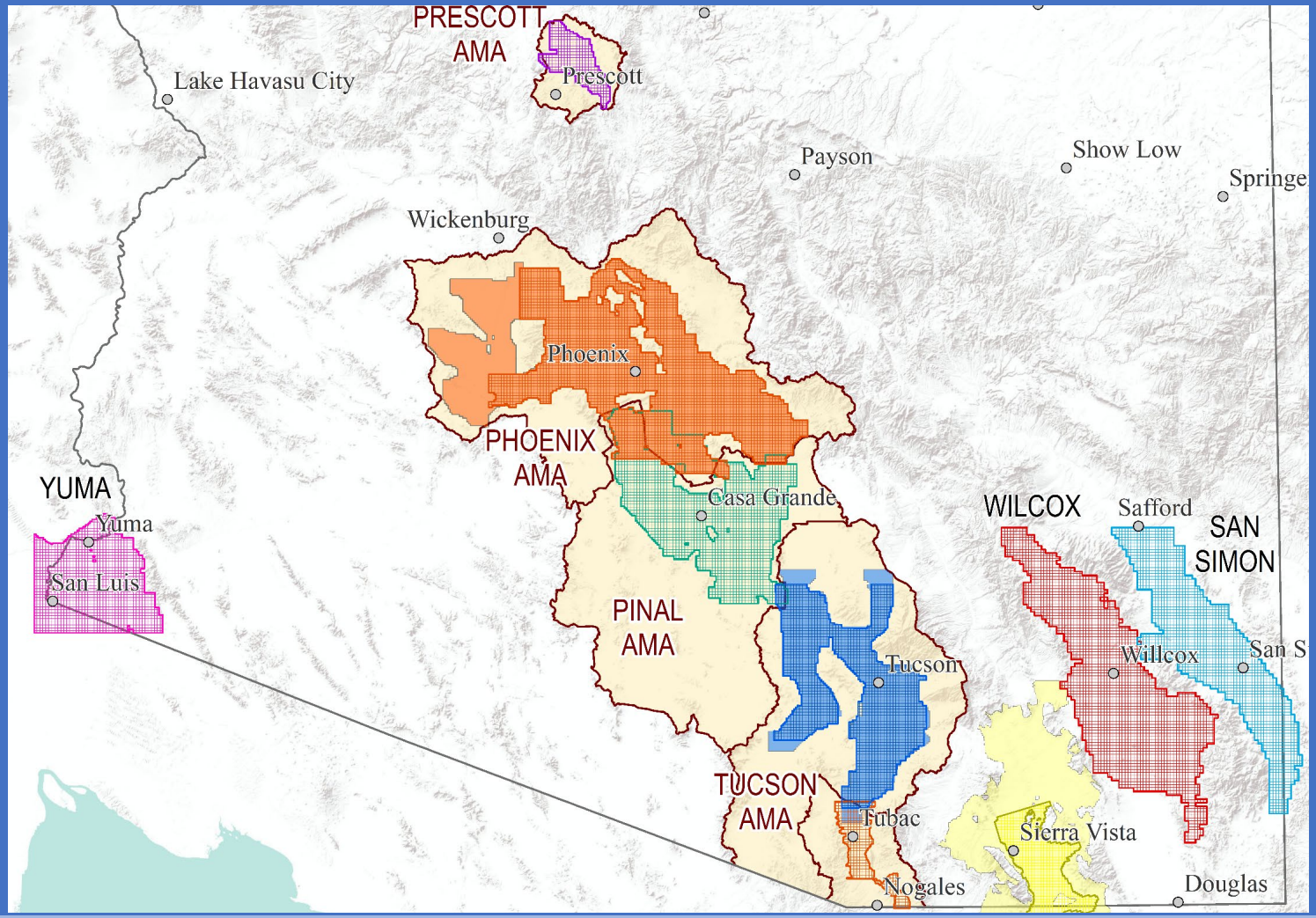


Groundwater Models in Arizona:

A Look at Development and Application

Justin Clark, Lynker Intel

April 19, 2023

Dedicated To …

Thomas Meixner (1970-2022)

Overview of Slides

- Historical Context
- USGS E.A. Models
- ADWR Regional Models
- USGS Numerical Models
- USBR Regional Models
- The Future of AZ Models
- Questions

OBJECTIVE

Document and communicate the complexity and status groundwater models in Arizona.

History

- Smith (Head of Ag. Engineering at U of A)
  - 1910 – Groundwater Supply and Irrigation in the Rillito Valley
  - 1938 – The Physiography Of Arizona Valleys And The Occurrence Of Groundwater
  - 1942 – The Groundwater Supply of the Eloy District in Pinal County, Arizona
- Meinzer (“Grandfather of Modern Hydrology”)
  - 1913 – Geology and Water Resources of Sulphur Spring Valley, Arizona
  - 1938 – Plants as Indicators of Ground Water
- Neuman (University of Arizona Professor)
  - 1972 – Theory of Flow in Unconfined Aquifers Considering Delayed Response of the Water Table
  - 1972 – Field Determination of the Hydraulic Properties of Leaky Multiple Aquifer Systems
  - Developed an analytical solution that helped stop semilogarithmic paper

Electrical Analog Models

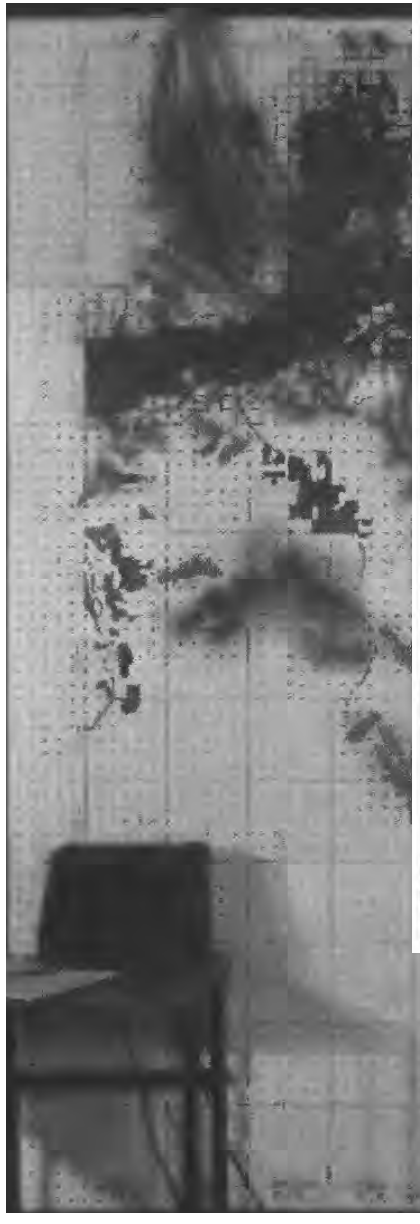
- Before Computers

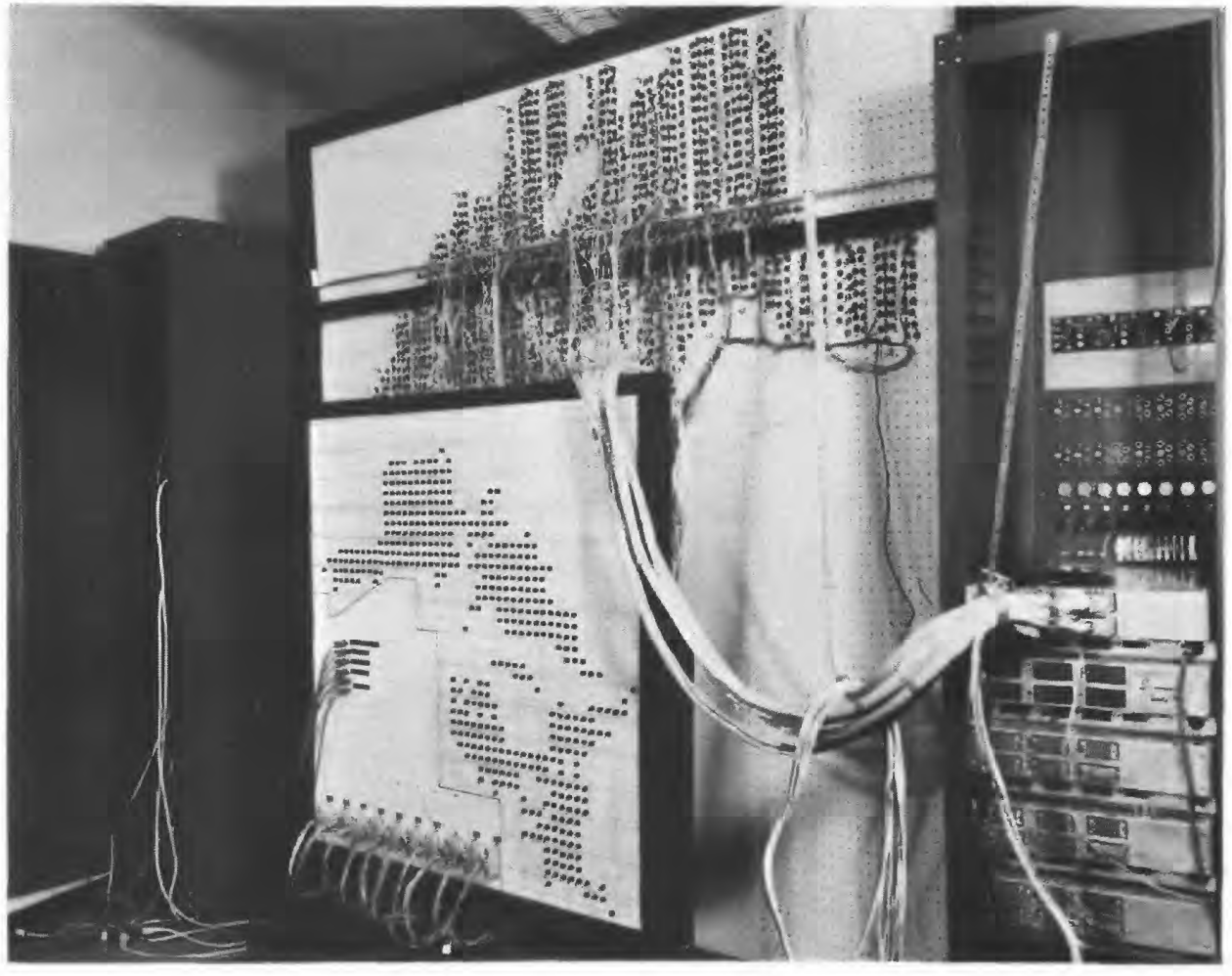
- 3 Primary Areas

-1968: Salt River Valley and Pinal Areas

-1972: Santa Cruz River Basin

-1972: Avra Valley Basin





Electrical Analog Models

- Before Computers
- 3 Primary Areas
  - Salt River Valley and Pinal Areas
  - Santa Cruz River basin
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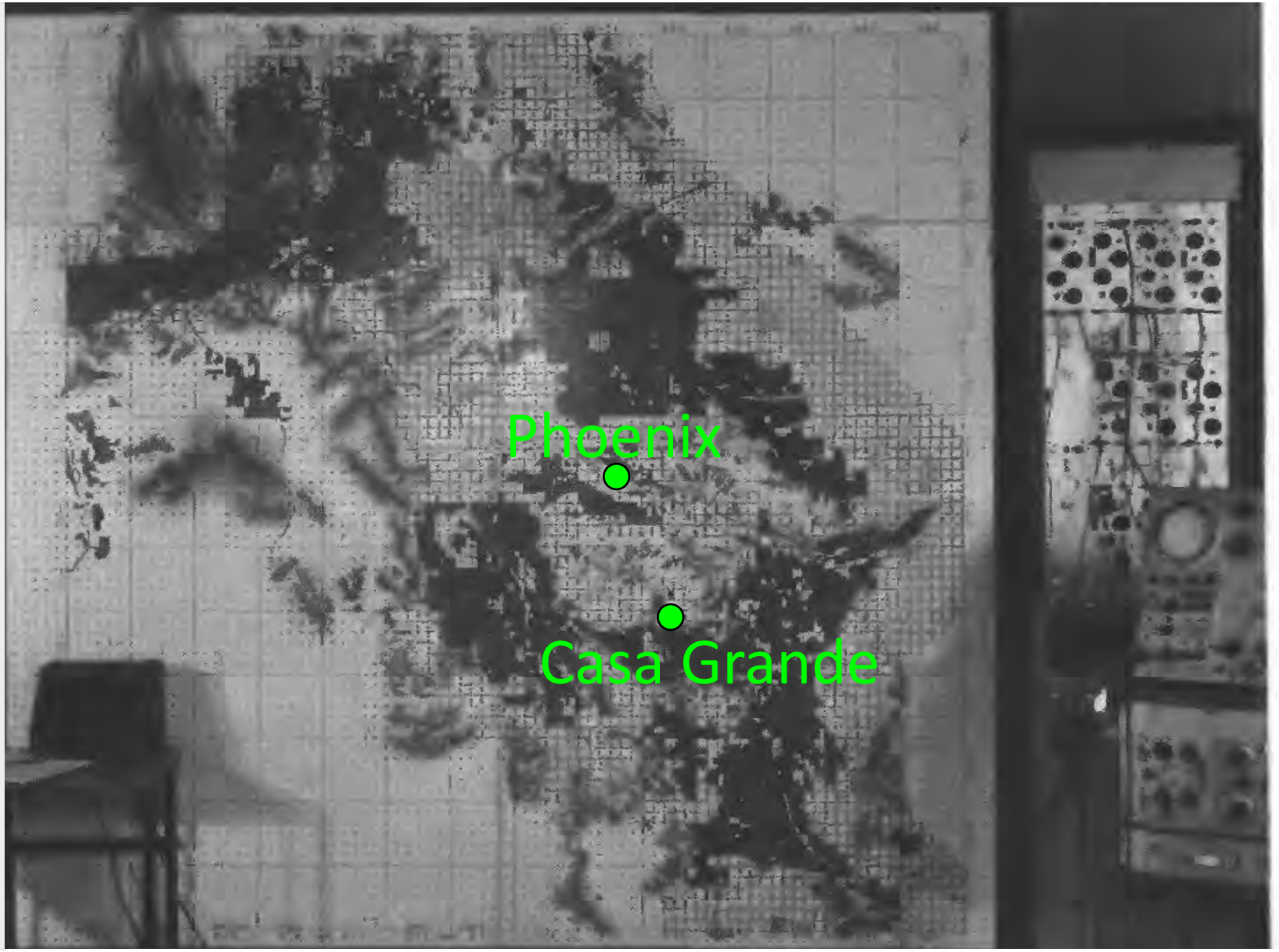
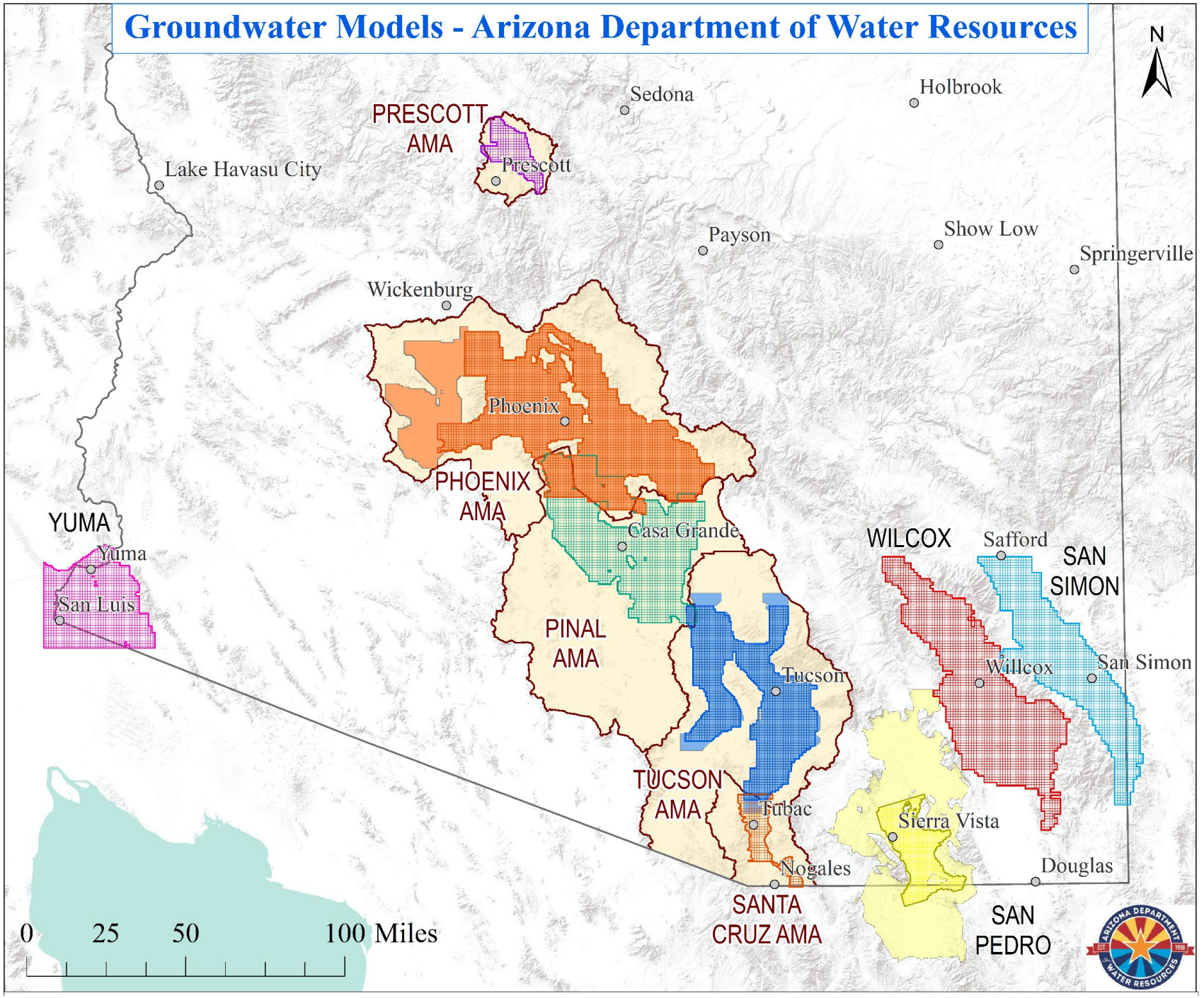


ADWR Models

- In Progress
  - Phoenix AMA
  - San Pedro
  - Tucson AMA
- Published Models
  - SRV 1983 - 2006 (2008)
  - Pinal 1940-2015 (2019)
  - Prescott AMA 1939 - 2019 (2021)
  - Upper San Pedro 1941-1990 (1996)
  - San Simon 1915 - 2015 (2017)
  - Santa Cruz AMA 1997-2018 (2020)
  - Tucson 1940 - 2010 (2013)
  - Wilcox 1940-2015 (2018)
  - Yuma 1978 - 1989 (1993)
- (Background)
  - Active Managment Areas (AMAs)

<https://new.azwater.gov/hydrology/groundwater-modeling/adwr-models>



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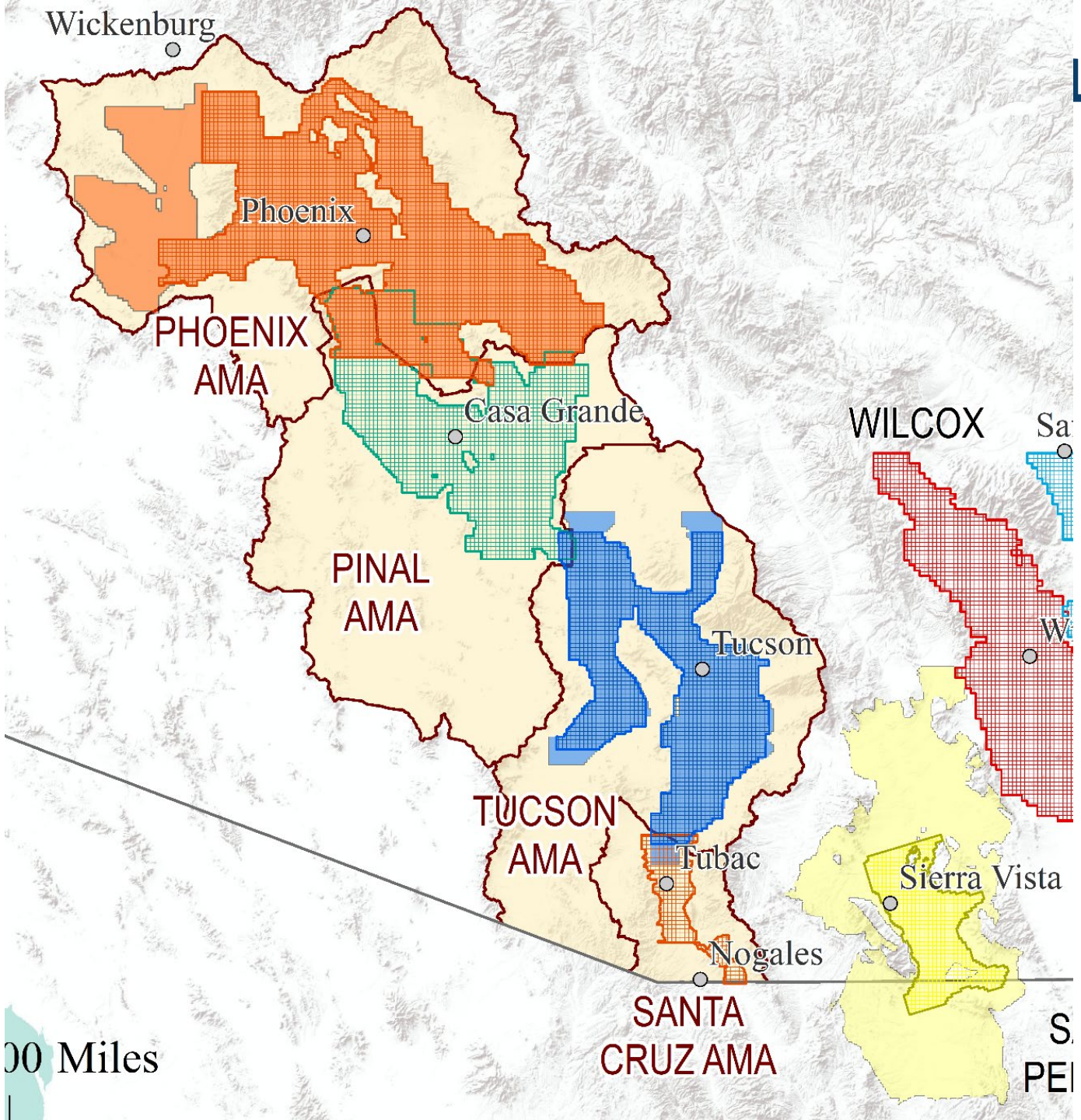

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ADWR Models

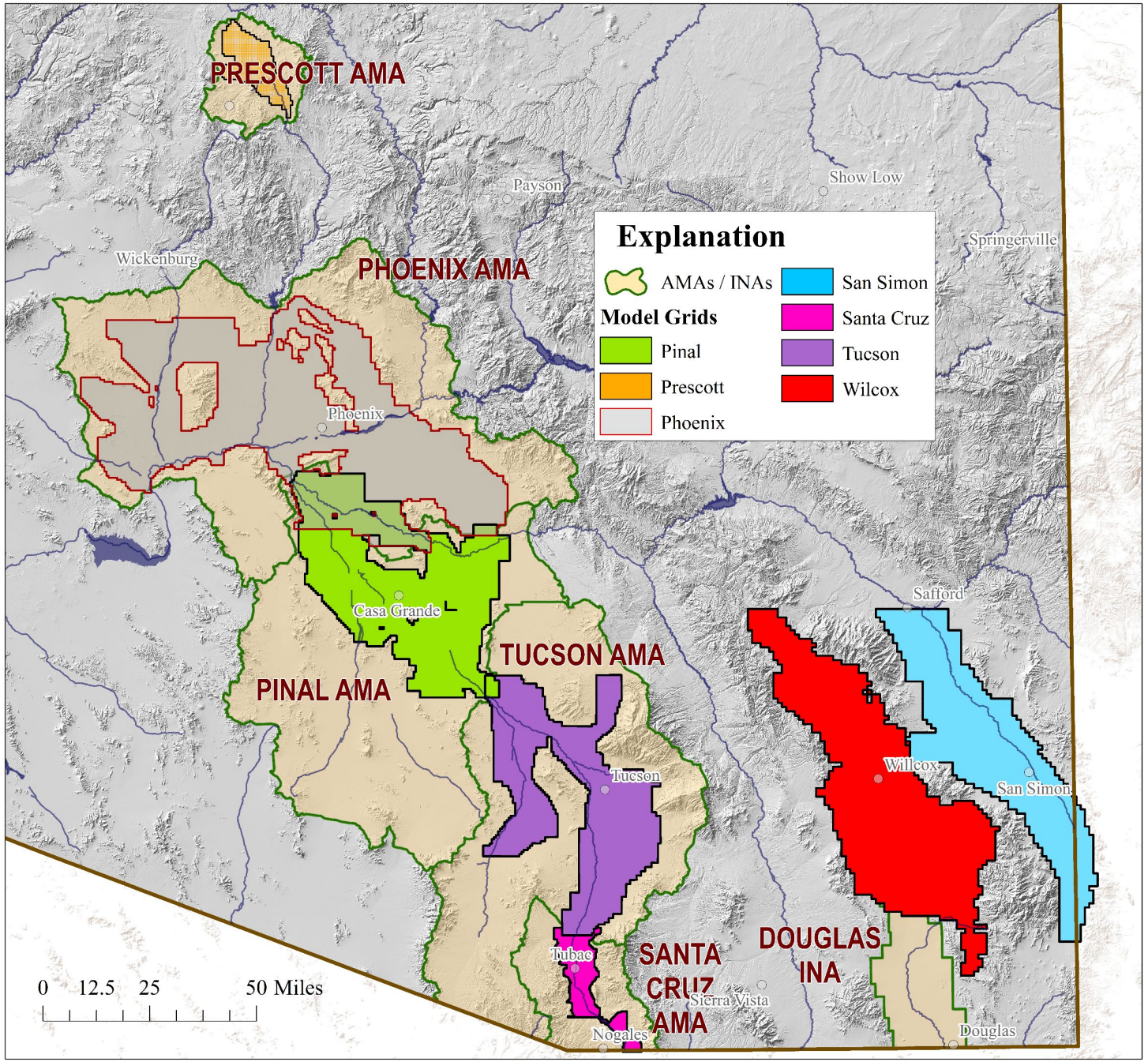
Active Management Area Predictive Models

1) Assured Water Supply (Usage Permits)

- 100 Year Model Scenario
- Depth and Management Criteria
- 20 Year Approval, 5 Year Re-Approval

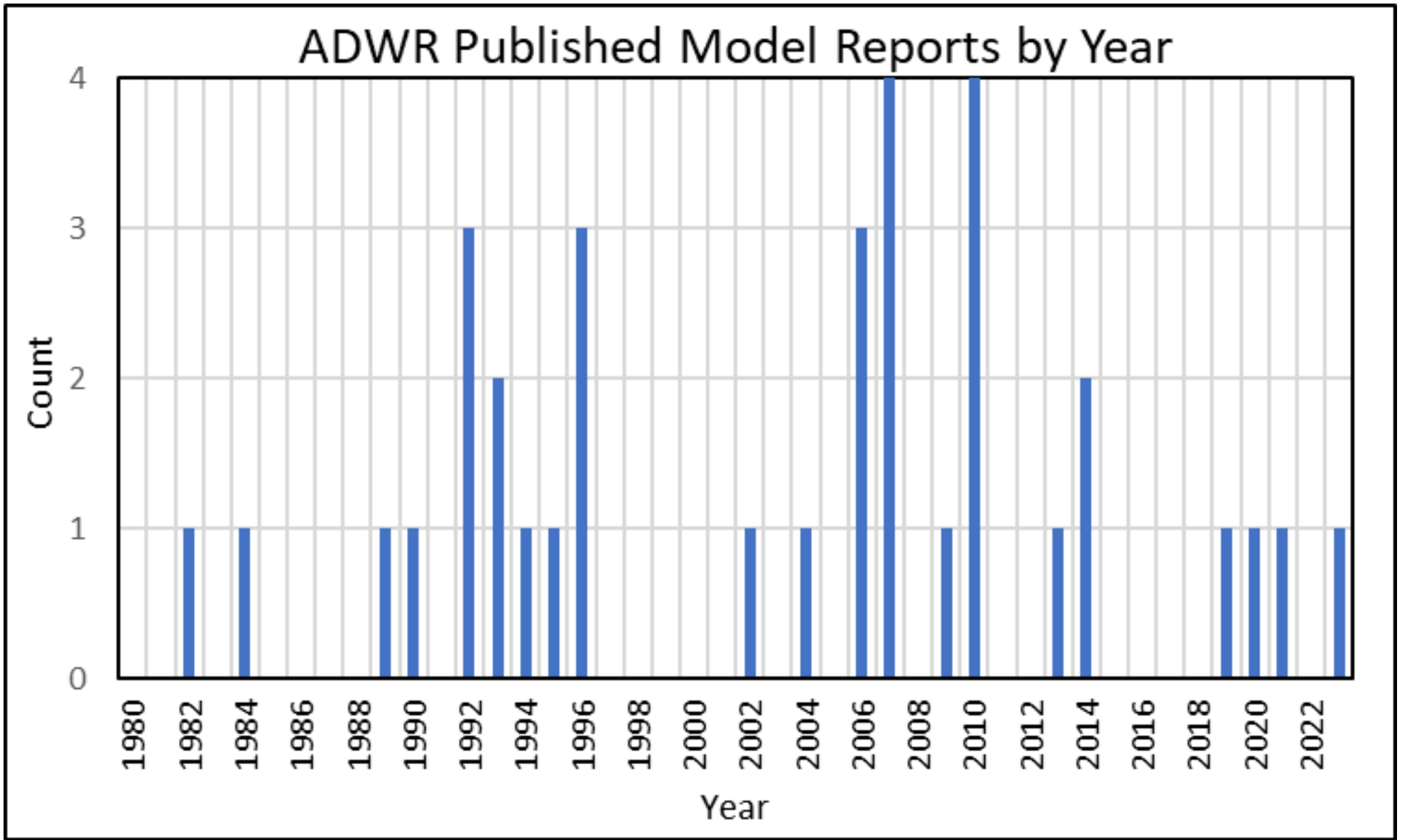
2) Underground Storage Facility (Recharge Permits)

- 20 Year Model Scenario
- Up to 20 Year Approval



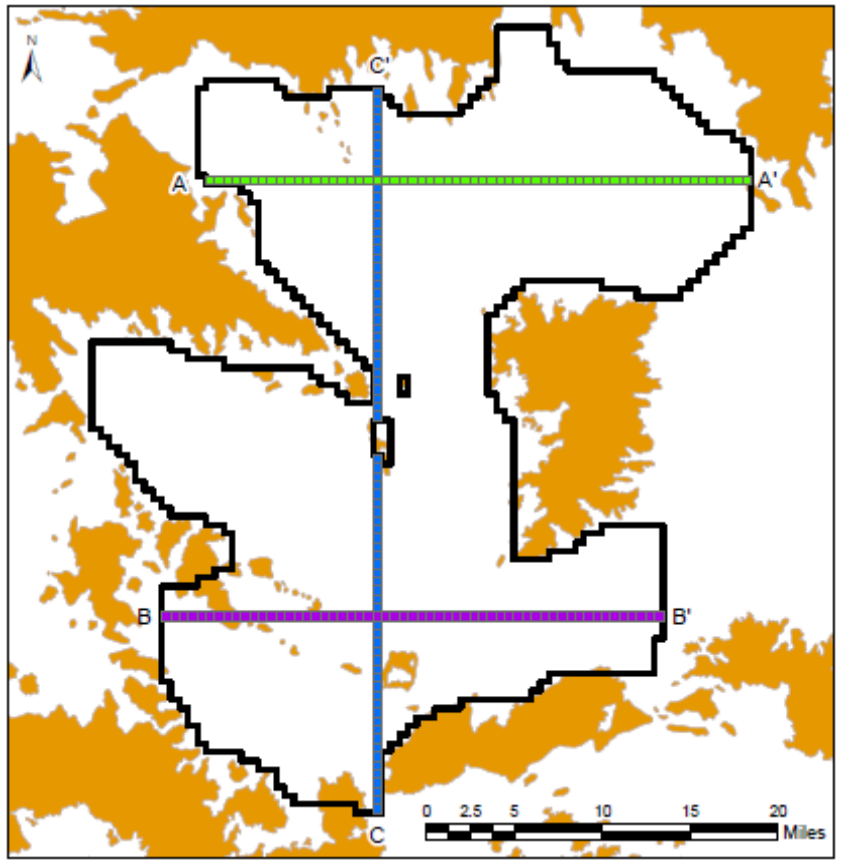
ADWR Models

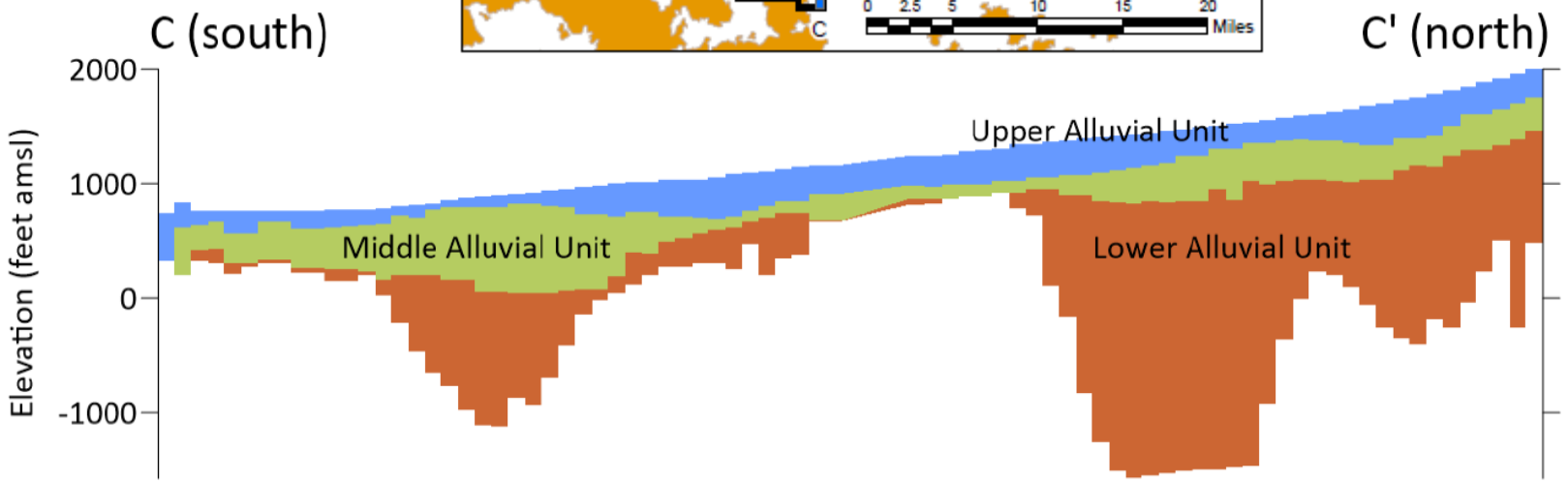
- Major Publications' Dates



ADWR Models

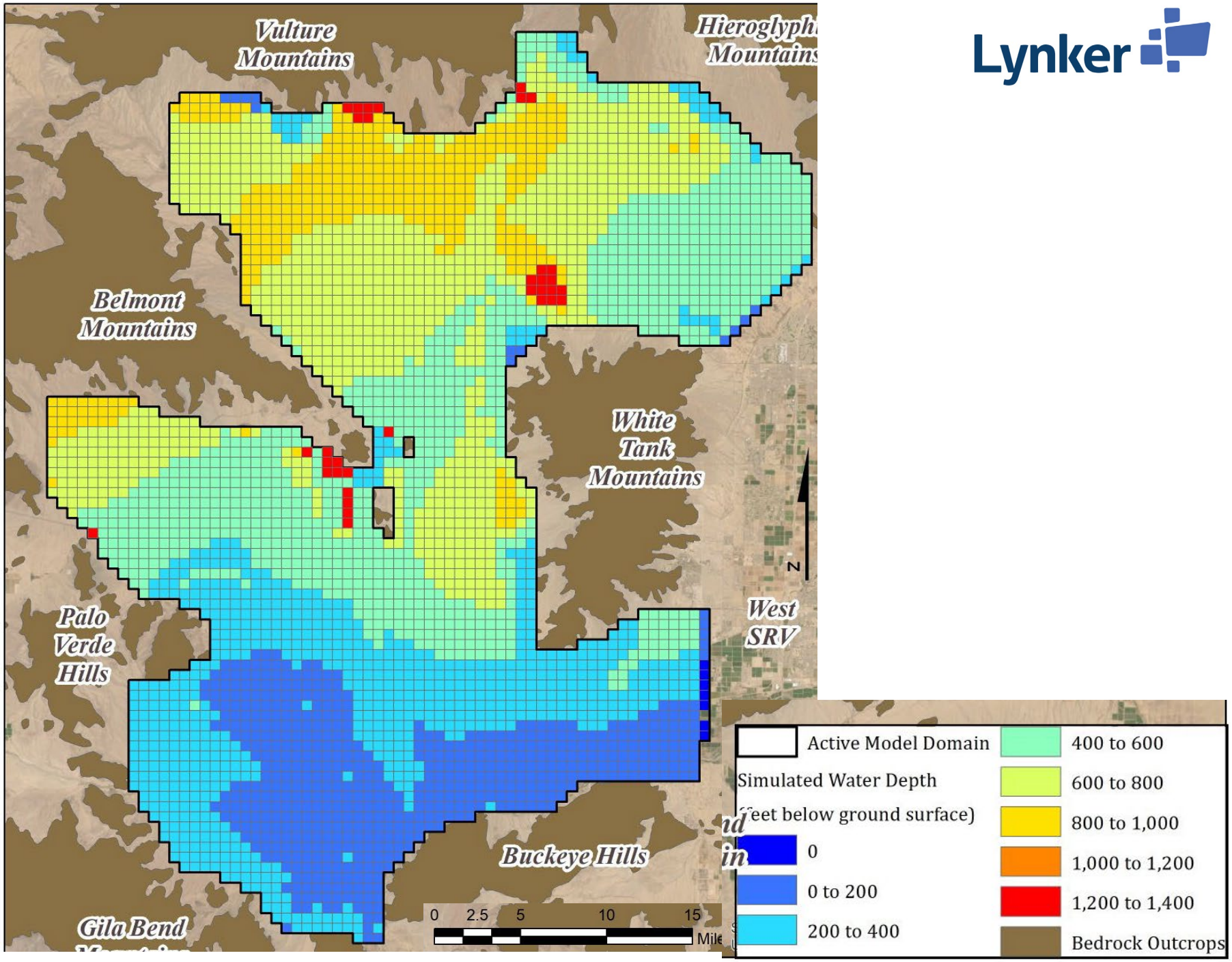
- Most of the Large Regional Groundwater Models in Arizona are 3 Layers with ½ Mile Grid Spacing
- Middle Fine Grain Unit Can Thin Out or be Discontinuous





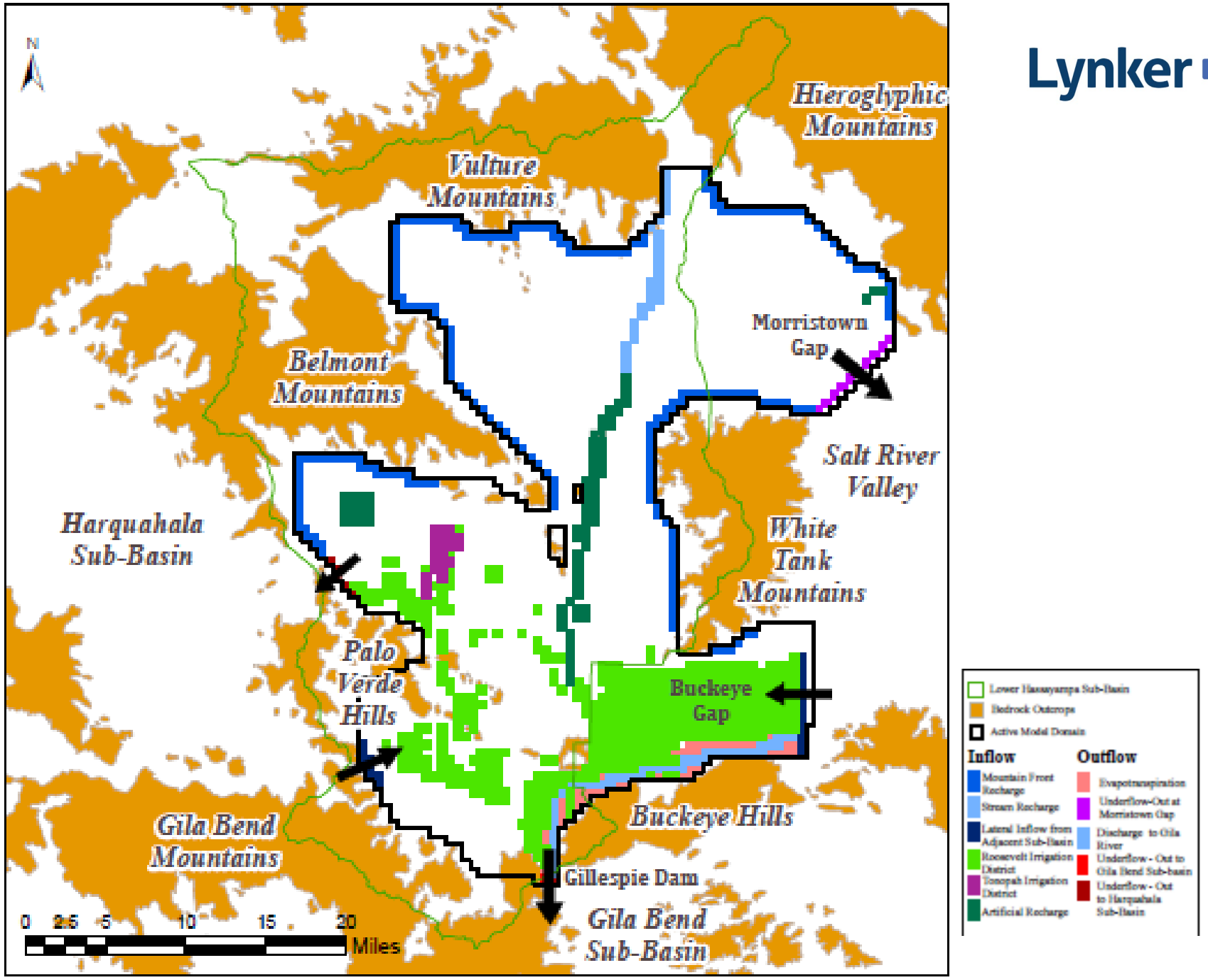
ADWR Models

- Hassayampa Sub-Basin
- Based on Brown & Caldwell 2006 Model, Completed for the Town of Buckeye & stakeholders
- 2016-2116 Run Completed by ADWR
- 1000 ft bgs was violated in 2 areas.
- Total Unmet Demand is 4.4 MAF



ADWR Models

- Hassayampa Sub-Basin
- Recharge for Most Inflow
- GHB Boundary Area
- STR Flow Routing
- WEL for Outflow
- ET balances inflows



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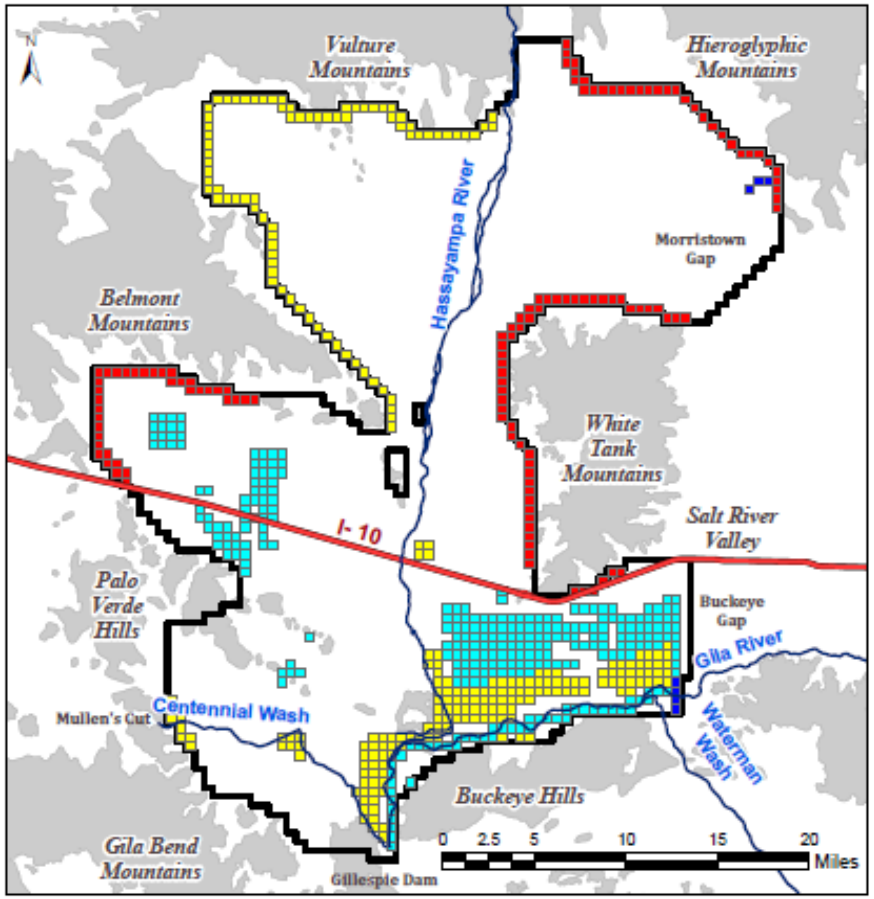


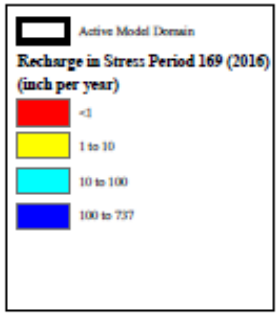
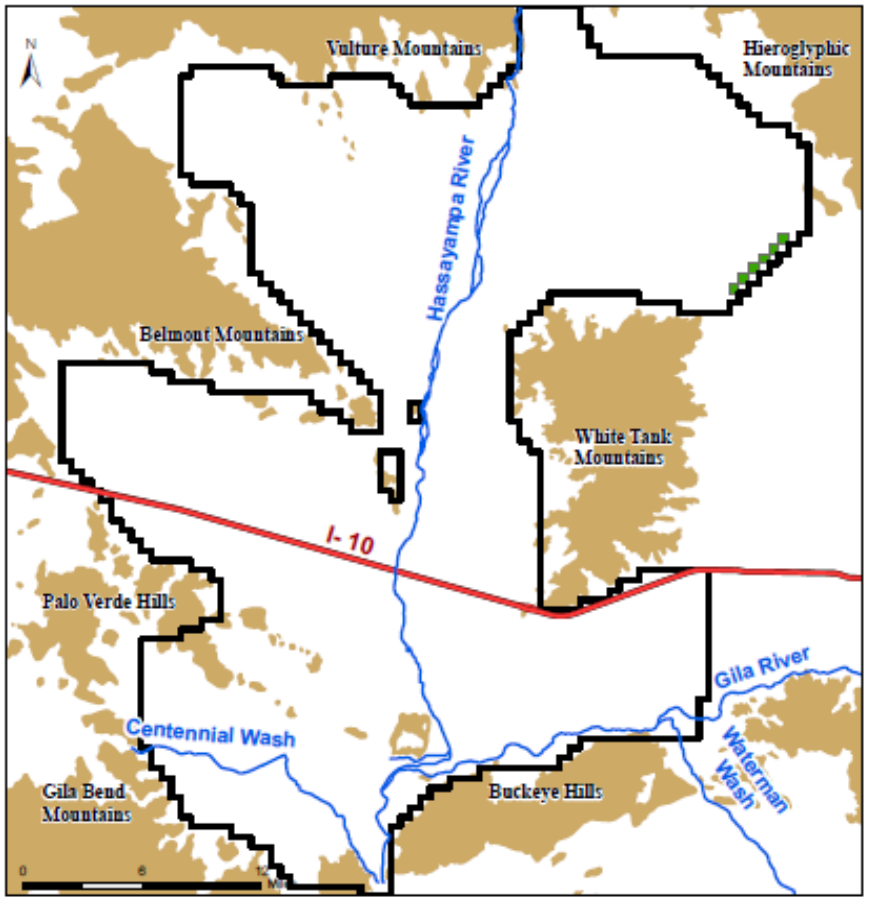


Figure 4-11

Distribution of Simulated Groundwater Recharge in Stress Period 169 (2016)

Groundwater Flow Model of the Lower Hassayampa Sub-basin in the Phoenix Active Management Area

ADWR January 2023



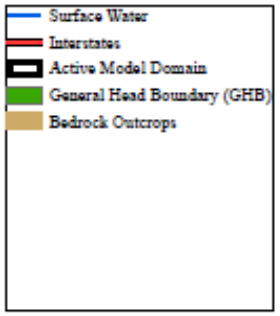


Figure 4-13

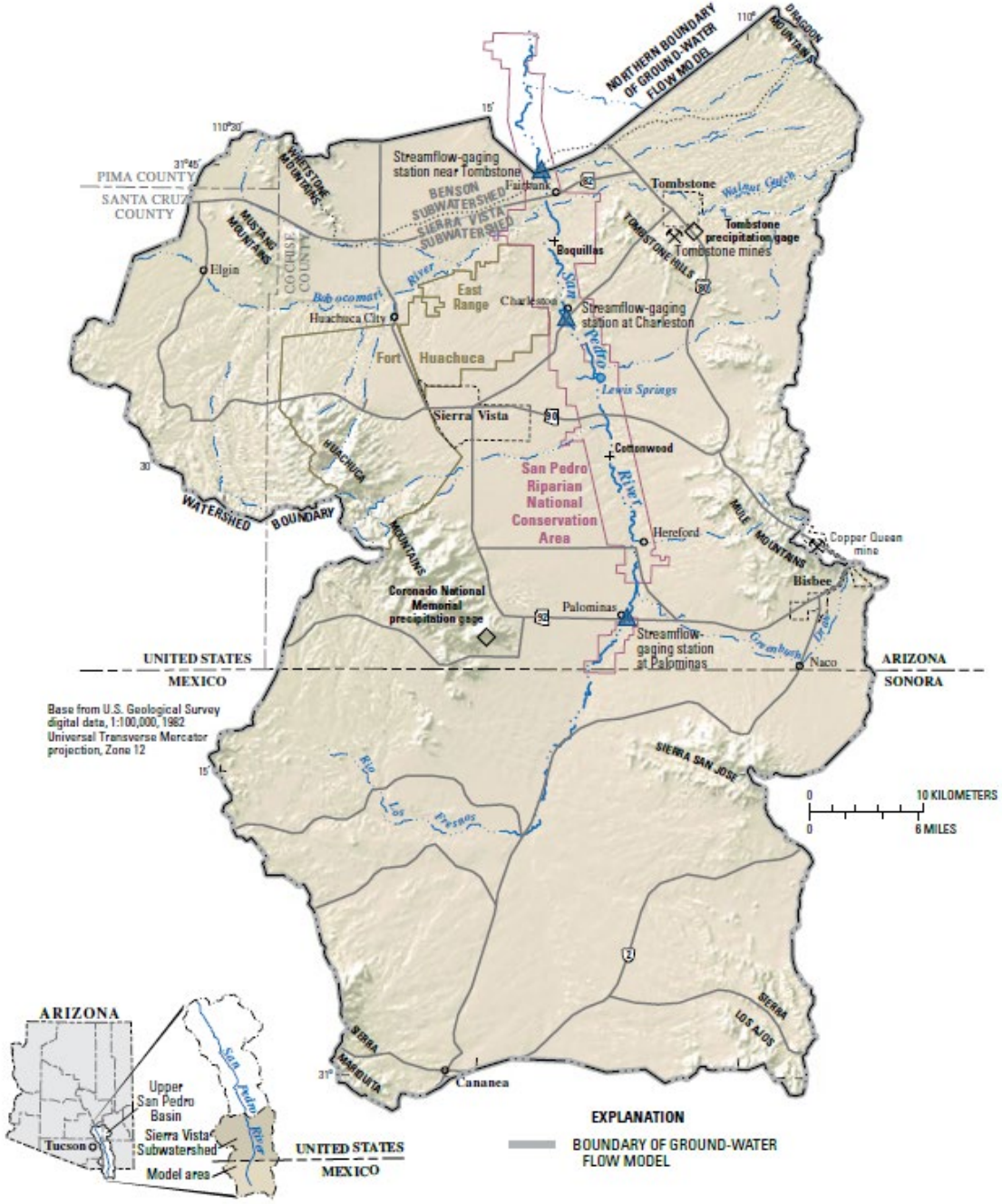
Distribution of General Head Boundary (GHB) Model Cells Simulating Underflow through the Morristown Gap

Groundwater Flow Model of the Lower Hassayampa Sub-basin in the Phoenix Active Management Area, Arizona

ADWR January 2023

USGS Models

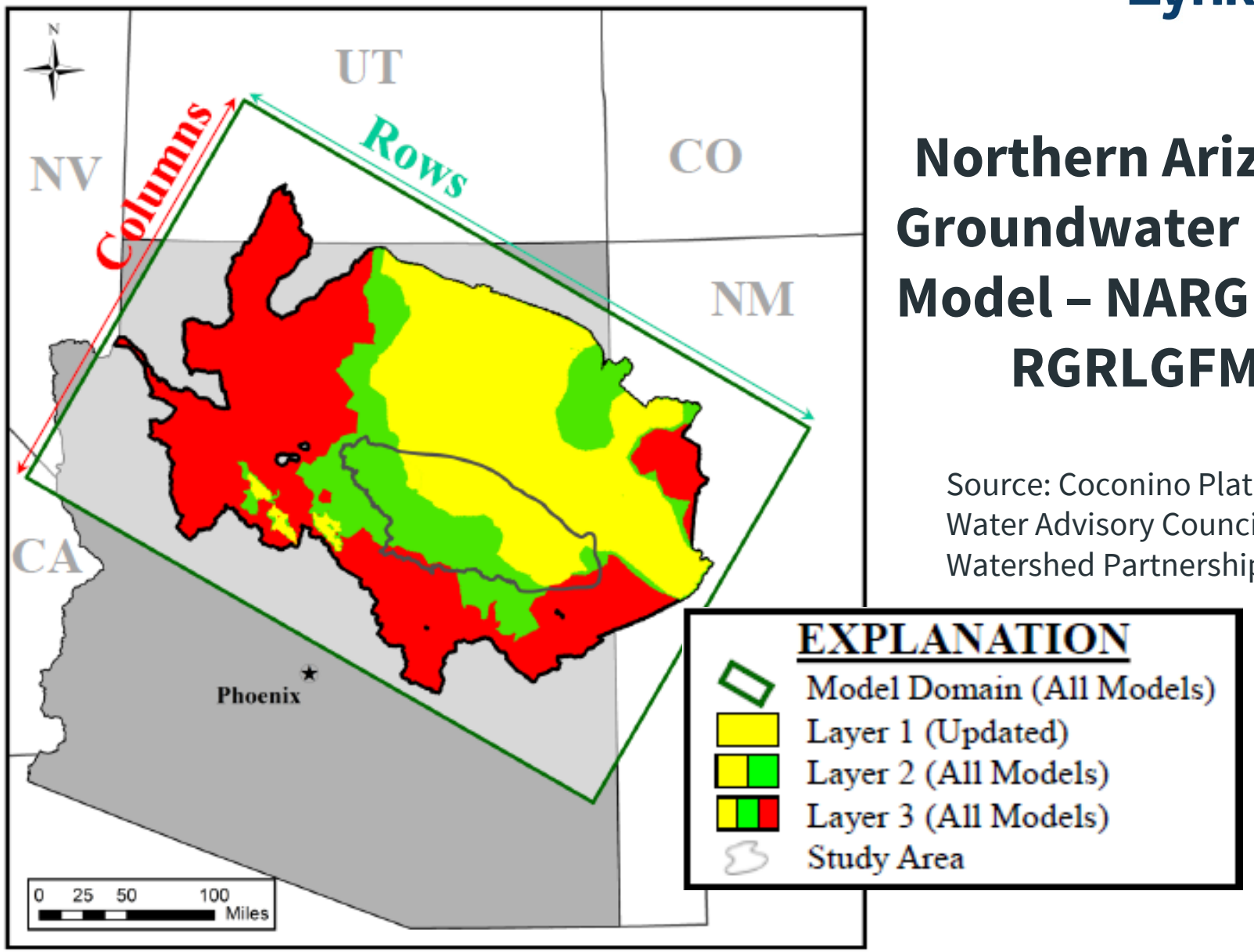
- San Pedro River
- Long History of Adjudications
- 2007: MF2005 Model
- Pool & Dickinson



"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 Models

- Northern Arizona's Colorado Plateau
- 2011: MF2005 Model
- Pool, Blasch, Callegary, Leake, and Graser (NARGFM)
- Later updated by Matrix New World for City of Flagstaff (RGRLGFM)



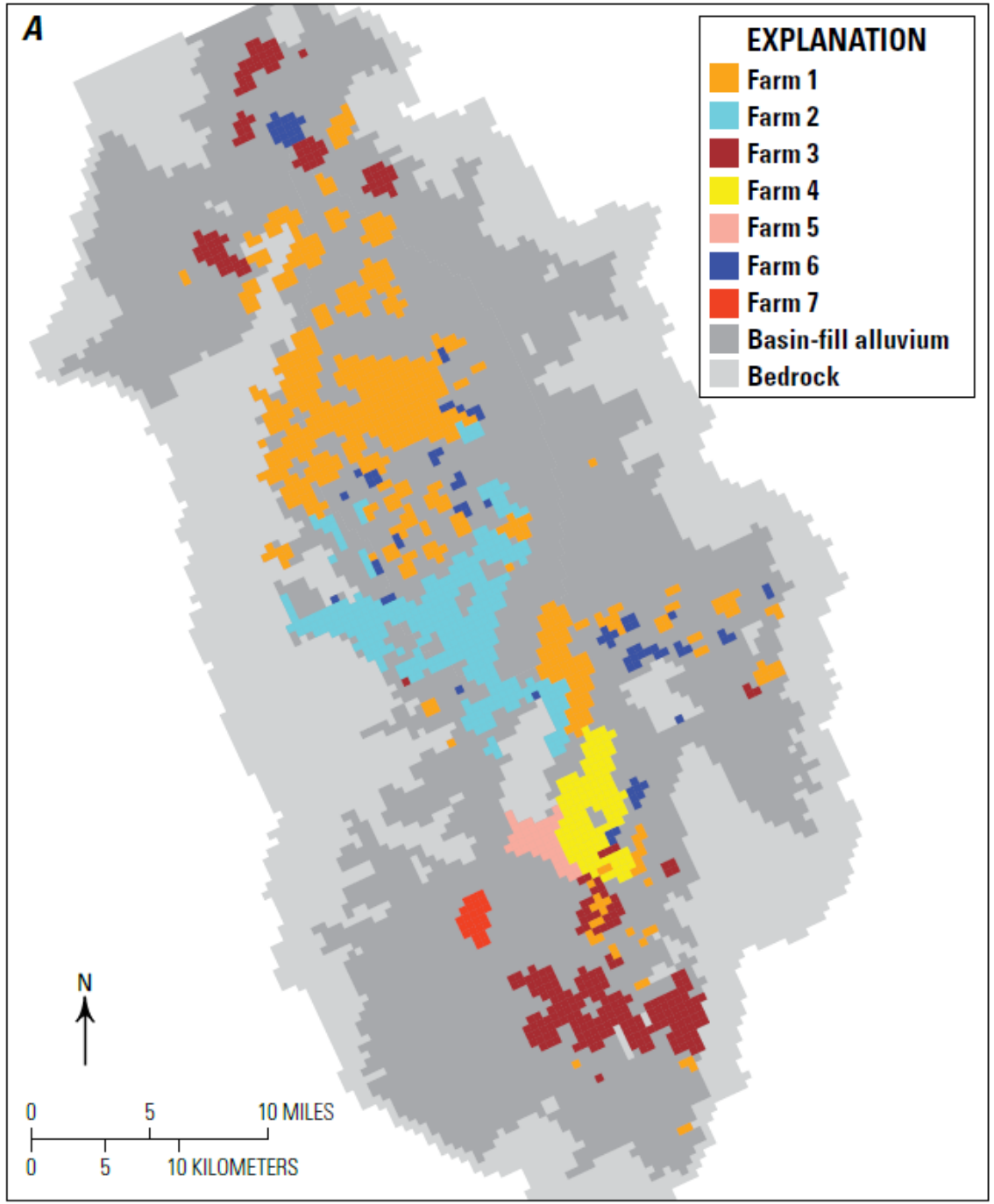
Northern Arizona Groundwater Flow Model – NARGFM & RGRLGFM

Source: Coconino Plateau Water Advisory Council and Watershed Partnership

http://www.cpwac.org/generalfiles/RGRL%20Groundwater%20Flow%20Model.pdf

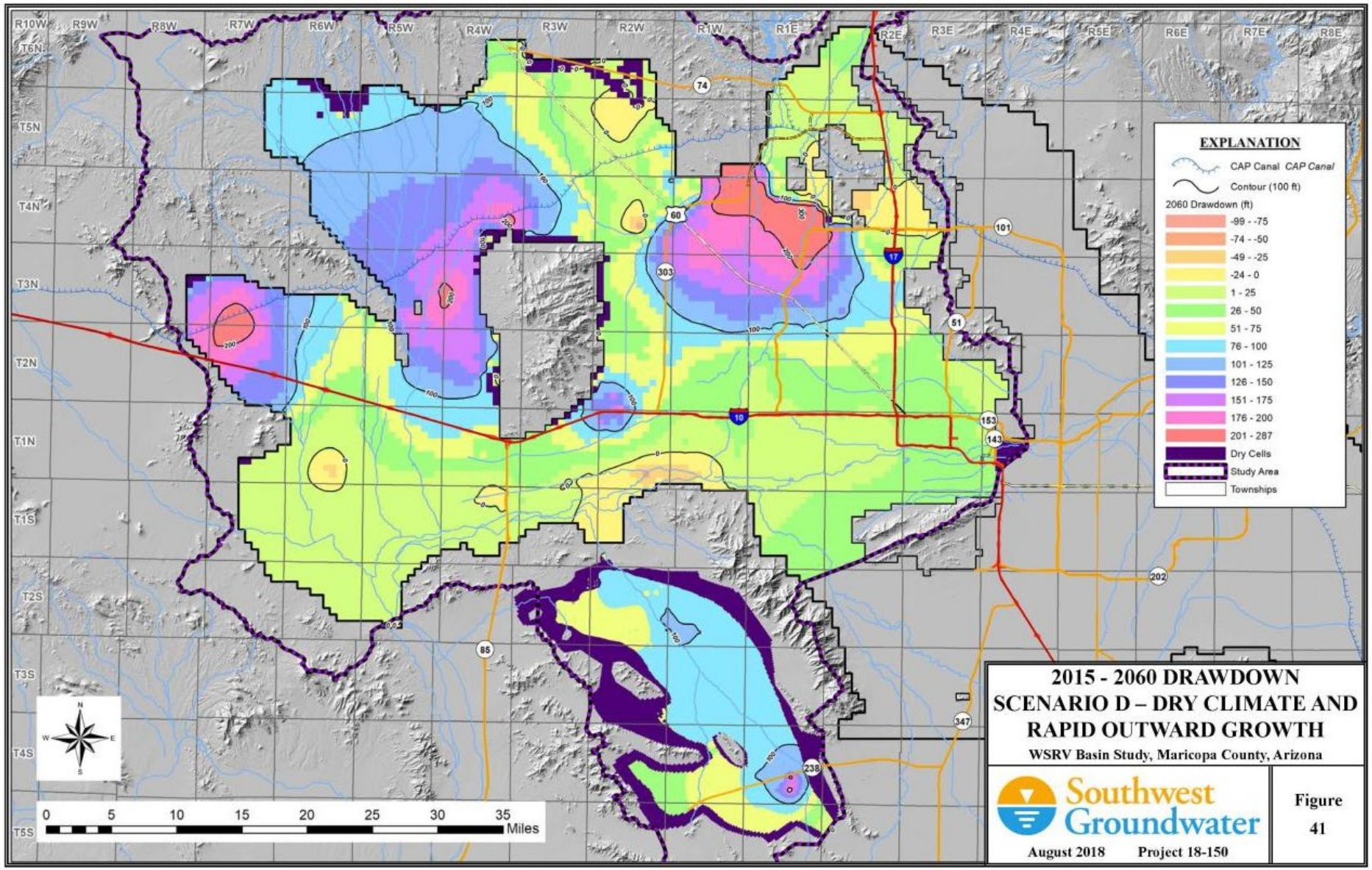
USGS Models

- Hualapai Valley Groundwater Basin
- Area of Concern due to Agriculture
- Released in 2022
- MF-NWT Model
- Jake Knight is Author / Modeler



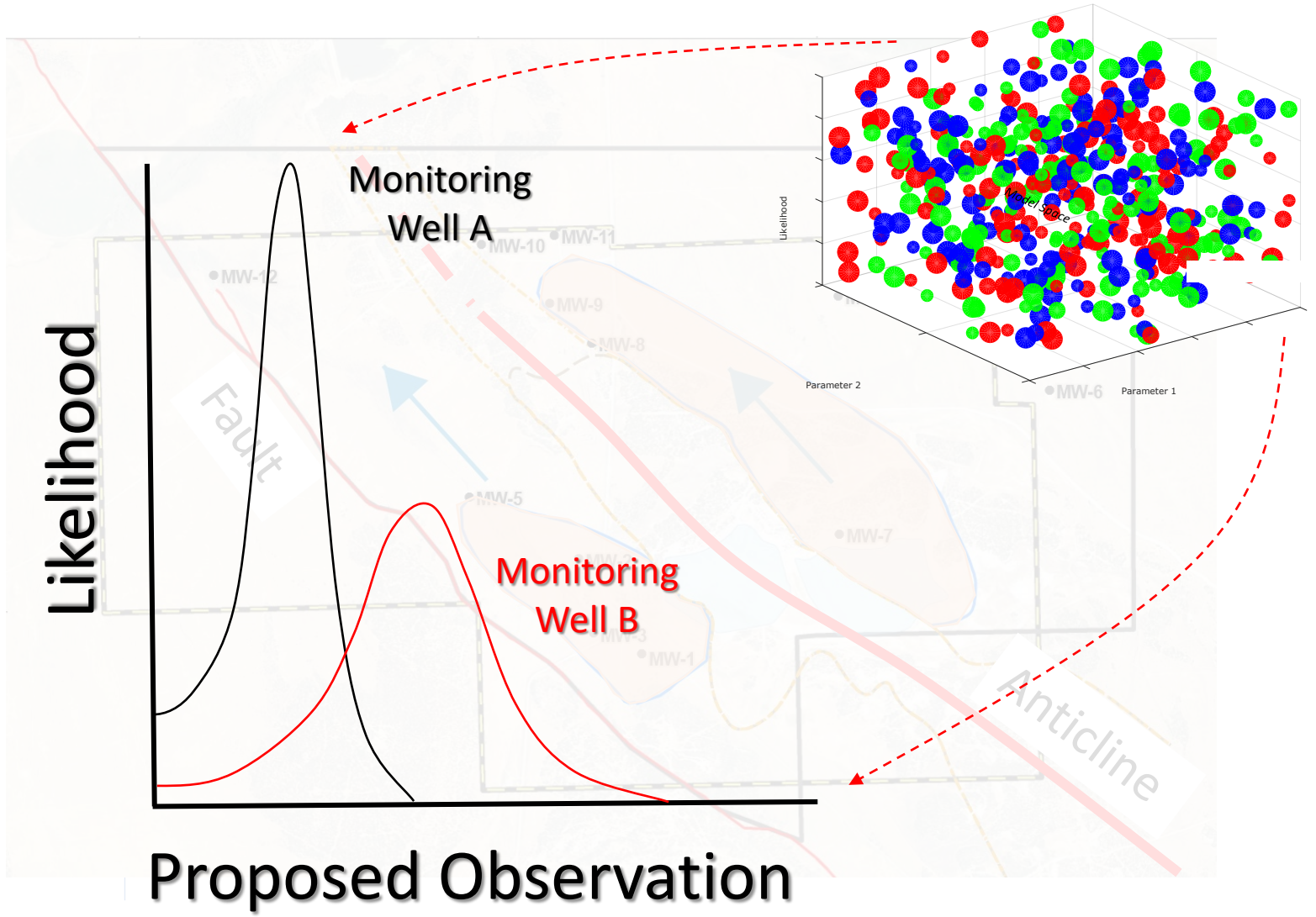
USBR Models

- Phoenix AMA
- Tucson AMA
- Pinal AMA
- Big Chino Valley



Future

- Multi-Model Approach
- From Ty Ferre Darcy Lecture



"The glories and the beauties of form, color and sound unite in the Grand Canyon"
– John Wesley Powell