BUREAU OF GEOLOGY AND MINERAL RESOURCES

Geologic Mapping Program: Managed aquifer recharge (MAR) in Albuquerque

New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
Earth Science for the 21st Century

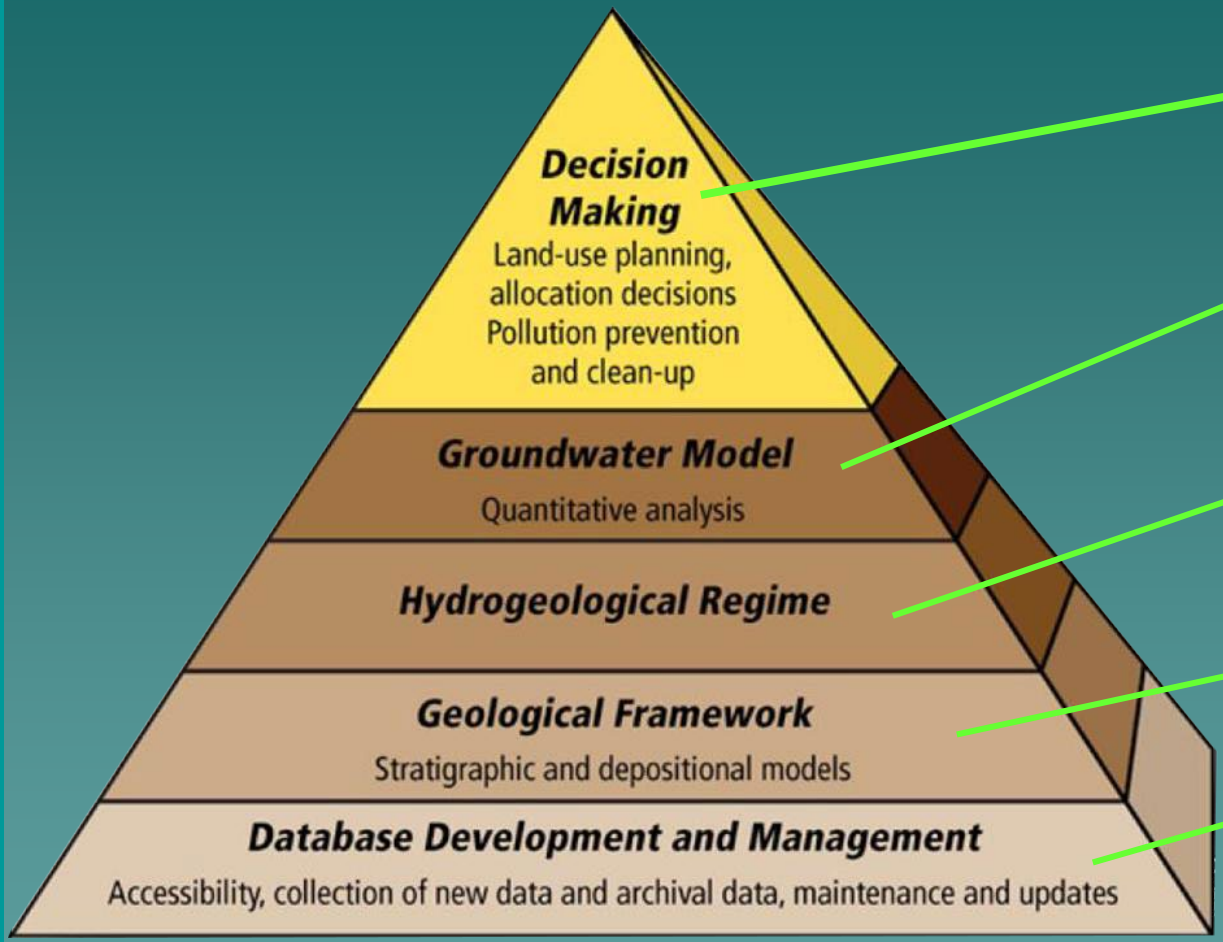
NEW MEXICO STATEMAP

AQUIFER MAPPING PROGRAM

Image from: www.abcwua.org/Education/23b_Recharge

Bear Canyon arroyo recharge project

Information for better decision making



(modified from Council of Canadian Academies, 2009)

Using a solid knowledge foundation to educate decision makers

Build numerical model(s) to test hypotheses and forecast future conditions

Build conceptual models of the system*

Geologic mapping, detailed cross sections*

Build a solid foundation with ongoing data collection*

** Essential work done by NM Bureau of Geology and Mineral Resources*

Good Management Requires Good Science!

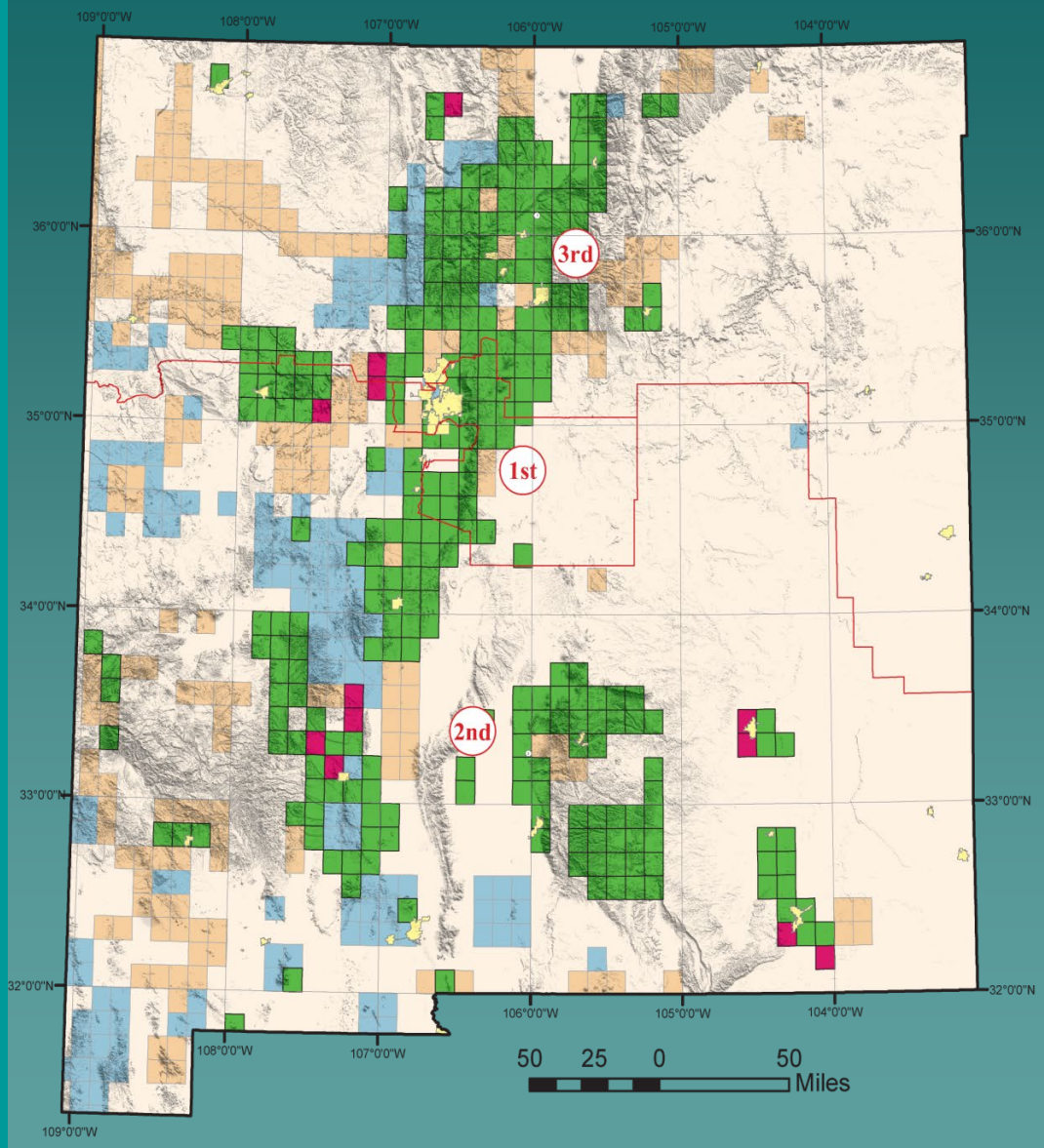
What A Geologic Study Tells Us:

- **Materials** (gravel, basalt, limestone, granite, etc.)
- **Structures** (faults, fractures, folds, etc.)
- **Processes** (erosion, rivers, volcanic eruptions, earthquakes, etc.)
- **History** (what happened when?)
- **All in 3-D plus the extra dimension of time!**

The Anatomy of an Ideal Water Resource Study:

- **Geologic Mapping**
- **Geophysical Studies** (gravity, magnetics, seismics, TDEM, T logging)
- **3-D Geologic Model**
- **Hydrogeologic Data Collection & Characterization** (well inventory, water levels, hydrologic properties, hydrogeochemistry, aquifer boundaries)
- **Hydrogeologic 3-D Conceptual Model**
- **Hydrologic Computer Model**
- **Apply the Science to Planning, Policy & Programs!**

Geologic Mapping Program



Basic and applied geologic mapping in a state that is only 33% mapped.

National Cooperative Geologic Mapping Program - STATEMAP component produces GIS-based maps for derivative studies

Competitive dollar for dollar matching program is based on state-defined needs

NM has been one of the most successful states in the nation, receiving more than $4.0 million over the last 26 years

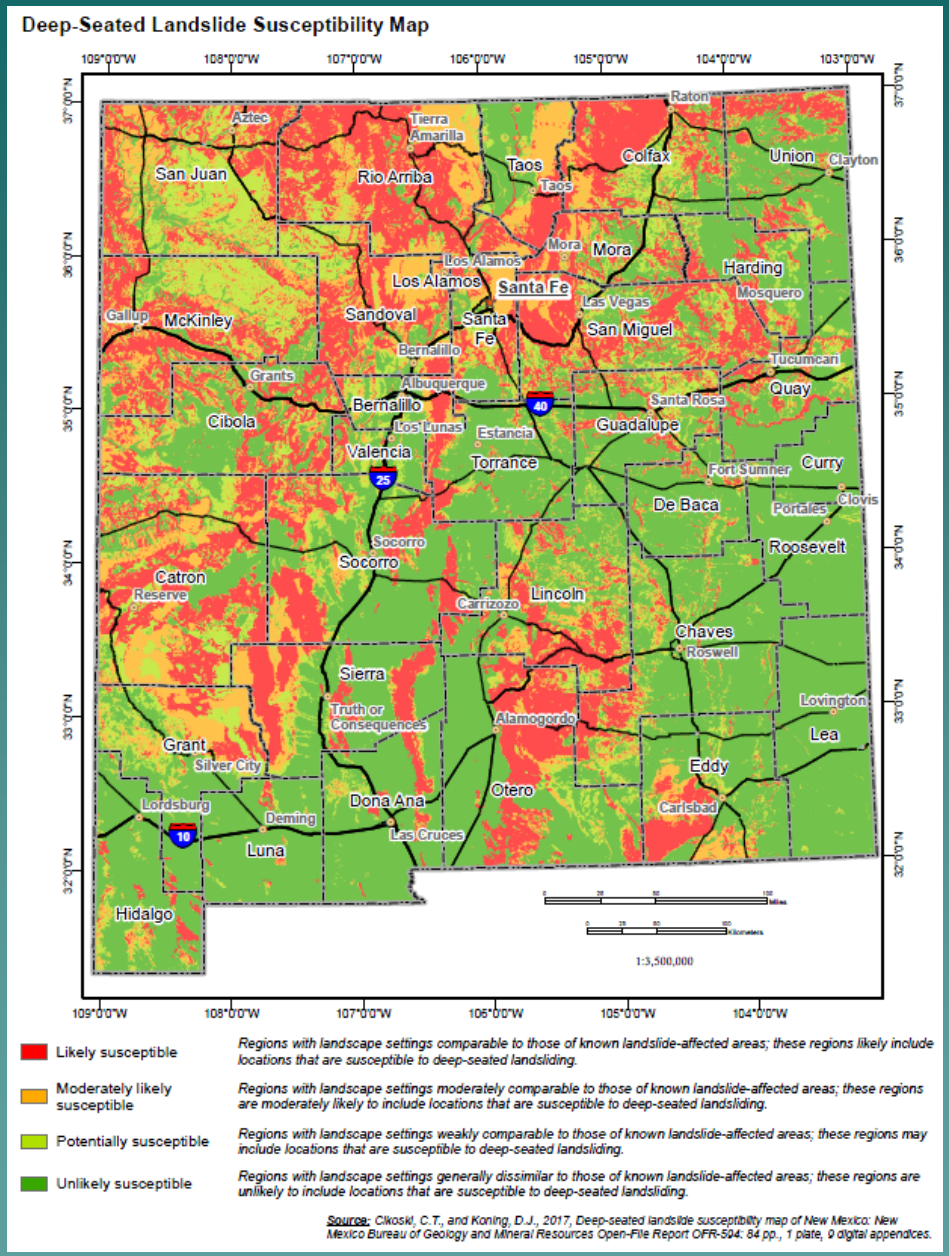
Explanation of Map Symbols

STATEMAP Program
- Mapping Completed
- Mapping In Progress

NMBGMR Monographs
- 1:24,000 Scale Monographs

USGS
- 1:24,000 Scale Publications

Geologic Mapping Program

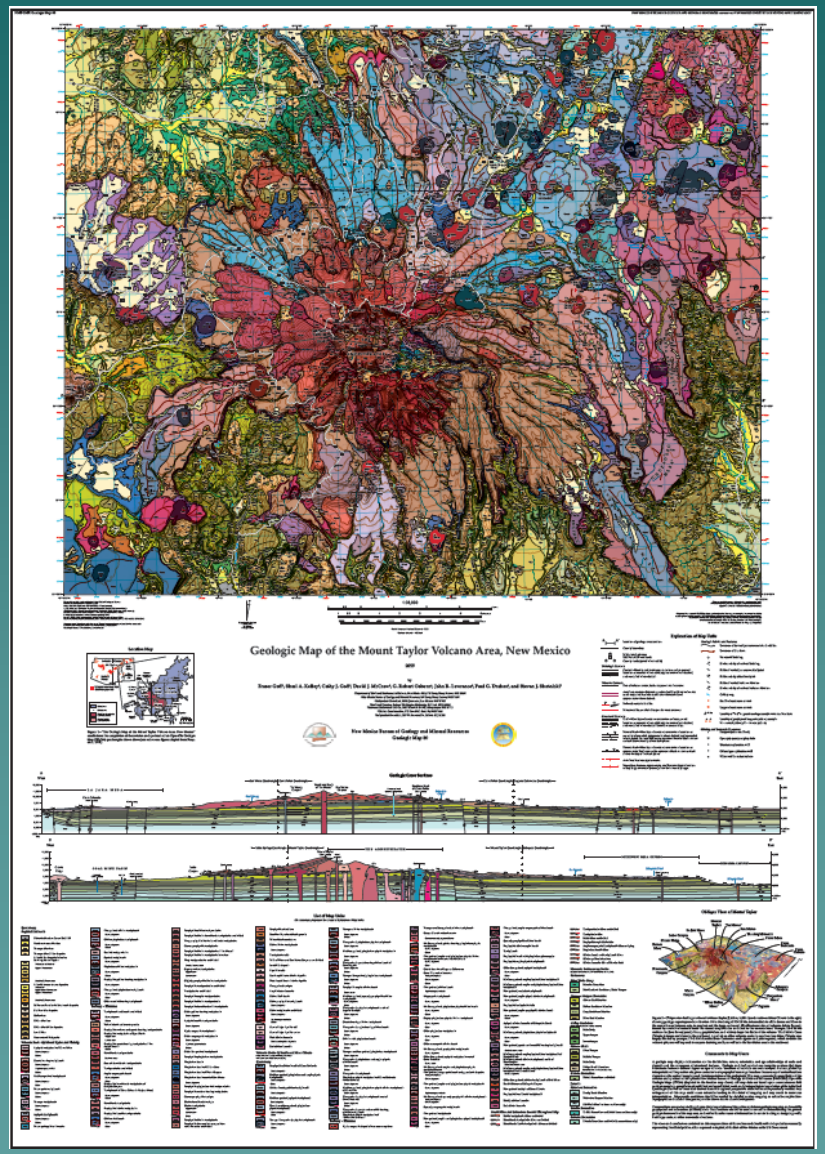


Mapping is used for mineral and energy resource evaluations, water assessments, city planning, hydrologic modeling and hazards assessments.

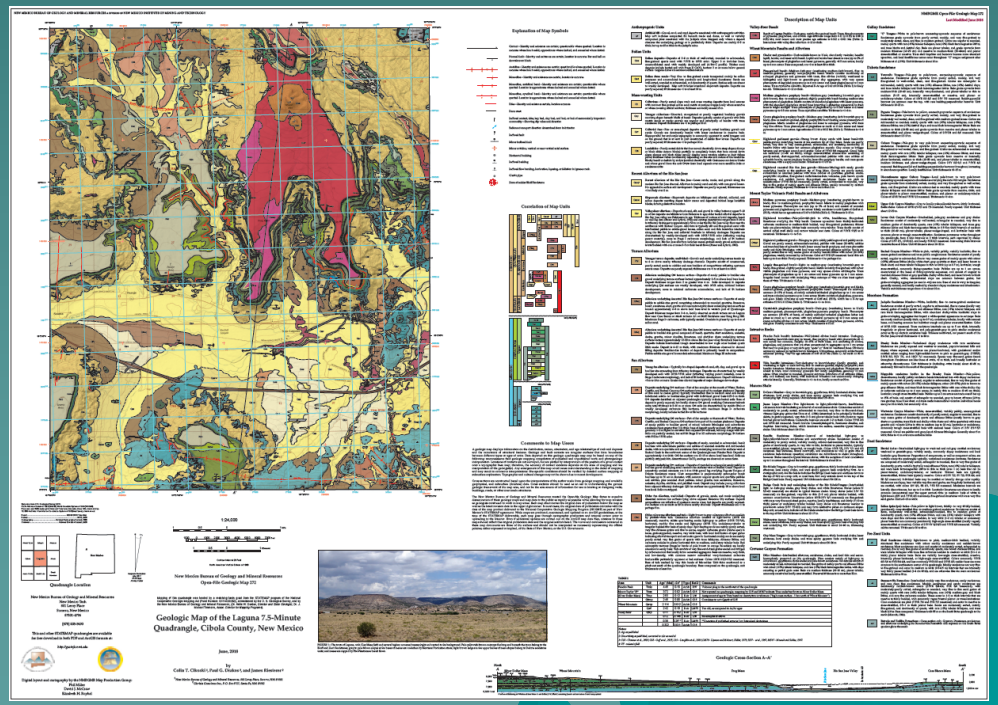
9 Bureau mappers and 2 contractors currently map in the state

Geologic Hazards research remain a critical area that few are examining on a state-wide basis. Improved ArcGIS tools and better elevation data is improving our understanding of the state's natural hazards.

The success of the program depends on timely dissemination of map products



Geologic quadrangle maps (below) and map databases can now be organized into regional geologic compilations for derivative studies (left). Most commonly these studies are organized around basin or mountain-scale hydrogeologic studies.



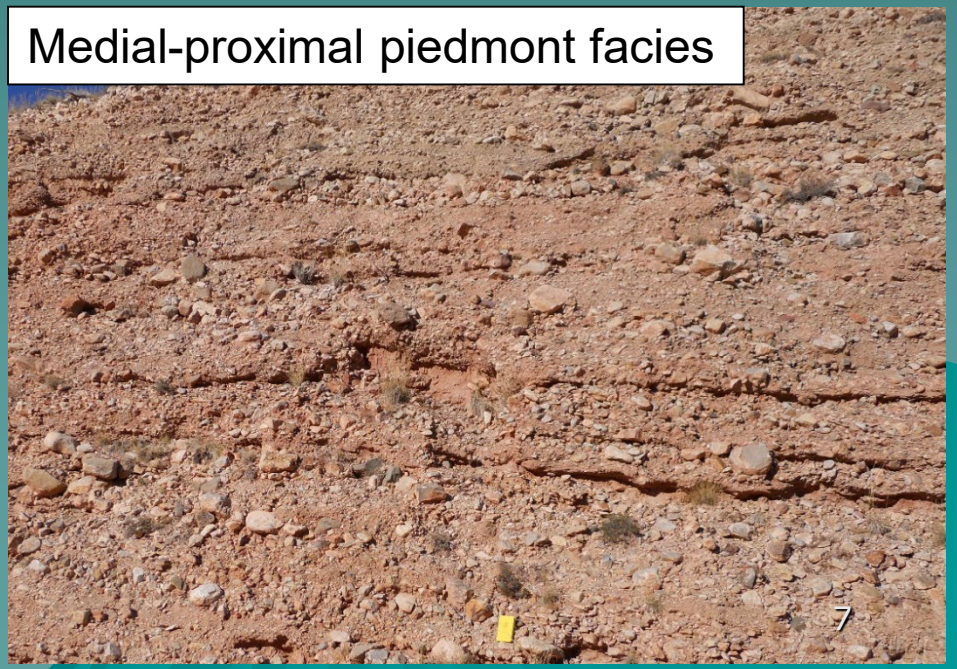
Geologic mapping

- Identify unique geologic material
- Map where it is
- In the Albuquerque area, many of the mapped units have unique water-related properties

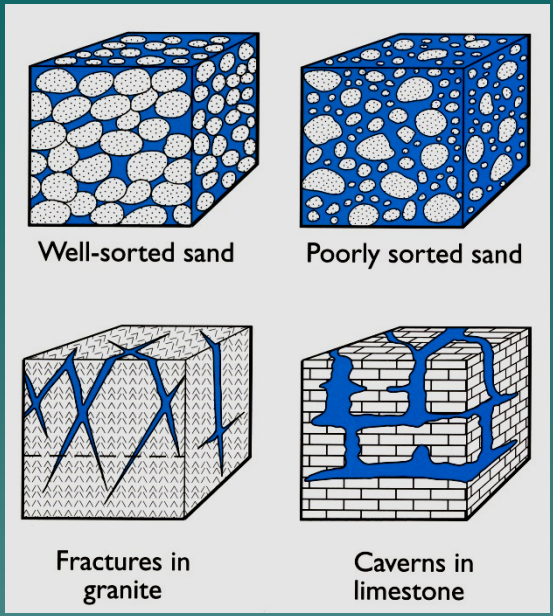
Axial facies

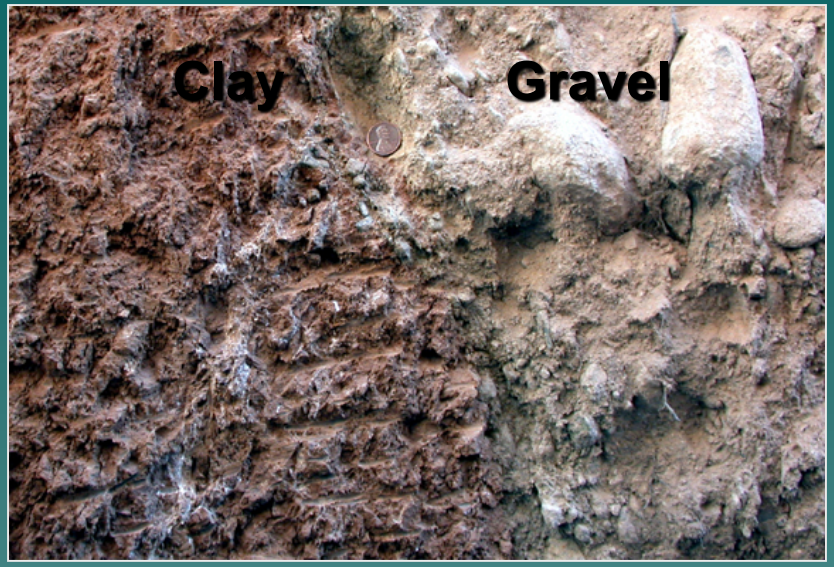
Distal piedmont facies

Medial-proximal piedmont facies

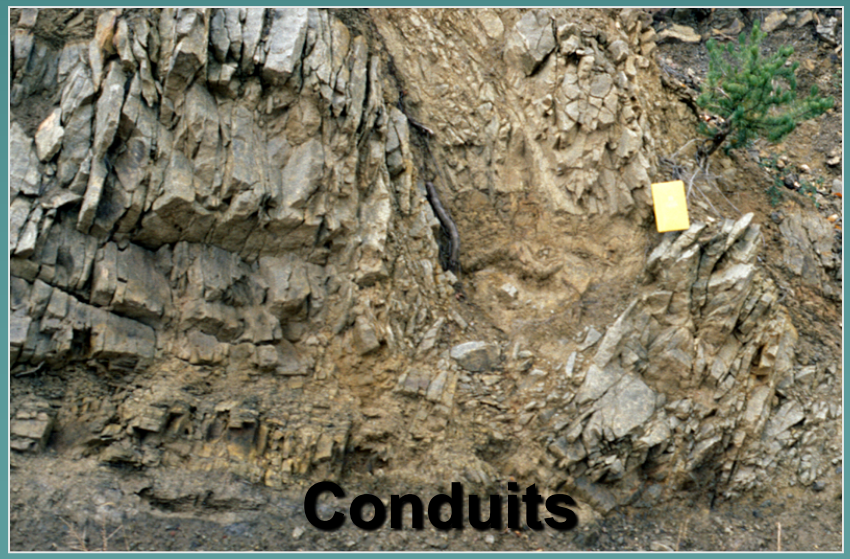


Different Materials Store and Transmit Water in Different Ways





And, Faults Can Influence Ground Water Flow



What is aquifer mapping?

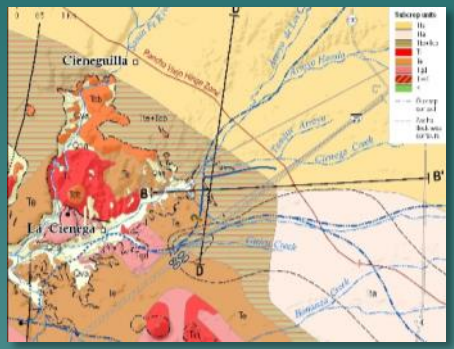
Aquifer mapping is a scientific process applying a combination of geologic, geophysical, hydrologic, and chemical field and laboratory analyses to characterize the quantity, quality, and sustainability of groundwater in aquifers.

Gathering data

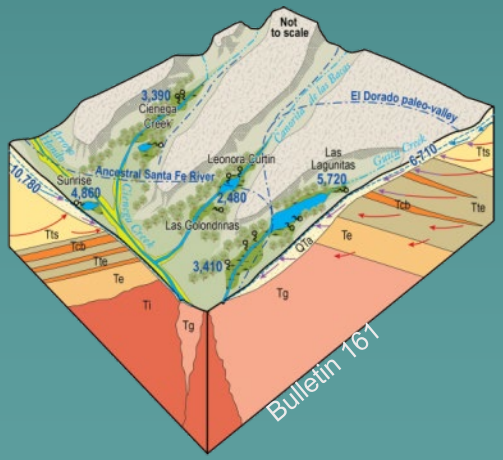
Water level measurements

Water quality sampling

Combine with geology to build models

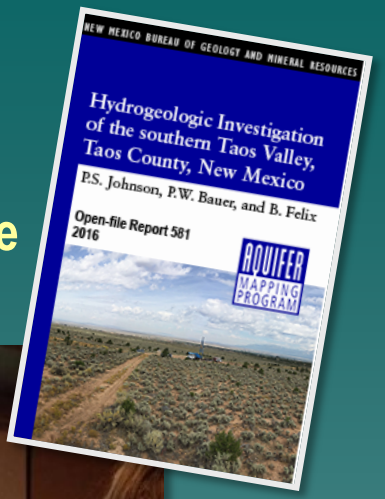


Maps of subsurface groundwater features



Hydrogeologic conceptual models

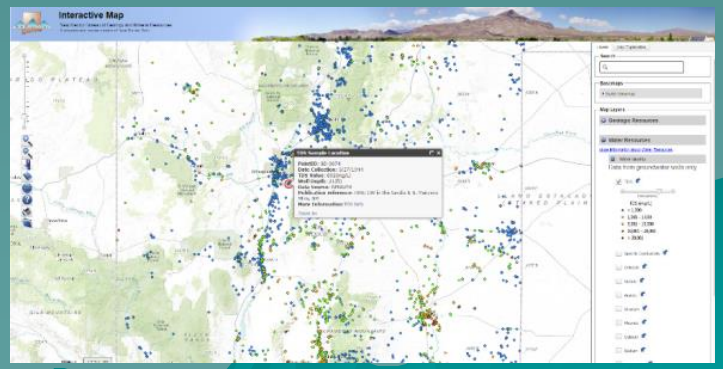
Publicly accessible products



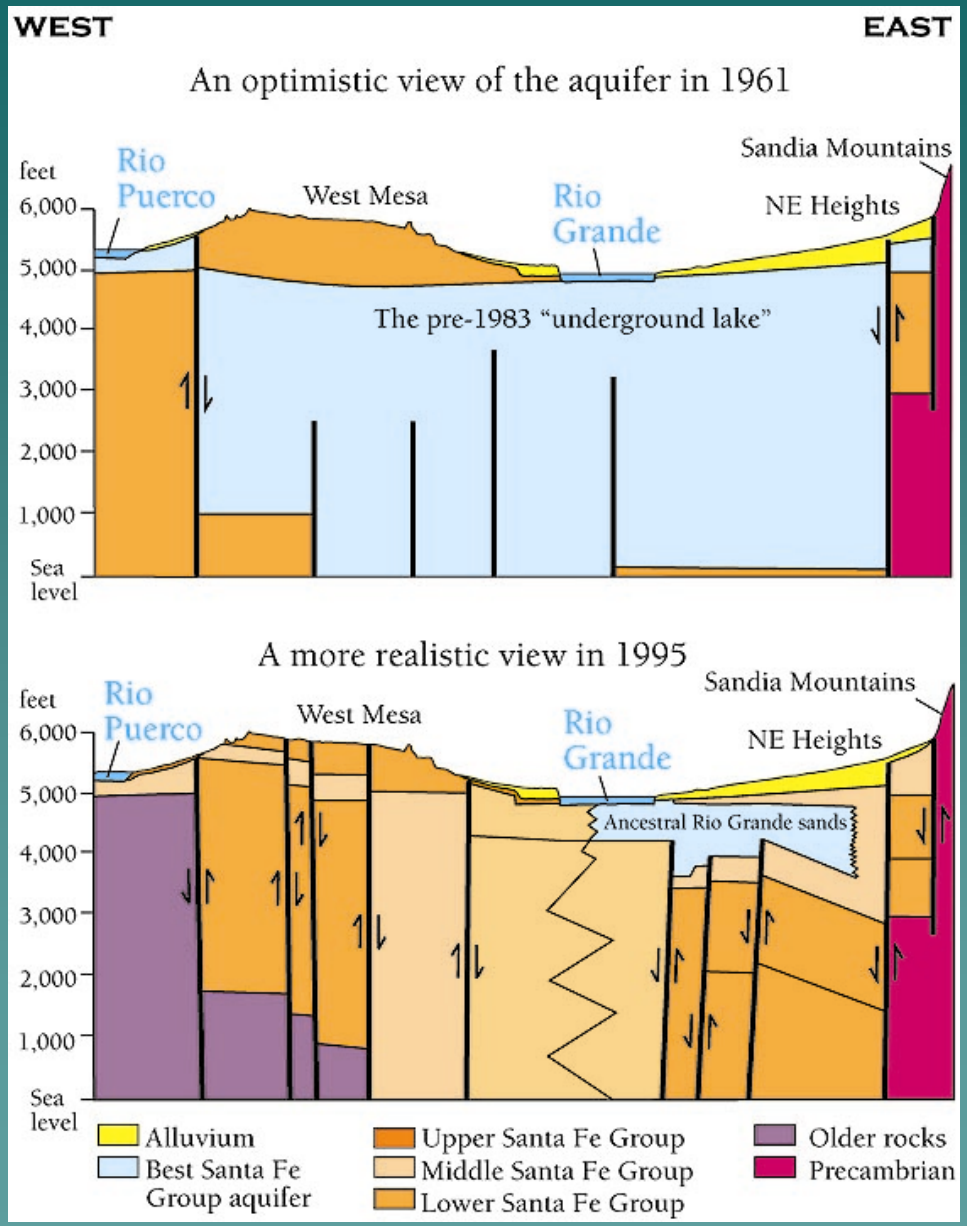
Regional hydrogeology technical reports and data

Community outreach and presentations

geoinfo.nmt.edu/maps



Aquifers of the Albuquerque Basin – Then & Now



Managed Aquifer Recharge (MAR)

The intentional recharge and storage of water into an aquifer for subsequent recovery or for environmental benefit.

Why do it?

- Save water for future use
- Analogous to savings account

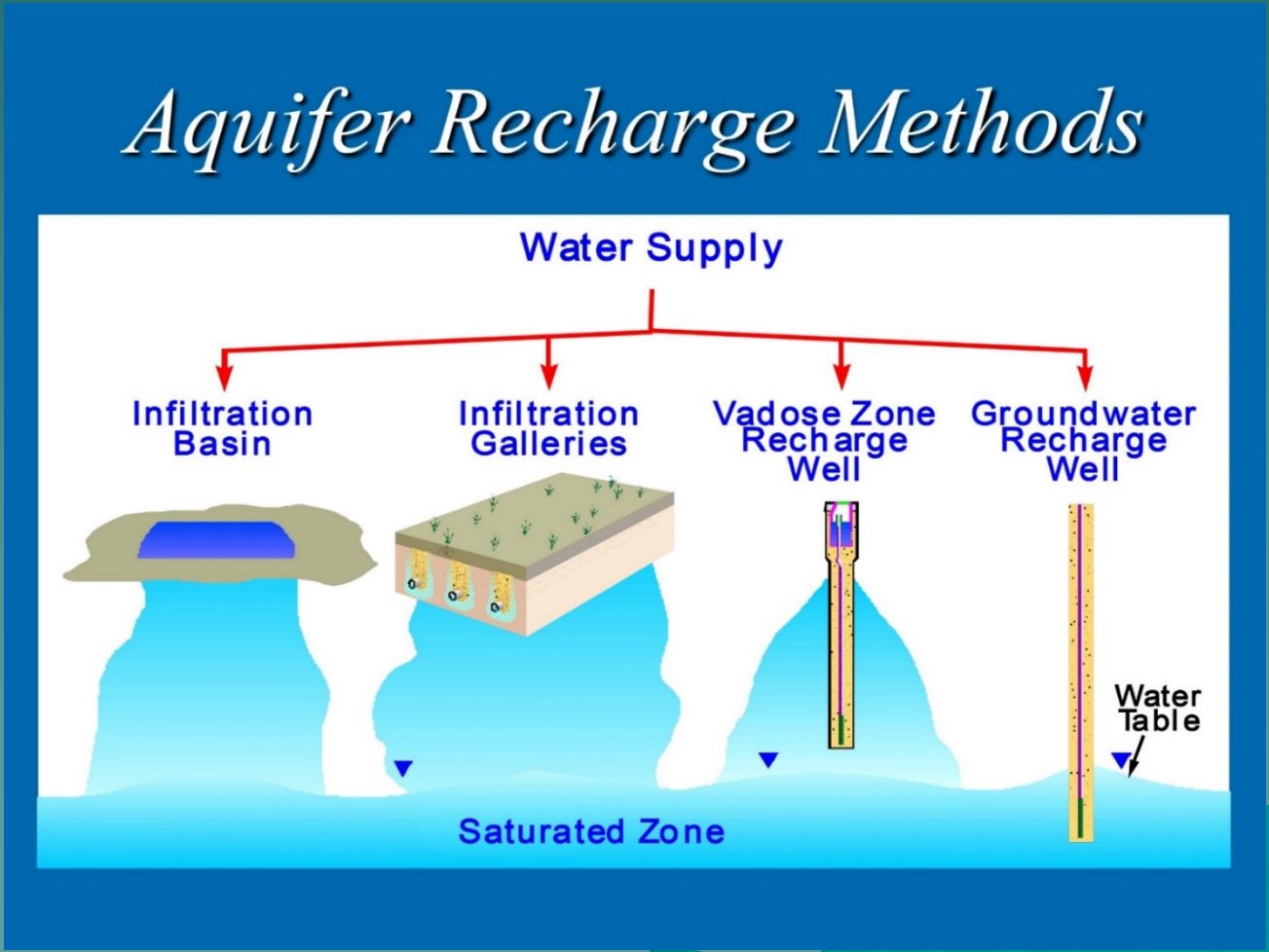
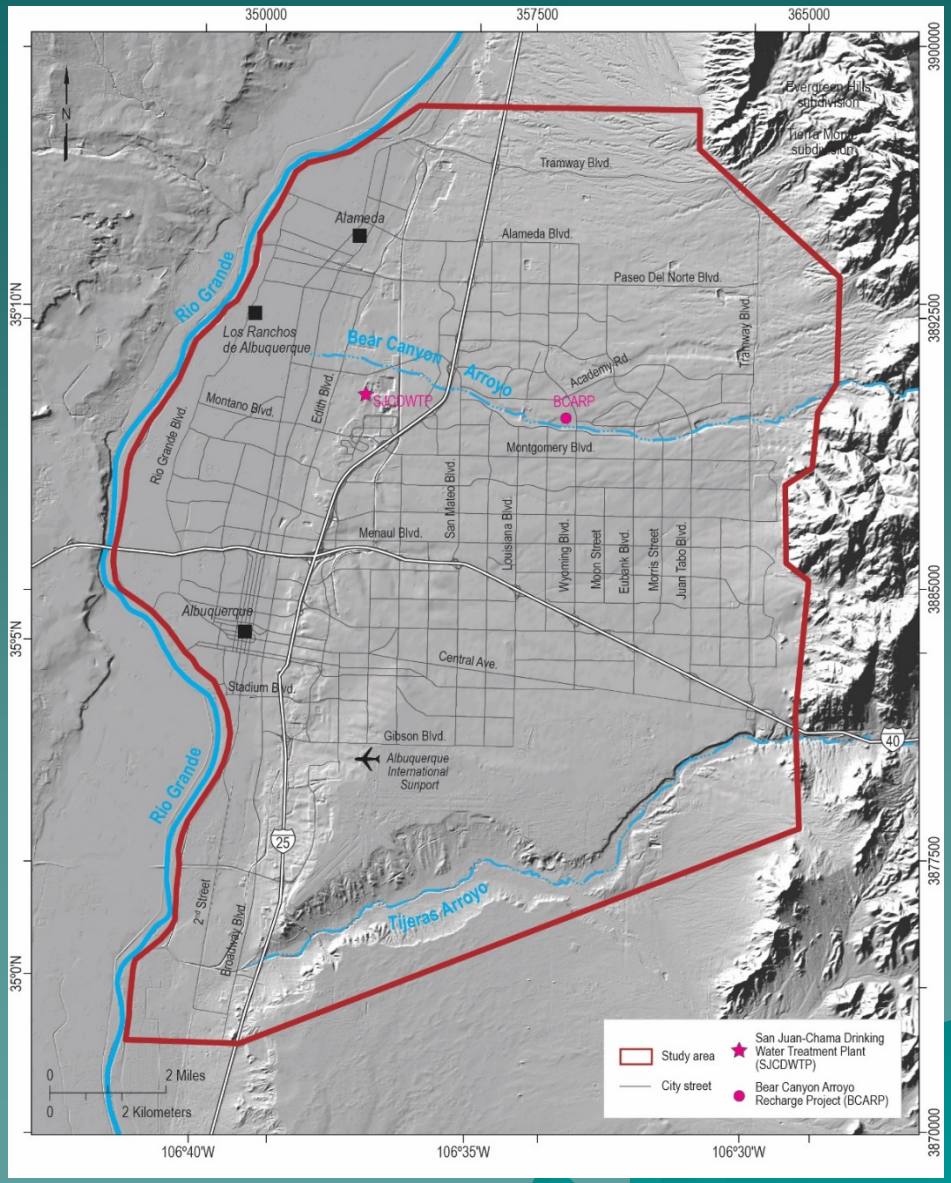


Figure from Daniel B. Stephens and Associates

Why MAR works in Albuquerque

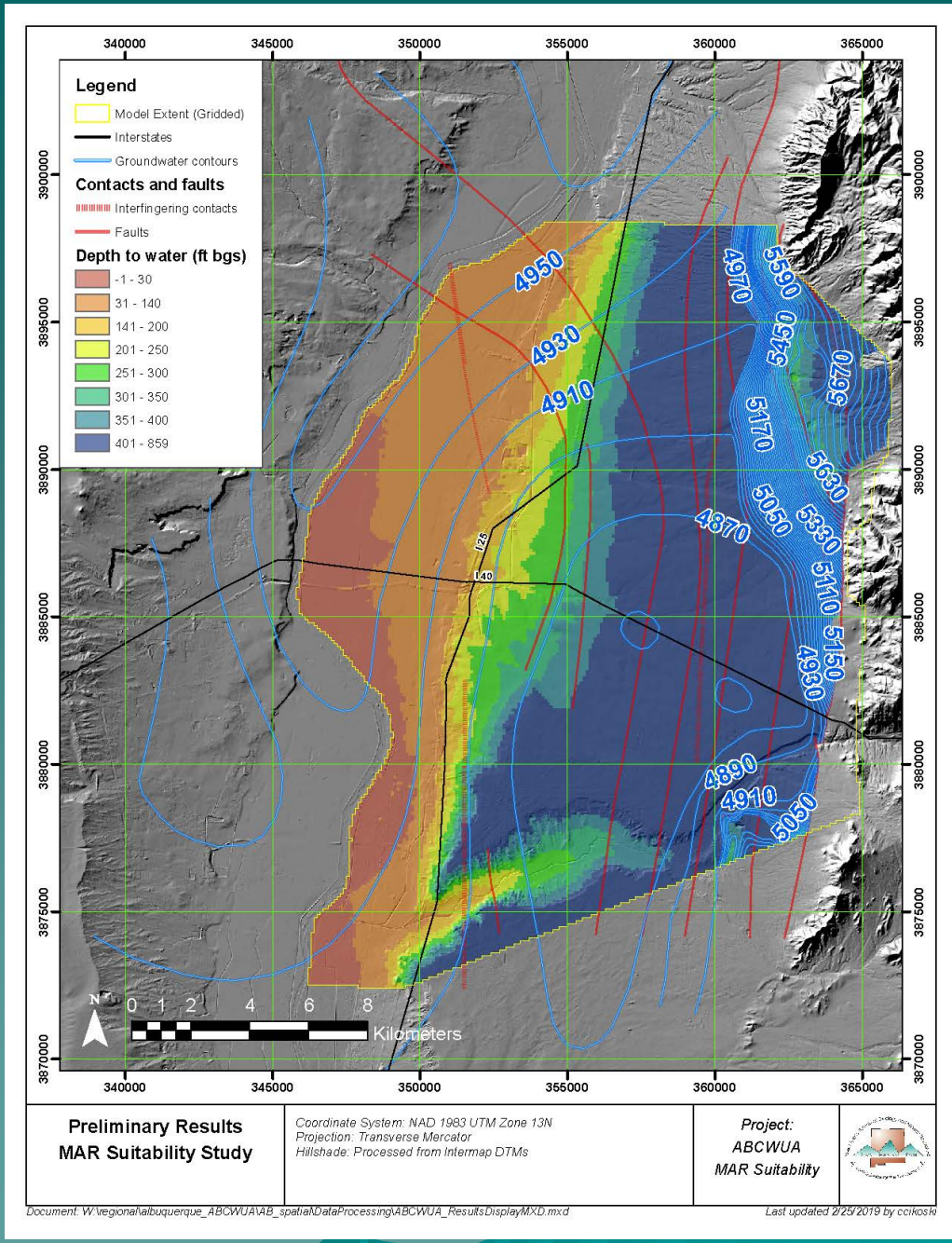
- Potential excess water from San Juan-Chama project
- Favorable water table geometry
- Deep basin filled with sandy sediment
- Favorable subsurface geology

To right, location of Albuquerque MAR mapping project



An ideal situation for storing water underground

- Long-term pumping has created an elongated cone of depression east of the Rio Grande.
- Mapping of water table indicates that most of the recharged water should stay within ABCWUA jurisdiction.



Albuquerque Basin

SFG = Santa Fe Group. Sandy and up to 15,000 ft thick.

Upper Santa Fe Group is primary aquifer and most permeable.

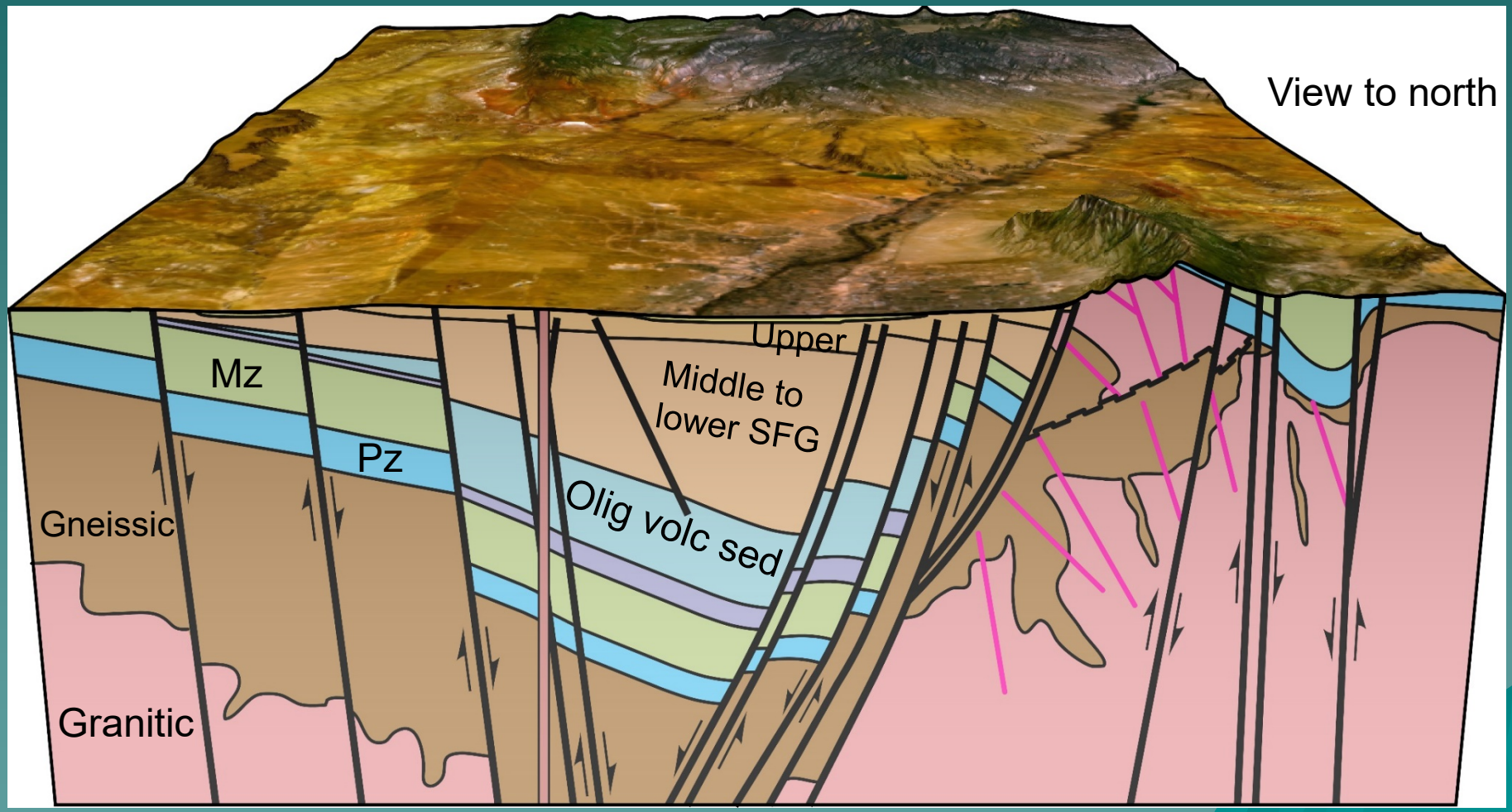
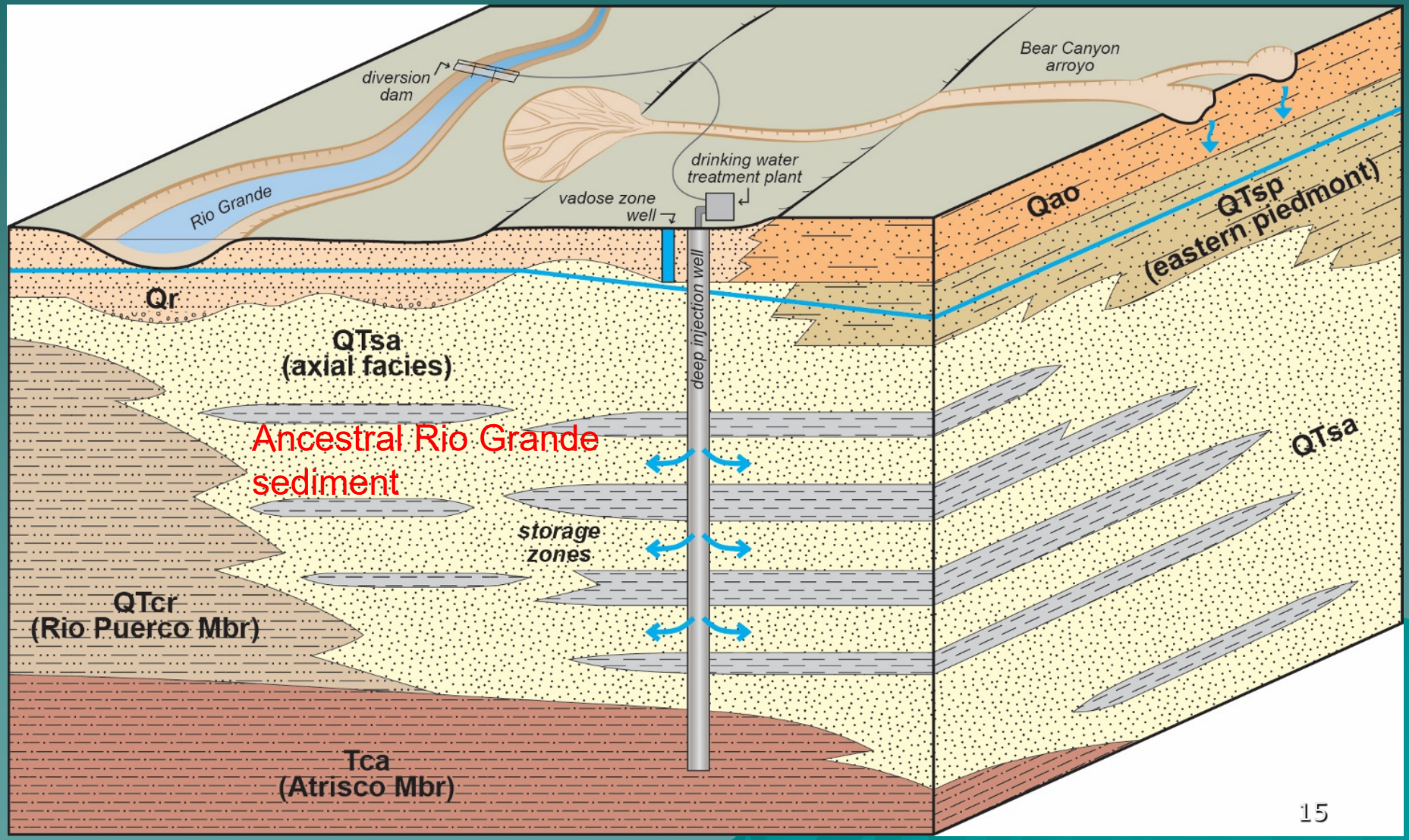


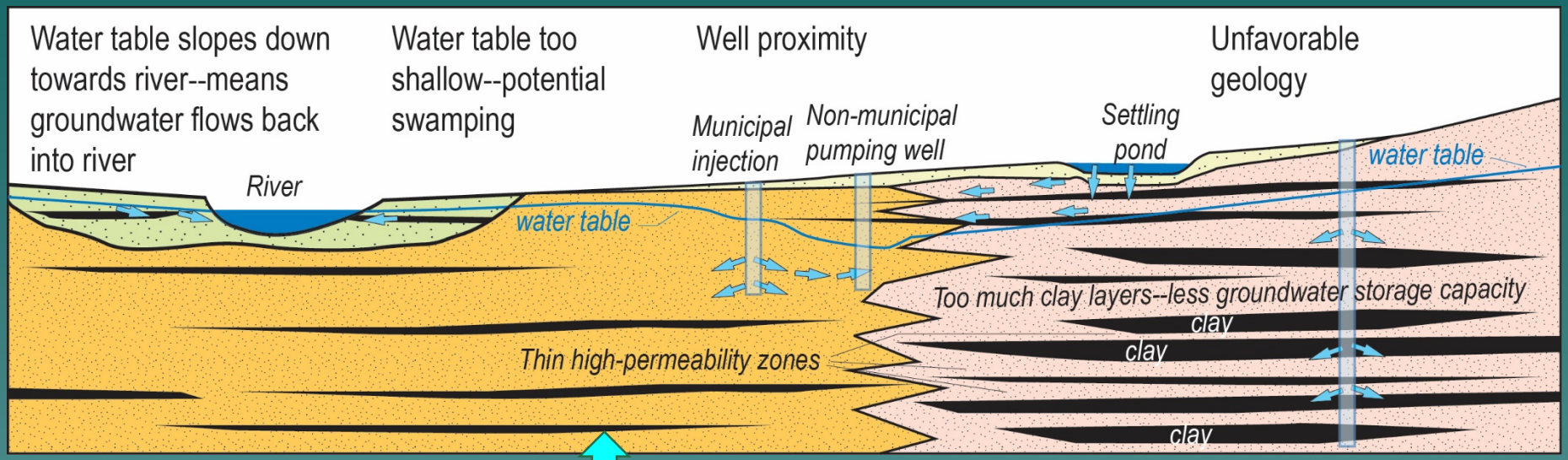
Figure created by Sean Connell

Favorable subsurface geology

The “axial facies” (ancestral Rio Grande sediment) can transmit and store groundwater better than most other units. It is relatively thick and widespread.

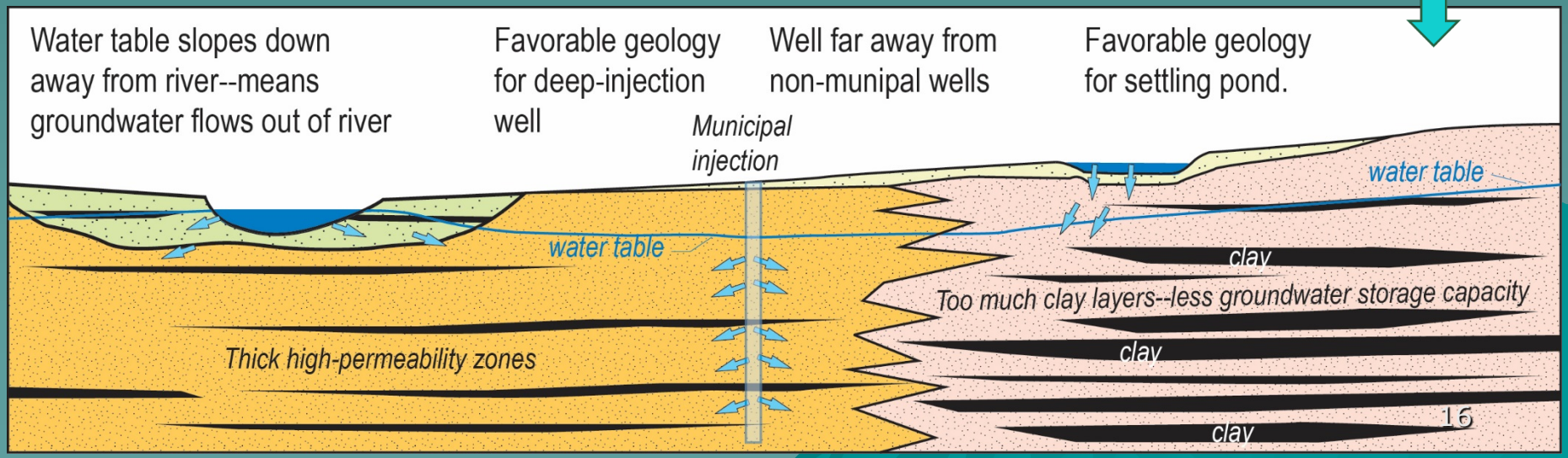


Efficacy of MAR – careful planning and study needed!



Not so good

Better



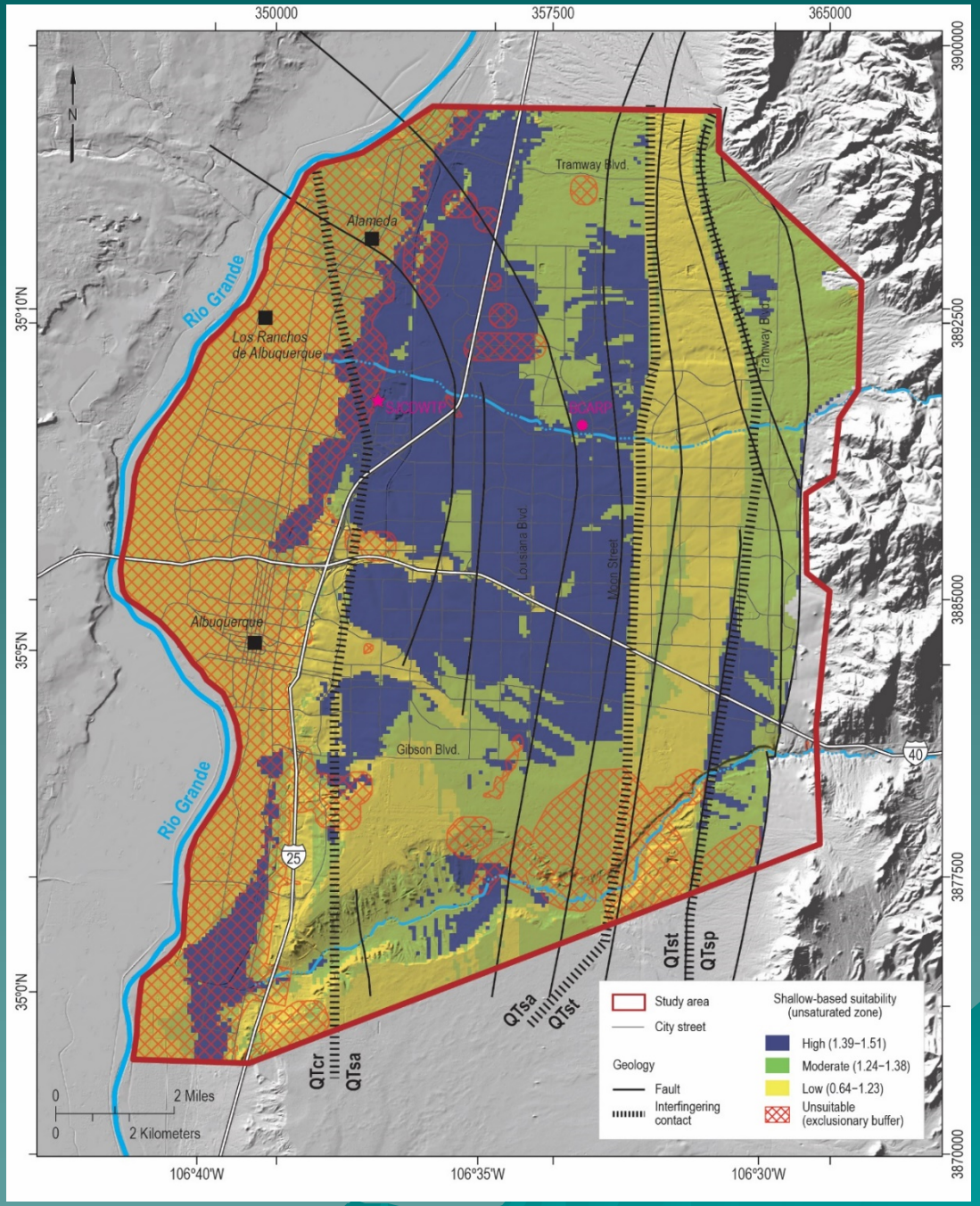
Suitability for shallow-based MAR

Open-file Report 605

➔Funded by ABCWUA

➔Method: ARC GIS method called weighted overlay analysis– incorporates geologic, hydrologic, and infrastructure criteria.

➔Products: Maps showing suitability for deep-injection recharge and shallow-based recharge.

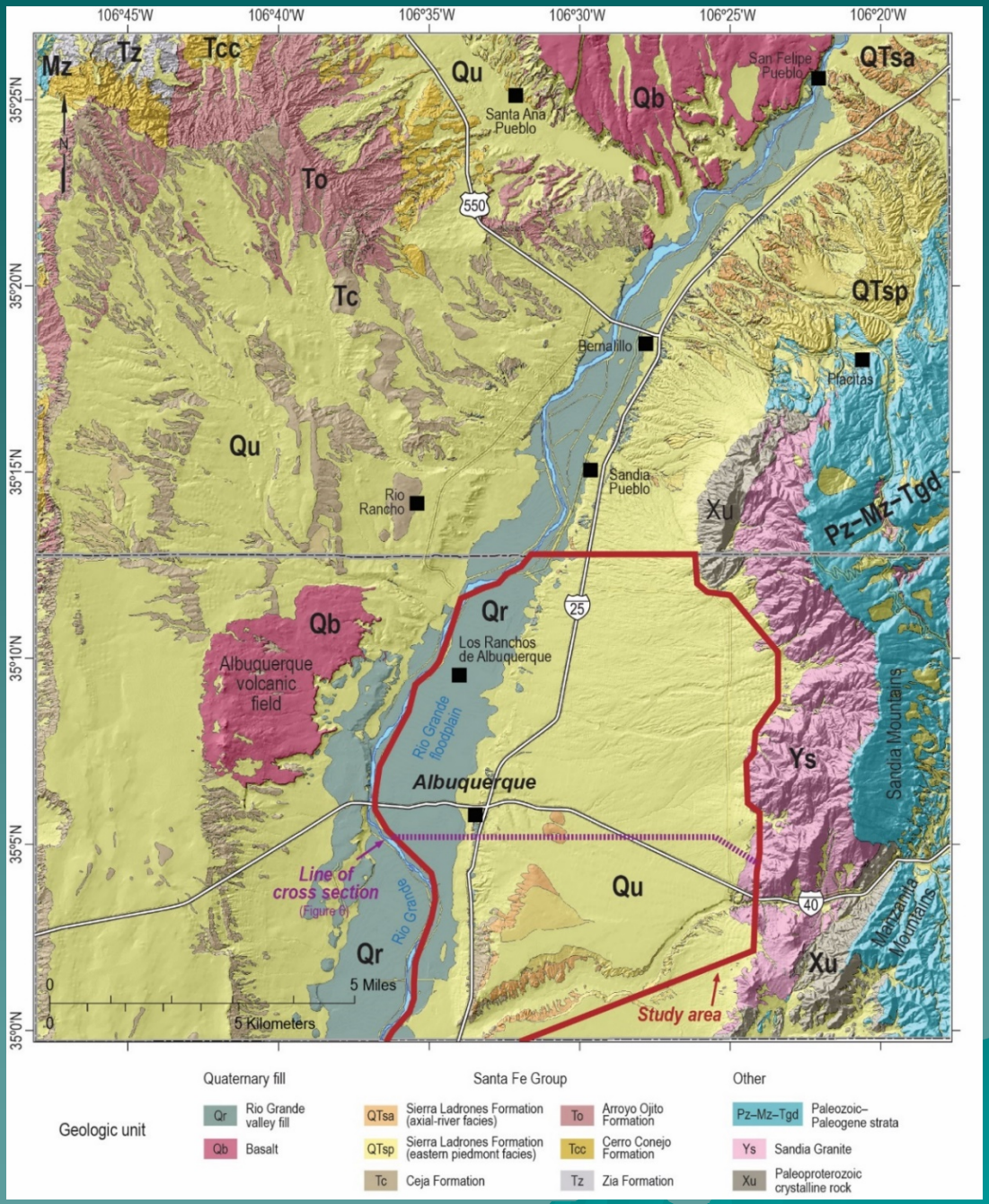


Role that previous geologic studies played in mapping MAR suitability

- Geologic mapping by NM Bureau of Geology (funded by STATEMAP program)
- Subsurface studies (Hawley, 1996, Connell, 2008)
- These allow us to make a 3D geologic model of the subsurface; this 3D geologic model was essential to accurately incorporate aquifer differences into the weighted overlay analyses.

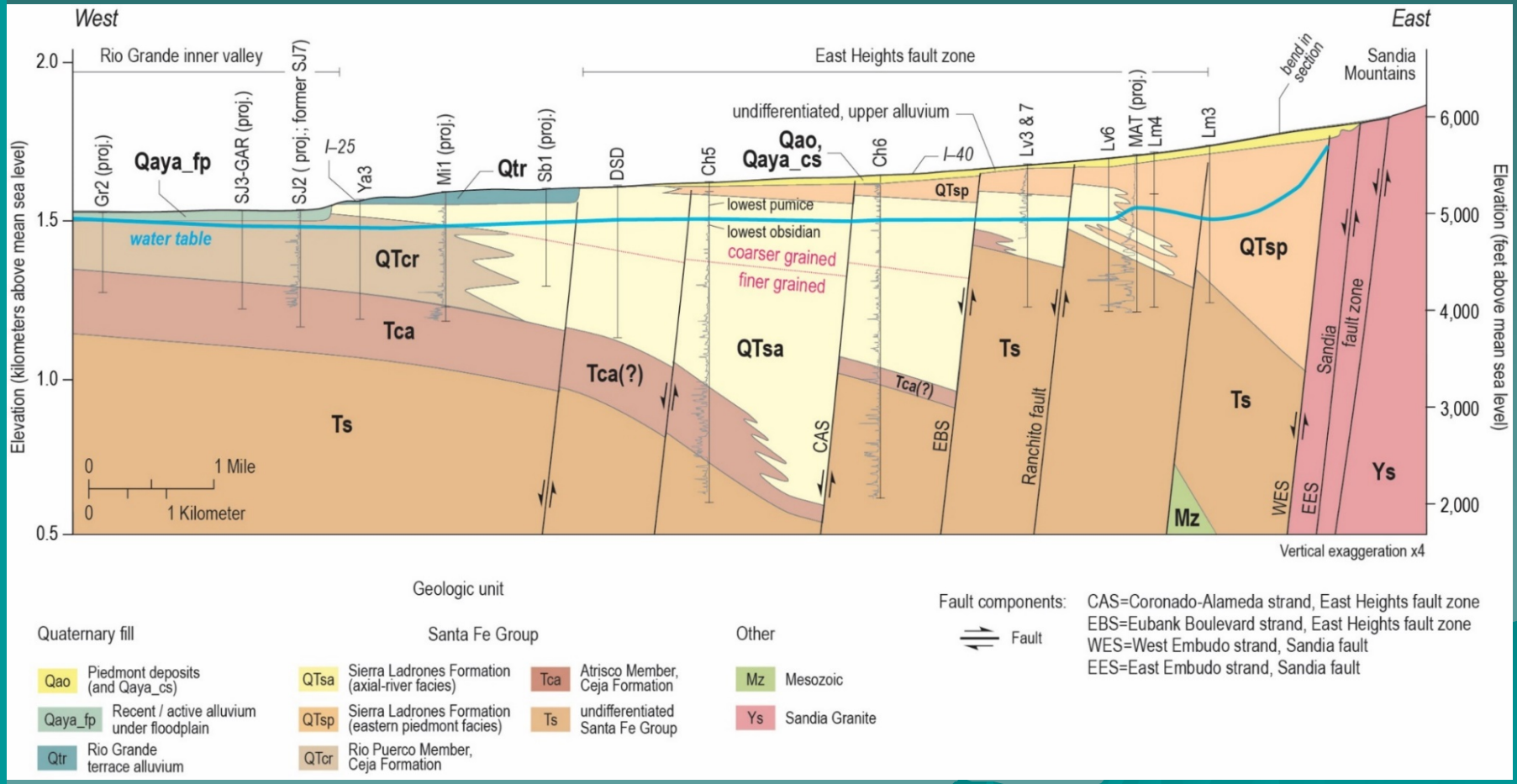
Geologic map of Albuquerque and Rio Rancho area

By Sean Connell, published in 2008 as GM 78.



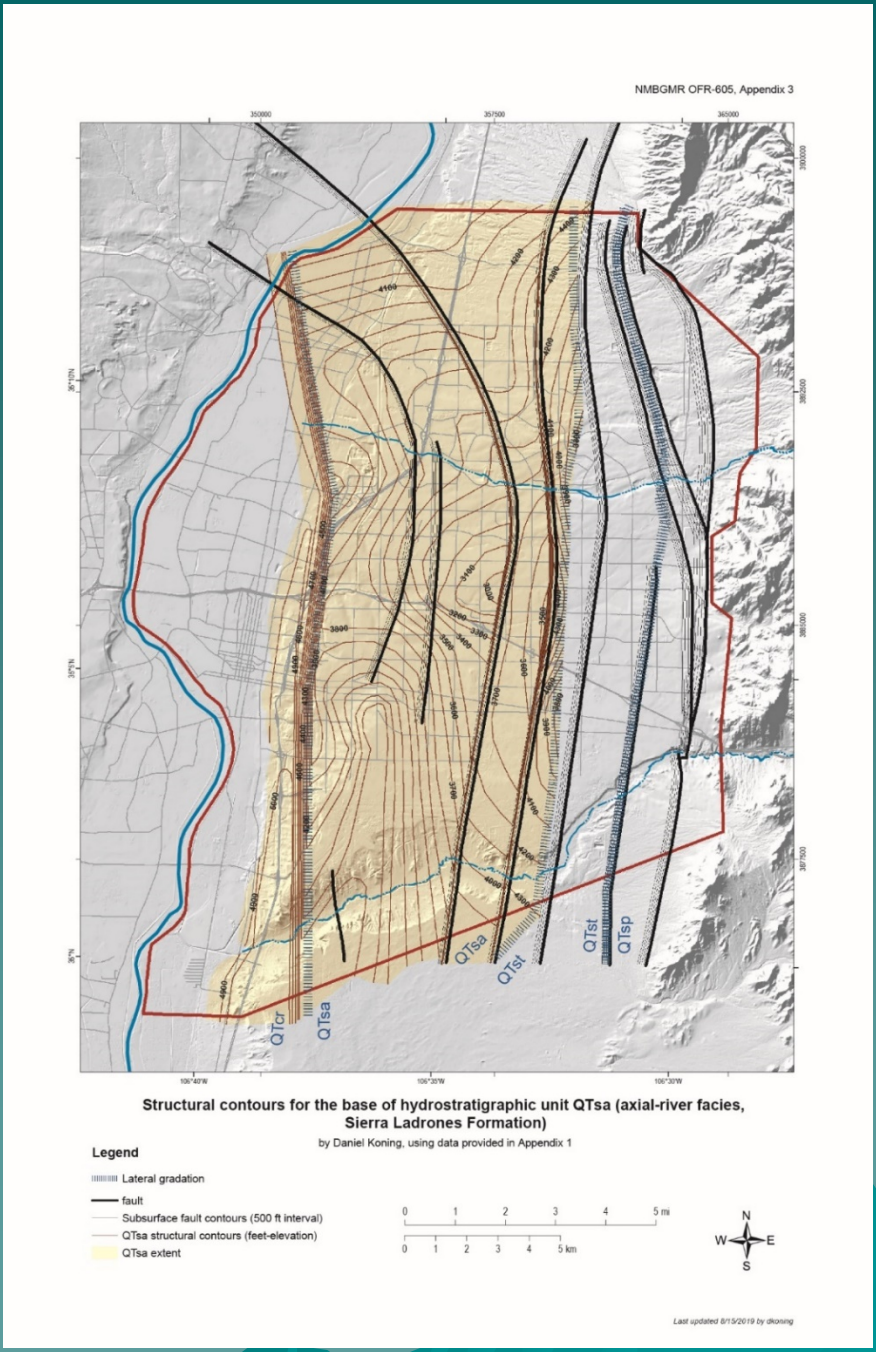
Geologic maps, coupled with well data and analyses, are used to make cross sections

One of four cross sections in GM-78



Cross sections and wells allow us to make structural contour maps

To right is a map showing the elevation of the base of the ancestral Rio Grande.



Geologic model

Structural contour maps allow us to make a 3D geologic model that was essential in the ABCWUA MAR project.