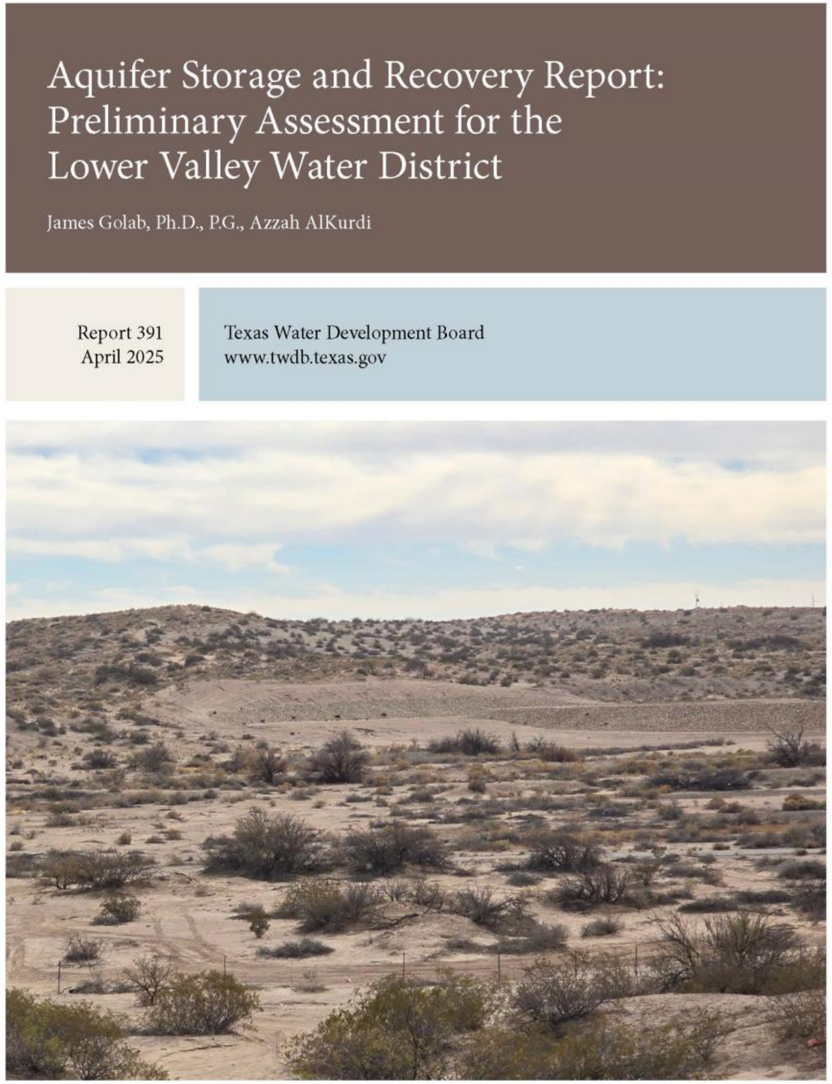
Aquifer Storage and Recover Report: Preliminary ASR and AR Assessment for the Lower Valley Water District



Public Webinar (June 11th,10am - 12pm)

https://www.twdb.texas.gov/innovativewater/asr/projects/LVWD/index.asp

Speakers

James Golab, Ph.D., P.G.

Principal investigator
TWDB IWT Manager

Azzah AlKurdi

Engineering Specialist, IWT

J.E. Long, P.E.

Chief Operations and Technical Officer
Lower Valley Water District

Webinar reminders and format

TYPE QUESTIONS IN THE CHAT SO WE CAN QUEUE THEM UP

TOPIC-RELATED QUESTION TIME AFTER SECTIONS

QUESTION TIME AT THE END TOO!

WEBINAR IS BEING RECORDED

Introduction Assessment Discussion Conclusion

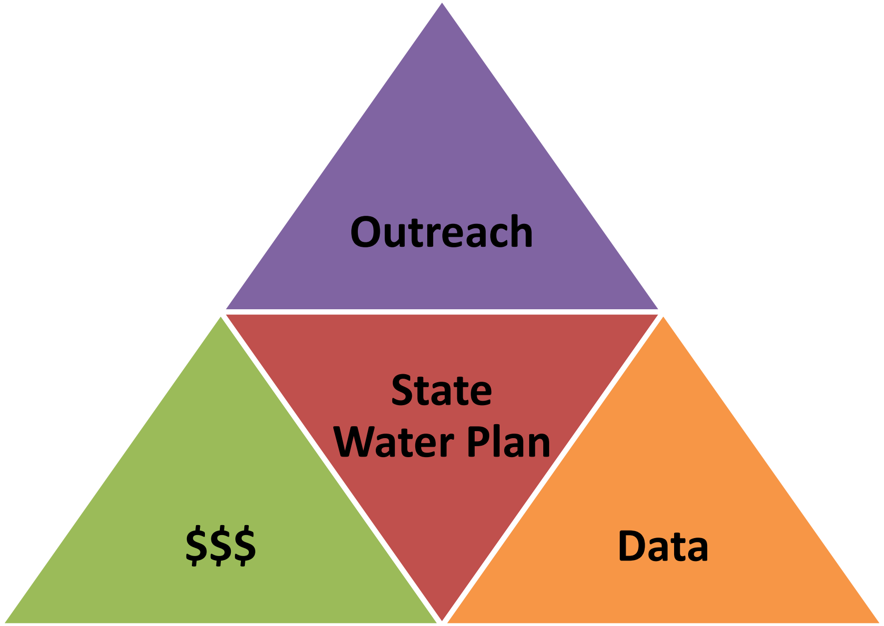
TWDB

ASR & AR

LVWD

Mission Statement:

"To lead the state's efforts in ensuring a secure water future for Texas and its citizens"



50-year State Water Plan updated every 5 years

Offices

- Water Science & Conservation
- Water Supply & Infrastructure
- Operations & Administration
- Texas Geographic Information Office
- Planning
- Finance

Innovative Water Technologies

- Reuse
- Aquifer Storage and Recovery
- Desalination
- Aquifer Recharge

IWT goal: advance and promote the development and use of alternative water supplies in Texas.

IWT webpage

Introduction Assessment Discussion Conclusion

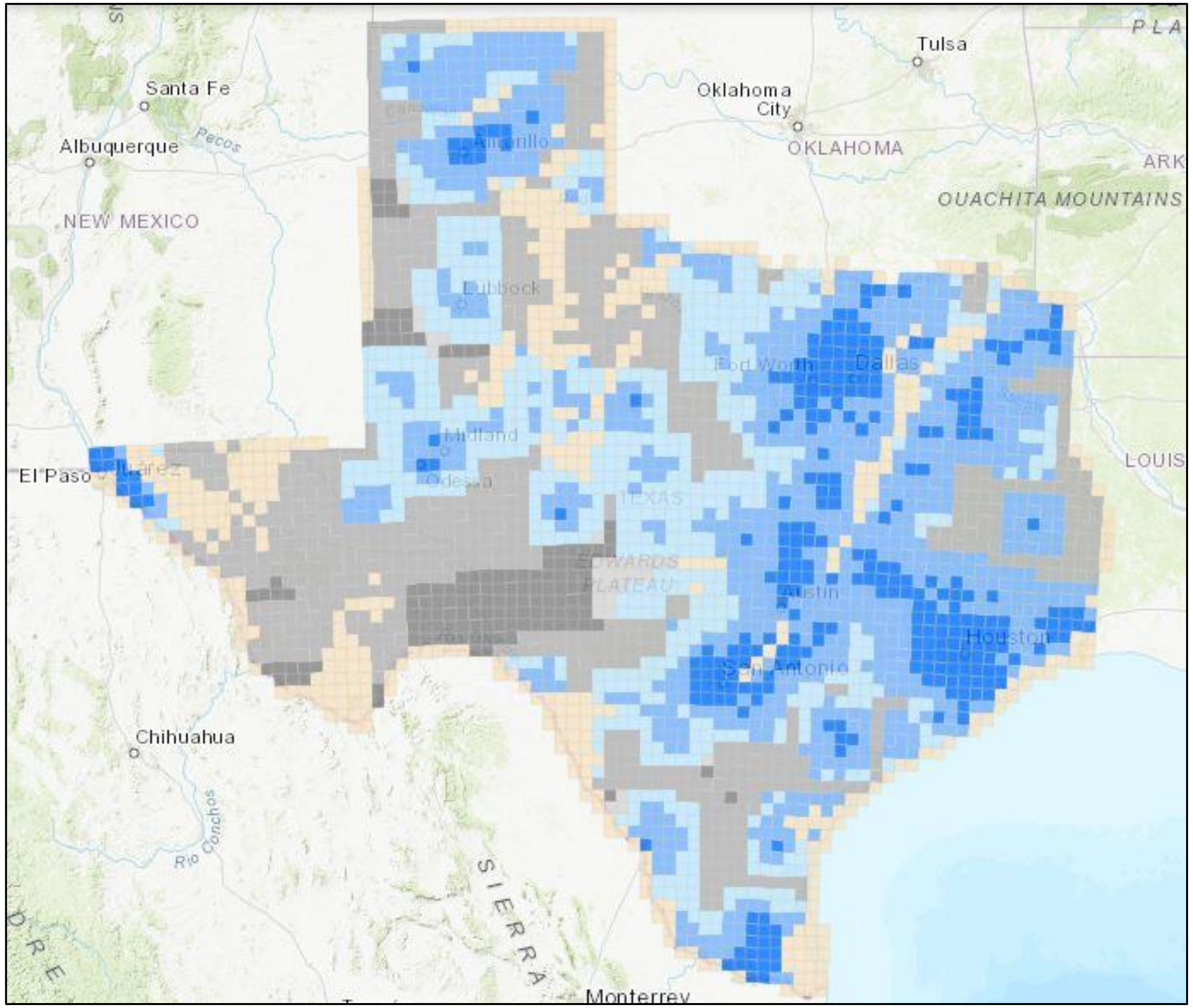
TWDB

ASR & AR

LVWD

Texas Water Code § 11.155

Statewide survey of aquifer suitability for Aquifer Storage and Recovery (ASR) or Aquifer Recharge (AR) projects in Texas



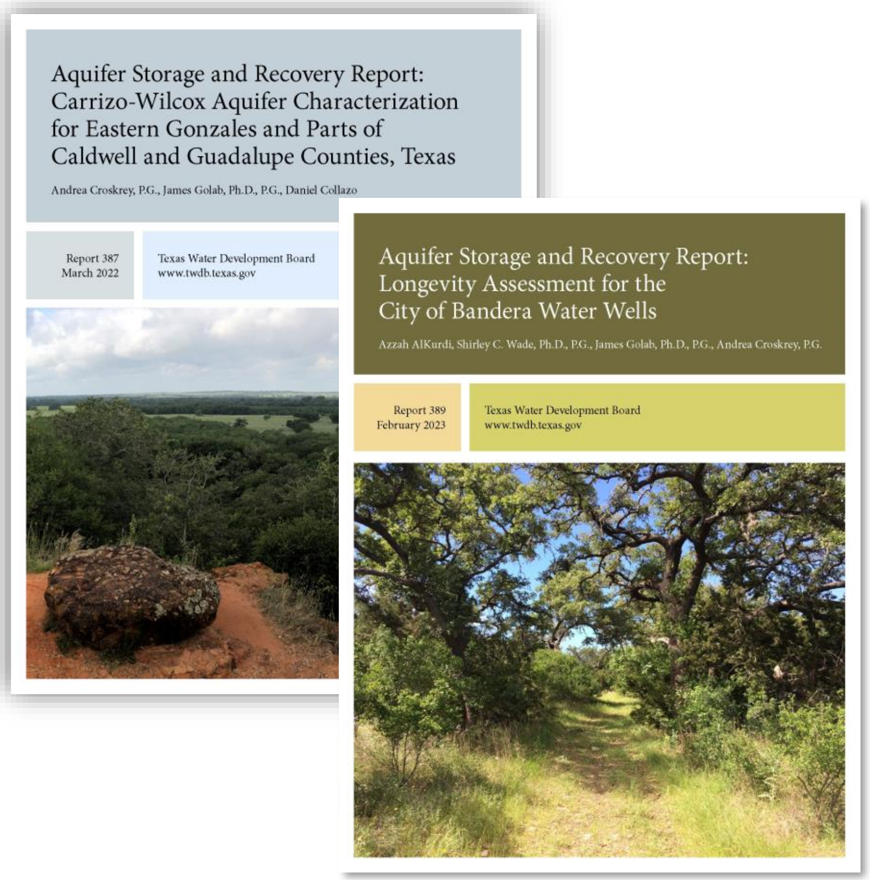
- most suitable
- moderately suitable
- less suitable
- no excess water identified
- no need identified
- neither excess water nor need

Project web page

Story map

Texas Water Code § 11.155

- Conduct ASR studies
- Share results


Aquifer Storage and Recovery Report: Carrizo-Wilcox Aquifer Characterization for Eastern Gonzales and Parts of Caldwell and Guadalupe Counties, Texas

Andrea Croskrey, P.G., James Golab, Ph.D., P.G., Daniel Collazo

Report 387
March 2022

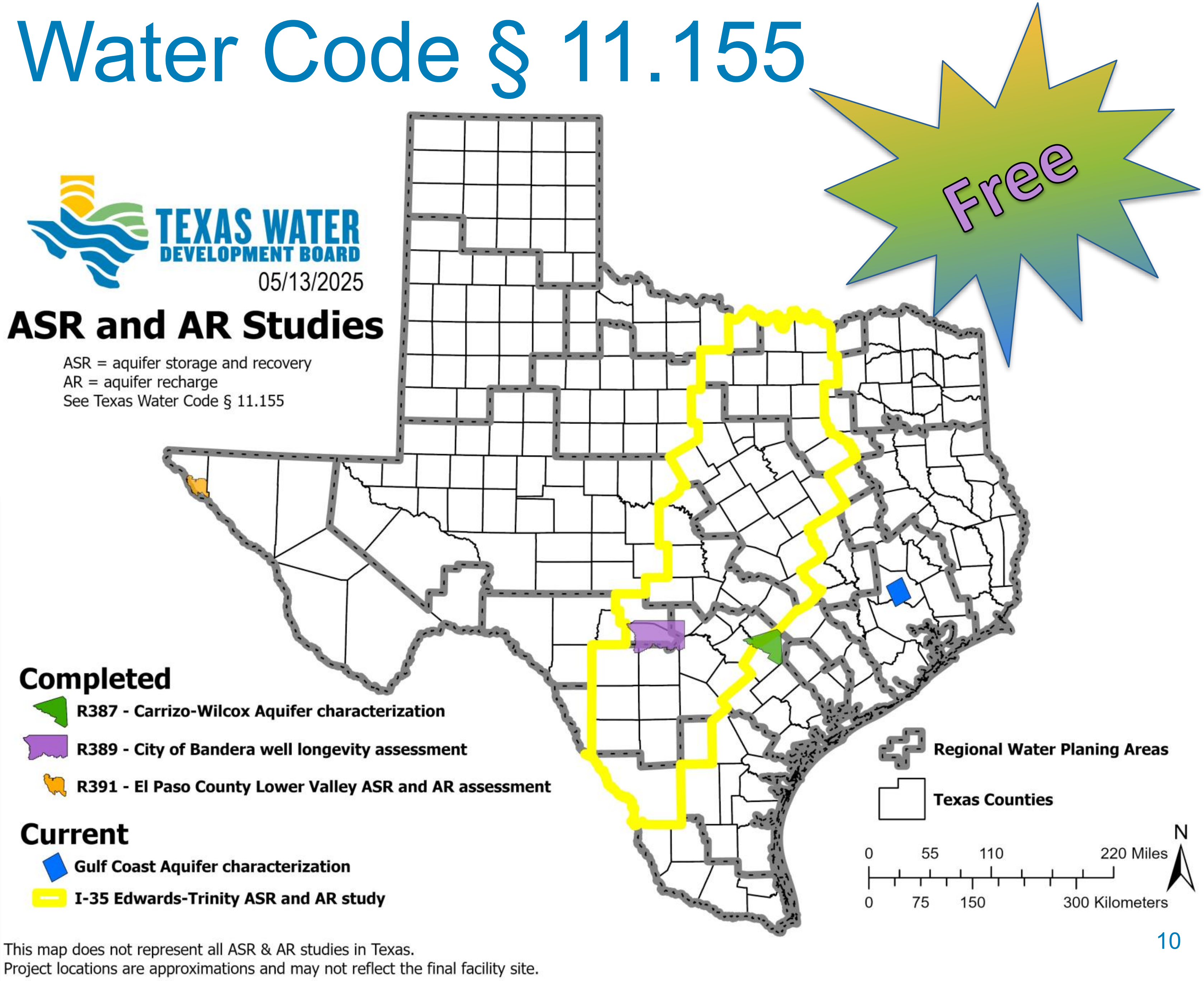
Texas Water Development Board
www.twdb.texas.gov

Aquifer Storage and Recovery Report: Longevity Assessment for the City of Bandera Water Wells

Azzah AlKurdi, Shirley C. Wade, Ph.D., P.G., James Golab, Ph.D., P.G., Andrea Croskrey, P.G.

Report 389
February 2023

Texas Water Development Board
www.twdb.texas.gov



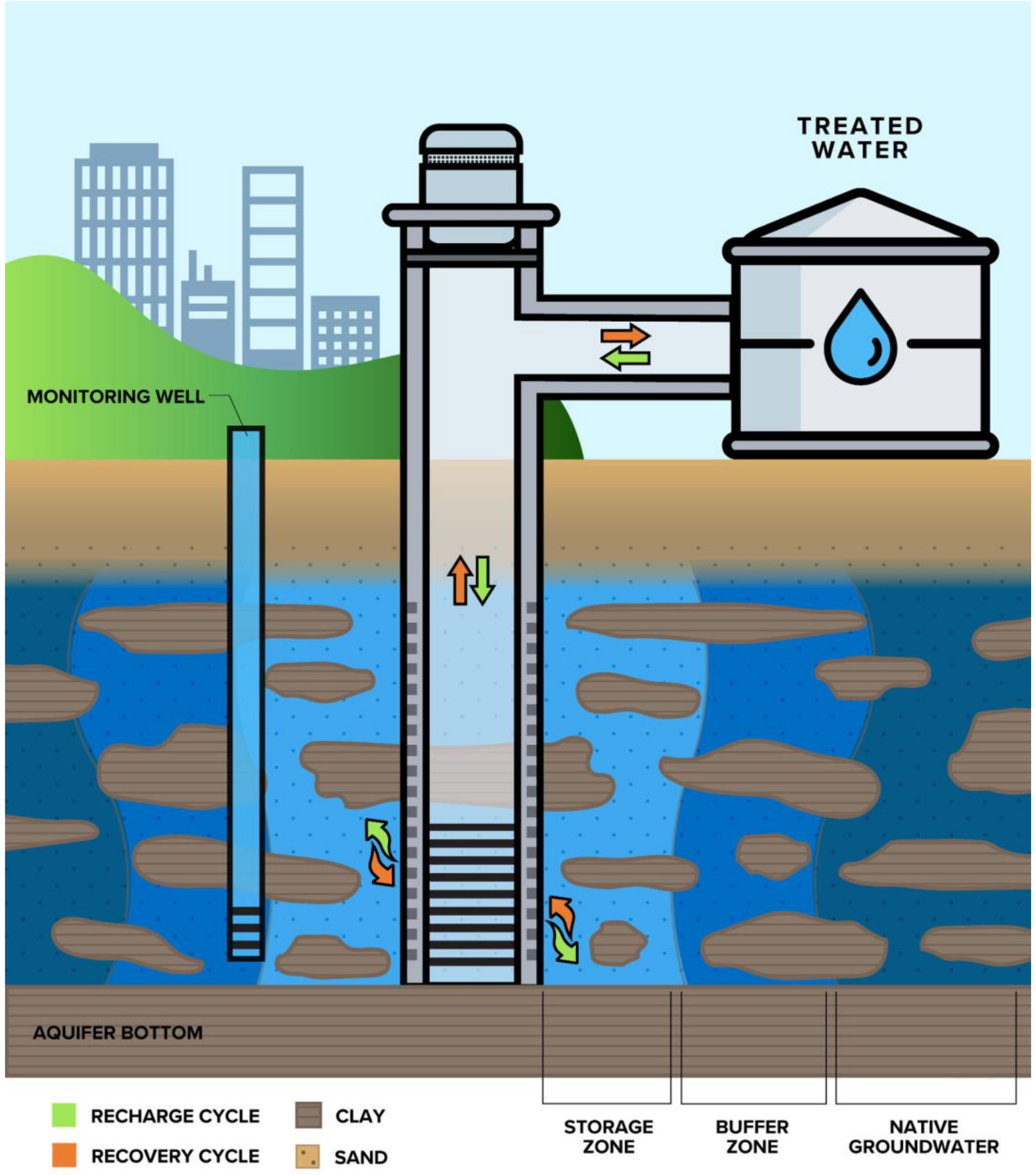
Aquifer Storage and Recovery (ASR)

- Groundwater savings account

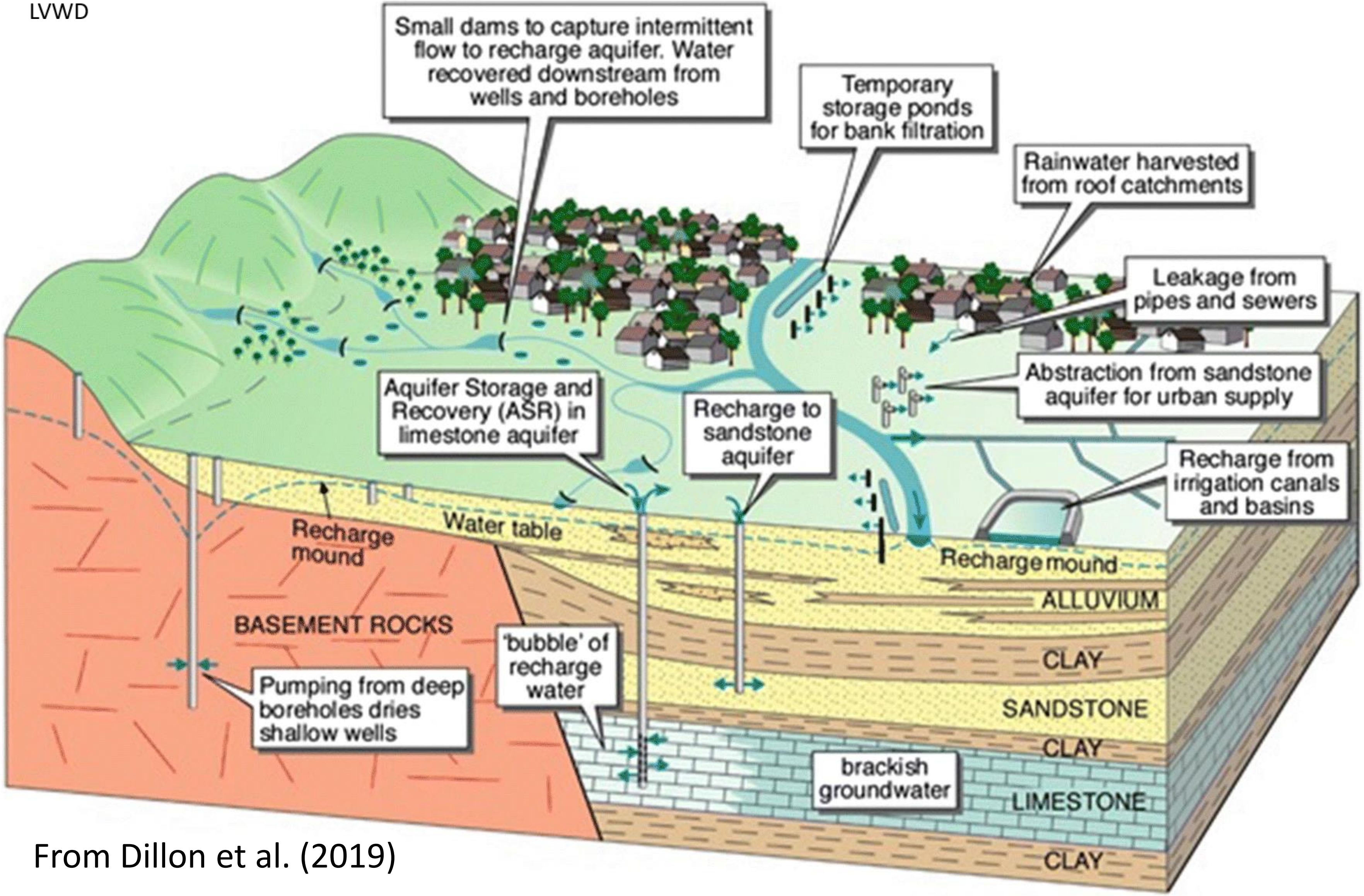
Texas Water Code

"…a project involving the injection of water into a geologic formation for the purpose of subsequent recovery and beneficial use by the project operator."

- Why ASR?
  - Drought and emergency supply
  - Seasonal storage
  - Reduce subsidence
  - Benefits over surface reservoirs



What is required for an ASR project?



From Dillon et al. (2019)

Water Needs
- Municipal
- Industrial
- Agricultural

Excess water*
- Surface Water
- Reclaimed Water
- Groundwater

Hydrogeologic characteristics*
- Storage
- Recharge
- Recoverability

***Compatible water quality**

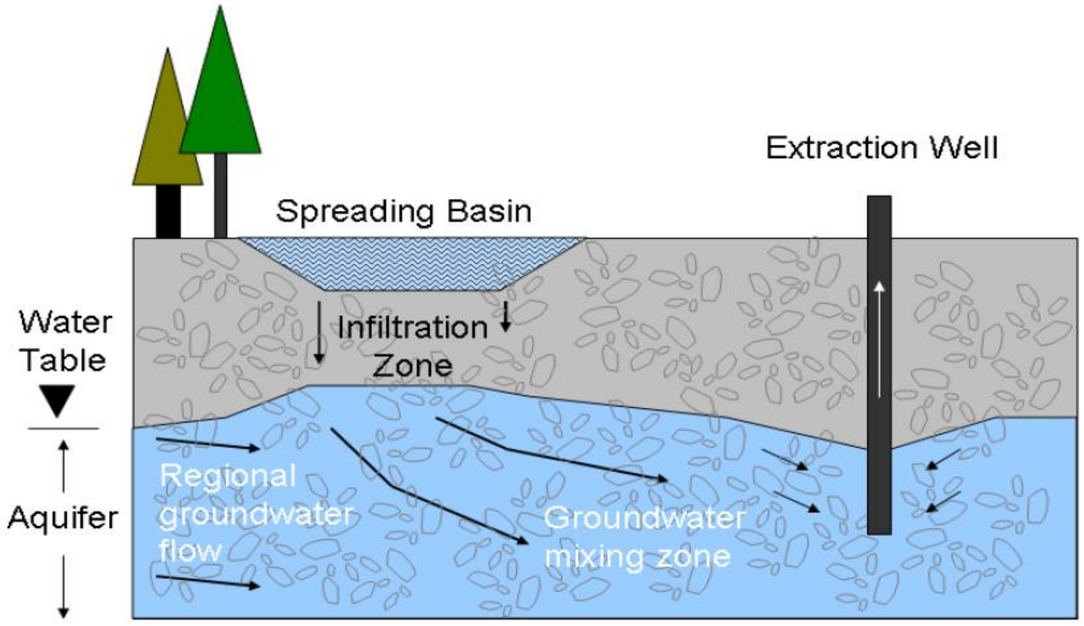
Aquifer Recharge (AR)

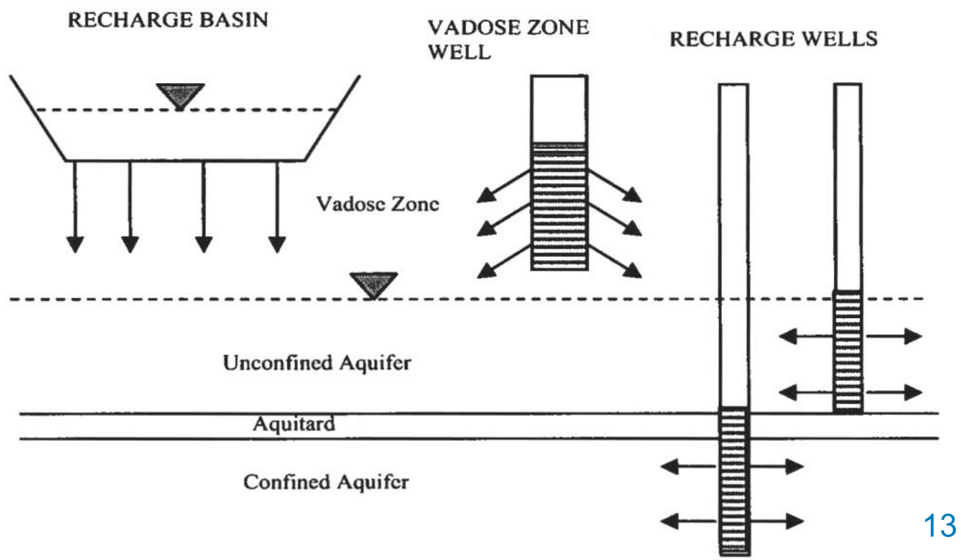
- Groundwater investment account

Texas Water Code

"… a project involving the intentional recharge of an aquifer by means of an injection well…or other means of infiltration."

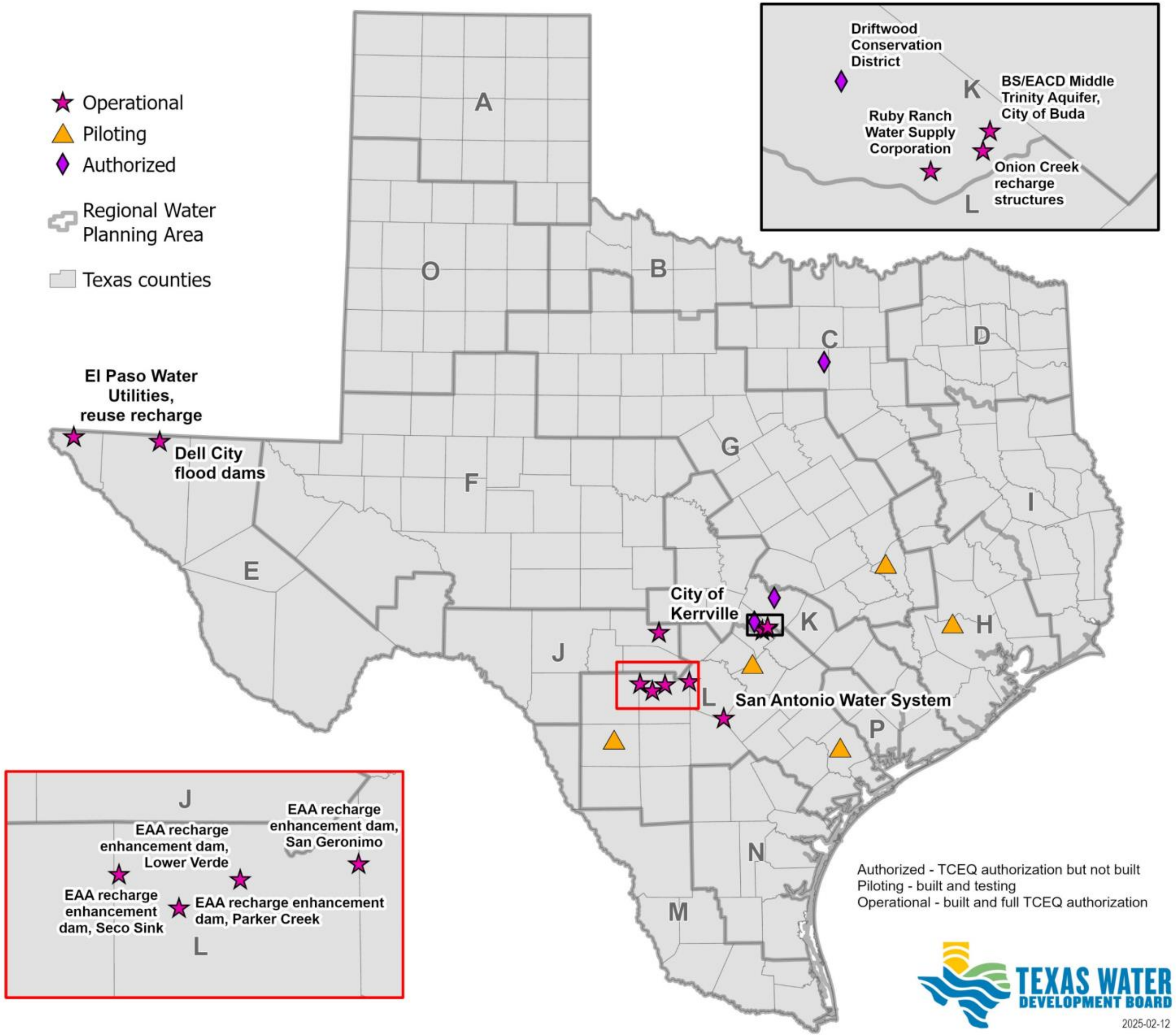
- Why AR?
  - Reduce water level declines
  - Supplement groundwater quantity
  - Improve water quality
  - Improve spring flows and groundwater-surface water interactions
  - Mitigate subsidence



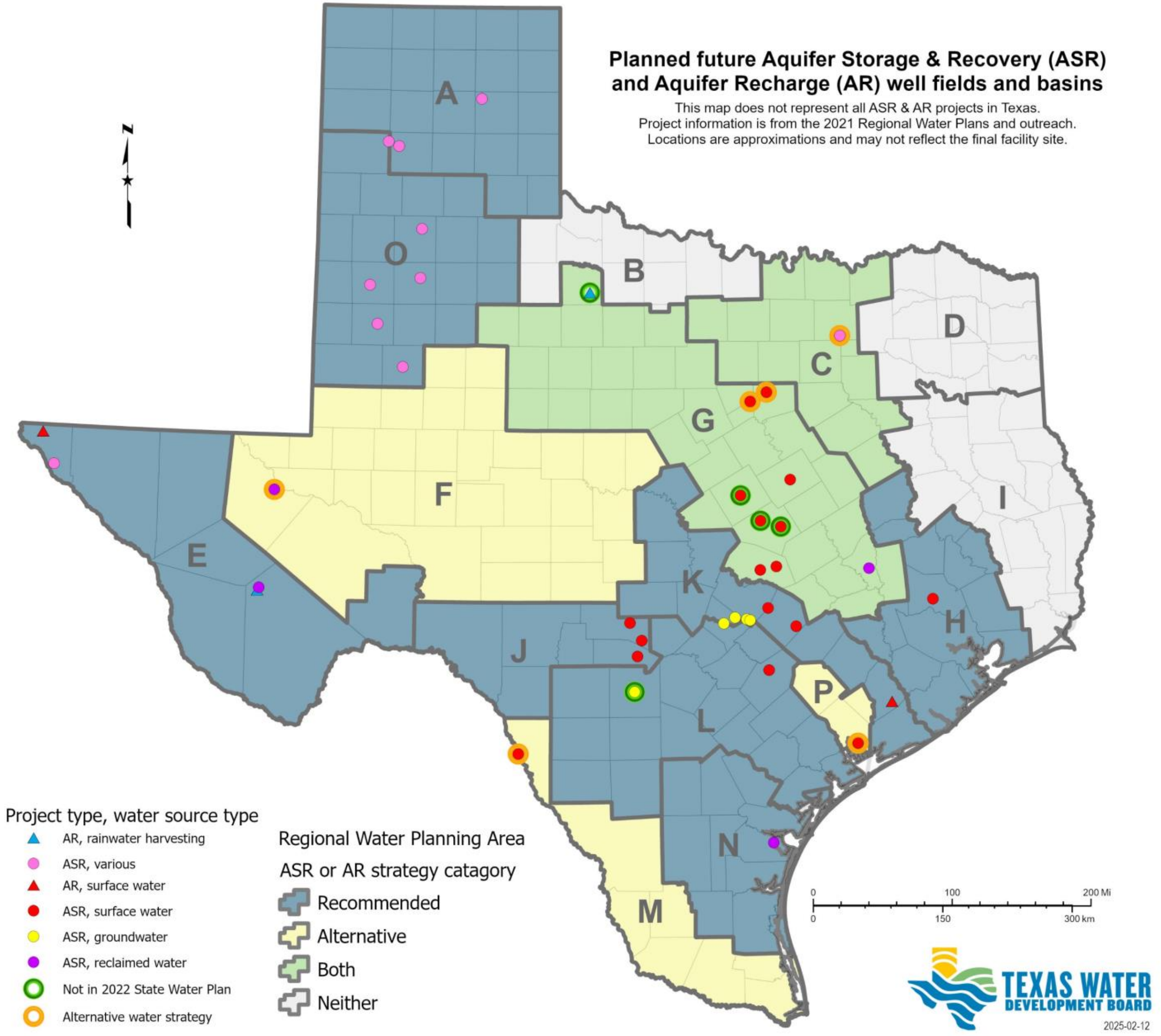


Existing ASR and AR in Texas

- **8 operational projects**
  - **ASR**
    - El Paso
    - Kerrville
    - San Antonio
    - Ruby Ranch
    - Buda
  - **AR**
    - Dell City
    - Onion Creek
    - Edwards Aquifer Authority
- 5 pilot testing ASR projects
- 3 authorized ASR projects



Future ASR and AR in Texas



State Water Plan (2022) projects

- 13 of 16 regional water planning groups plan implementing ASR or AR
- <u>27 ASR</u> projects, 3 <u>AR</u> surface infiltration facilities
- 193,000 acre-feet per year by 2070
- 3% of total new supply

Challenges

- Available source water
- Suitable geology
- Economics
- Public perception and expectations

Introduction Assessment Discussion Conclusion

TWDB

ASR & AR

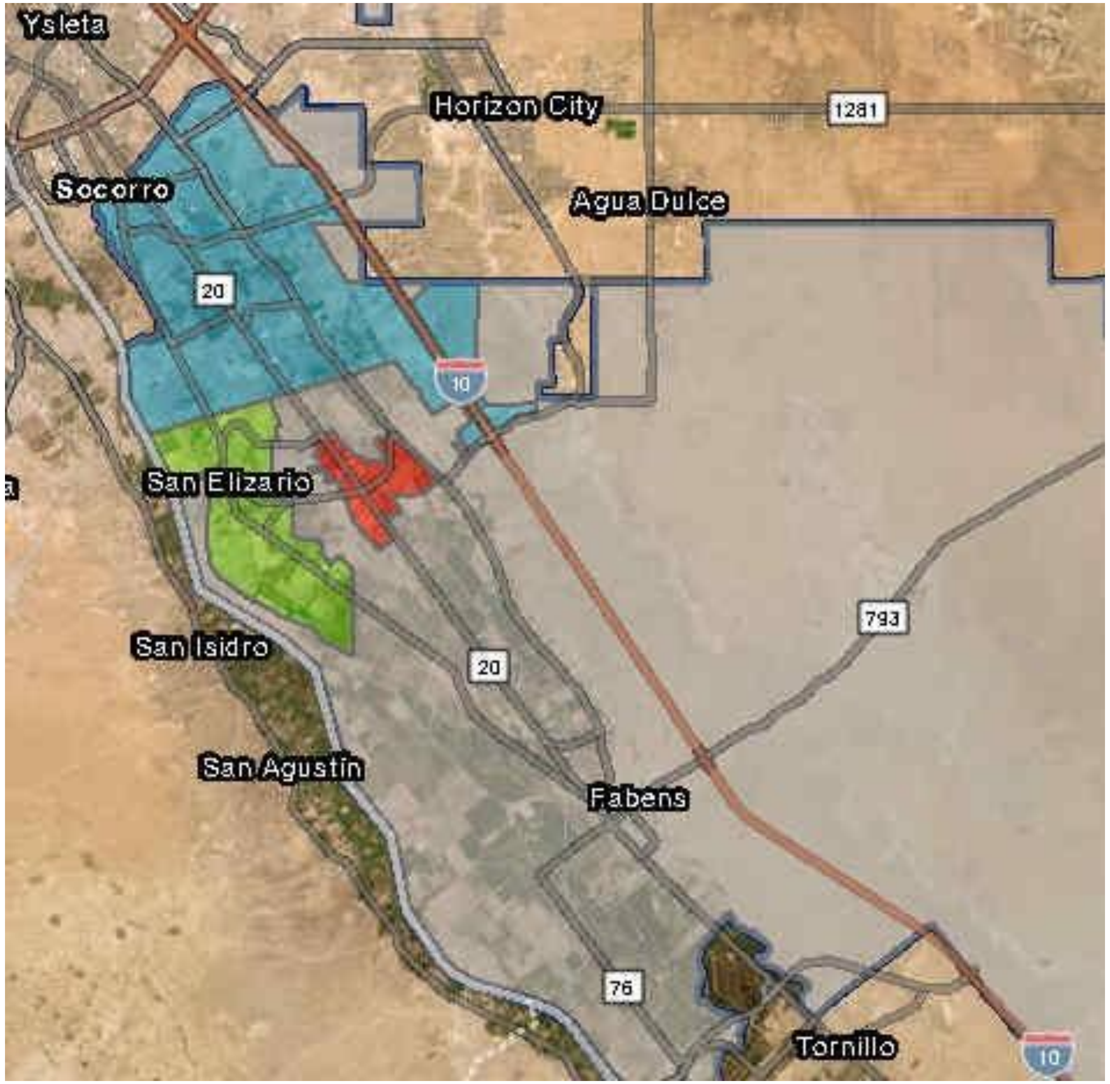
LVWD

Lower Valley Water District

Prepared by: Ed Long, PE
Chief Operation and Technical Officer

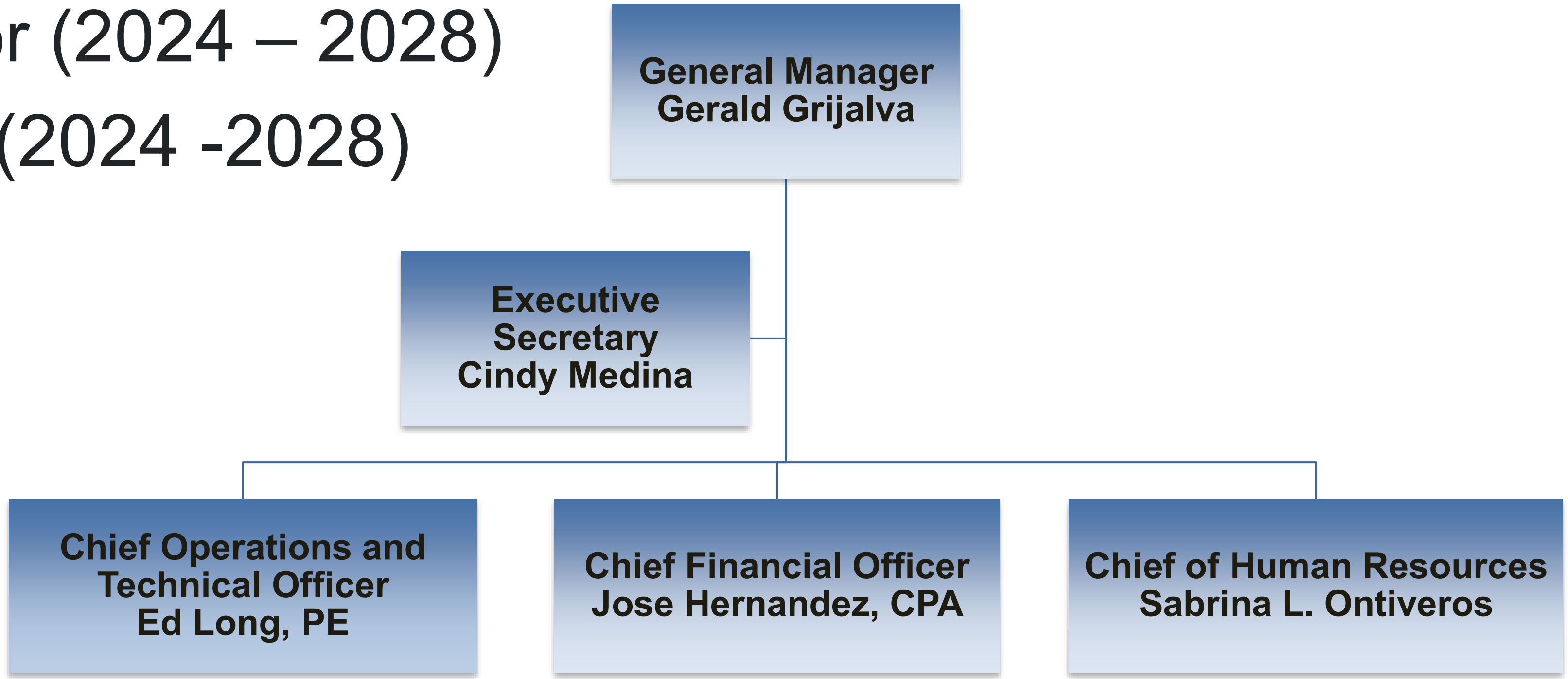
District history / boundary

- Approved by the 69th Legislation on June 14, 1985, as a Governmental Agency as El Paso County Lower Valley Water District Authority
- Approved by the 71st Legislation on June 14, 1989, as a Municipal Utility District
- Approved by the 74th Legislation on May 23, 1995, as Lower Valley Water District



Board of Directors and Executive Staff

- Rosalinda Vigil – President (2022 - 2026)
- David Carrasco – Vice-President (2024 - 2028)
- Henry Trujillo - Secretary / Treasurer (2022 – 2026)
- David Estrada – Director (2024 – 2028)
- Rod Chavez – Director (2024 -2028)



Water infrastructure

Water Connections

- Water connections 21,134

Water Storage Tanks (6) and Pump Stations (4)

- Eastlake Ground Storage Tank (2 MG)
  - Pump Station (3 pumps @ 2000 gpm)
- Mitchell Ground Storage Tank No.1 (2 MG)
- Mitchell Ground Storage Tank No.2 (2 MG)
- Sand Hills Tank No.1 (350,000 GAL)
  - Pump Station (2 pumps @ 400 gpm)
- Sand Hills Tank No.2 (350,000 GAL)
  - Pump Station (2 pumps @ 400 gpm)
- Fordham Elevated Storage Tank (200,000 GAL)
  - Pump Station (2 pumps @ 300 gpm)

Sanitary sewer infrastructure

Sewer Connections

- Sewer Connections 18,357

Wastewater Treatment Facilities (2)

- Cuadrilla Decentralized Wastewater Treatment Facility
  - 5,000 gpd
- Mesa del Norte Wastewater Treatment Facility (Permitting Phase)
  - Phase I - 300,000 gpd

Lift Stations (20)

- 7 Lift Stations in Socorro, Texas
- 3 Lift Stations in Clint, Texas
  - 1 Lift Station in construction
- 4 Lift Stations in San Elizario, Texas
- 5 Lift Station in County of El Paso, Texas

Solid waste department

Solid Waster Customers
- Solid Waste Customers 20,305

Heavy Duty Trucks
- 7 - Front Loader Garbage Trucks
- 17 - Side Loader Garbage Trucks
- 2 - Grapple Trucks
- 2 - Delivery Trucks
- 2 - Roll-Off Trucks
- 2 - Septic Pumper Trucks

Commercial Containers
- 2371 - Containers (2, 3, 4, 6 and 8 yard)

Roll-Off Containers
- 34 - Containers (20, 30 and 40 yard)

Residential Containers
- 24,540 - Polycarts

Introduction **Assessment** **Discussion** **Conclusion**

Objective

Geology

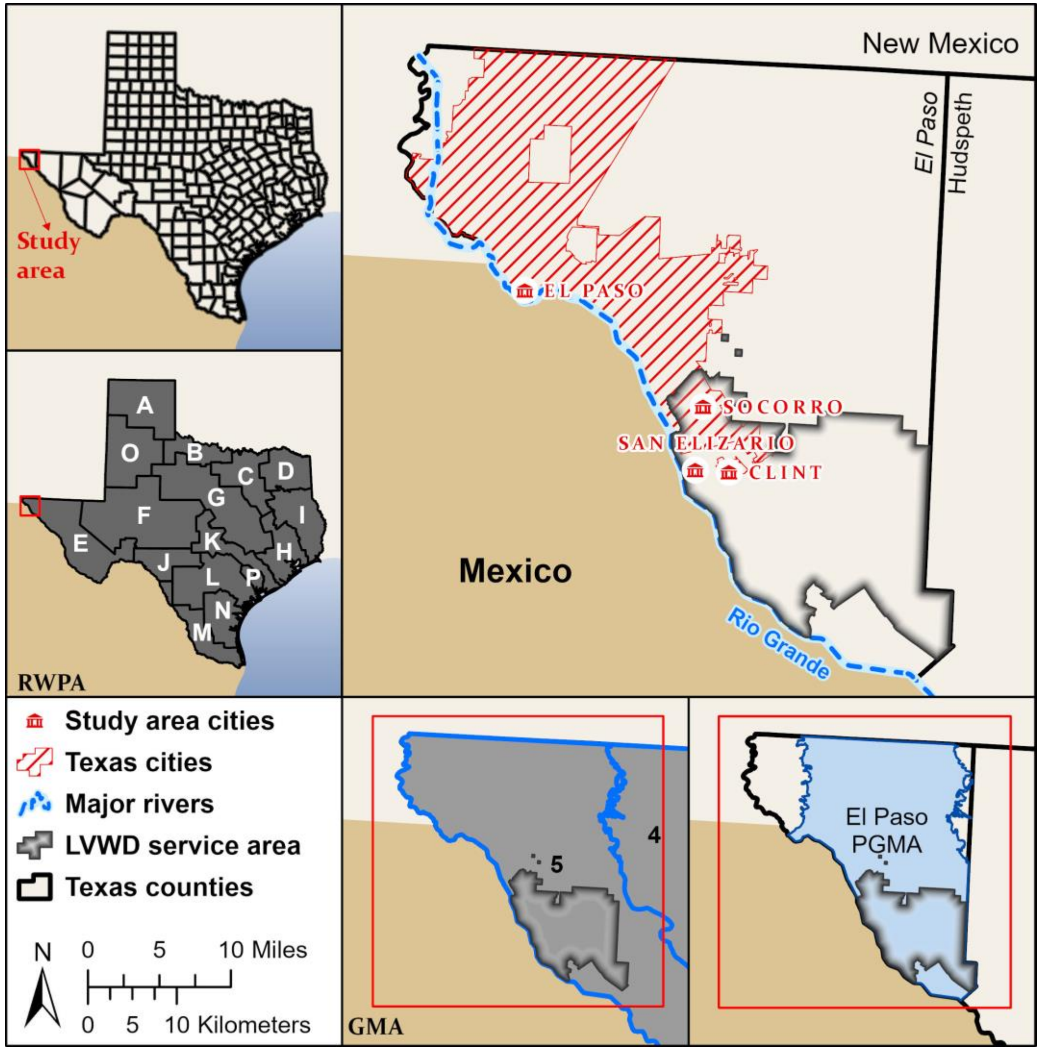
Water quality

Objective

- The LVWD ASR/AR project was selected to continue fulfilling Texas Water Code § 11.155
- LVWD currently receives its water supply from El Paso Water and is interested in securing an alternative water sources
- This study’s primary goal was to provide LVWD with a geological analysis that would support further development of an ASR or AR project

LVWD need

- Planning the construction of a wastewater treatment facility
- Plant will discharge Type I wastewater and is permitted for up to 900,000 gallons per day
- Type I treated wastewater is not potable, however, it is suitable for human contact
- LVWD is interested in options to help recharge the Hueco Boslon aquifer
- Project would benefit LVWD customers and agricultural users



Introduction **Assessment** **Discussion** **Conclusion**

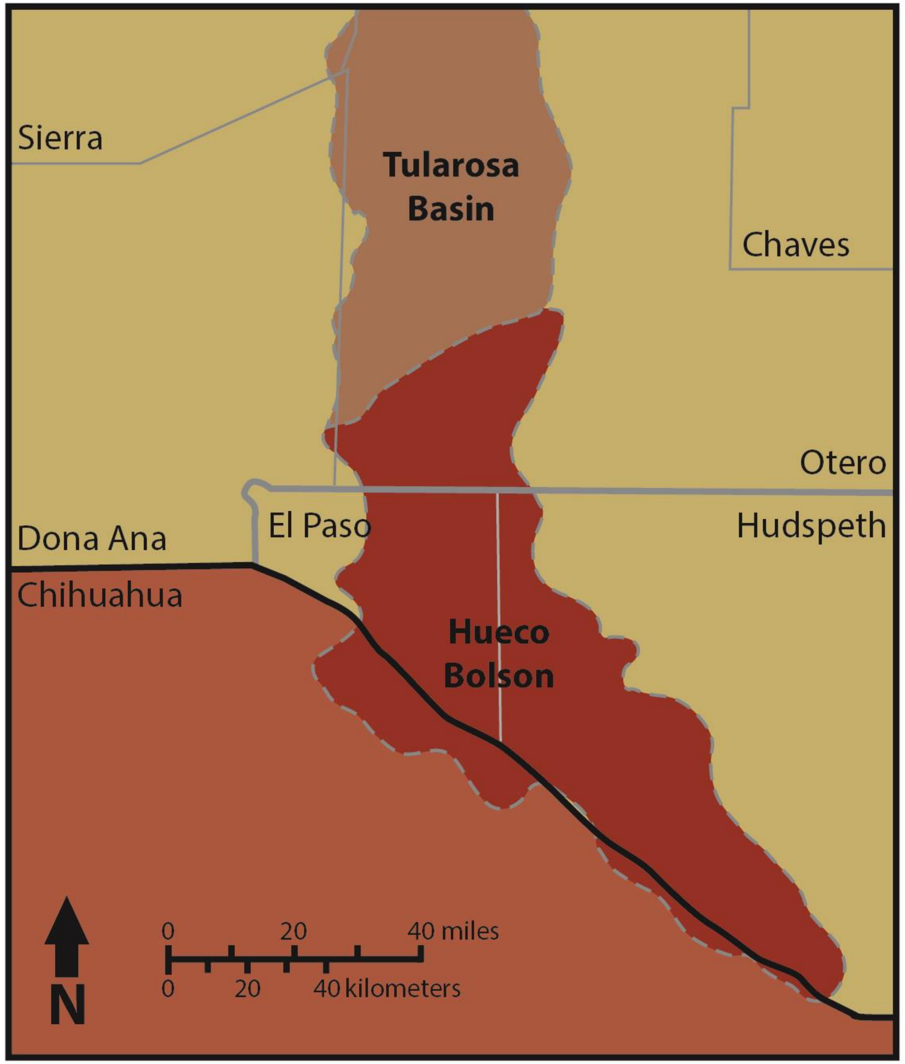
Objective

Geology

Water quality

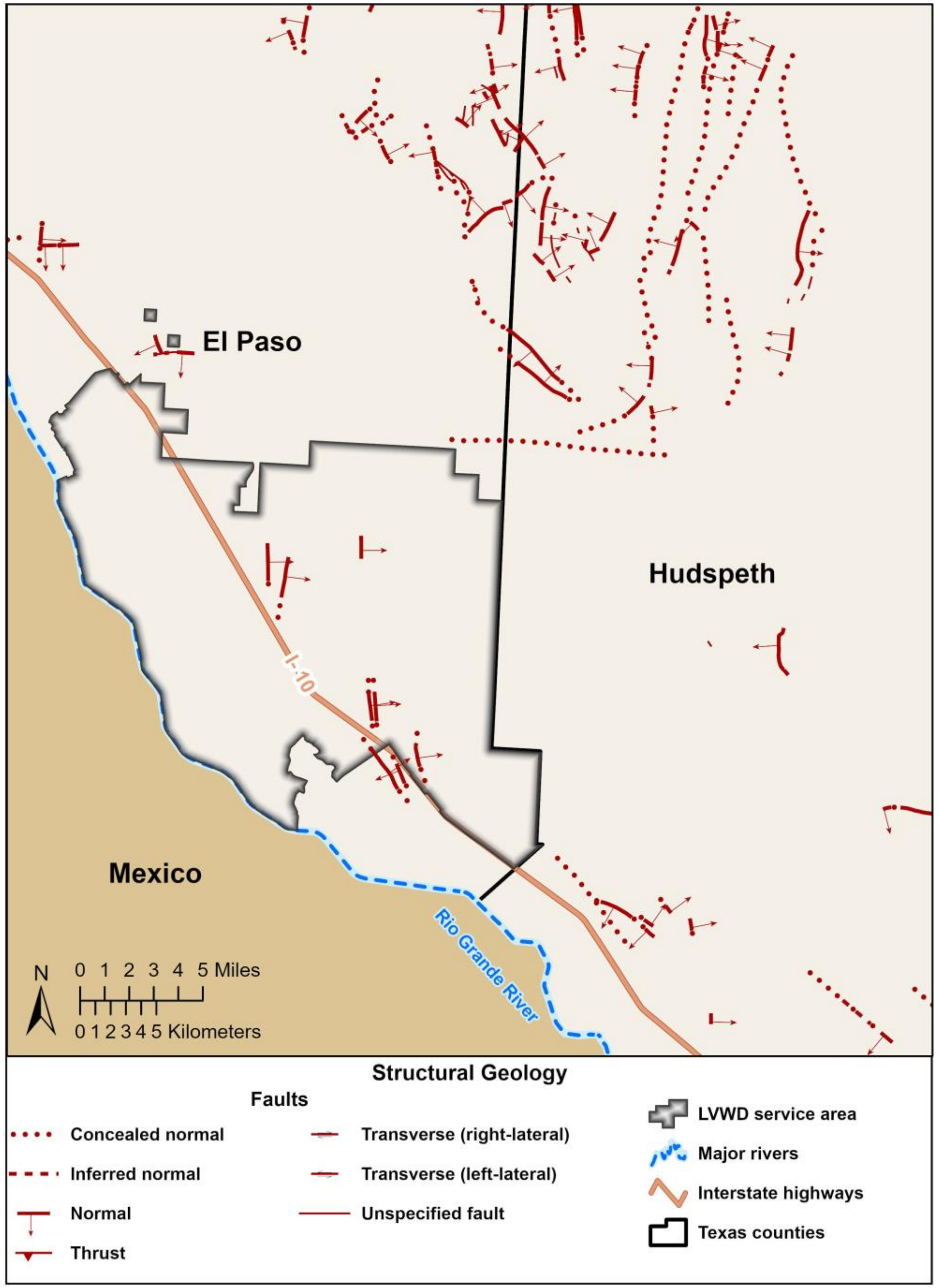
Geological framework

- **The Hueco Bolson**
  - Trends north-south, grades into Tularosa Basin
  - Approximately 200 mi long and over 25 mi wide
  - Complex tectonic and depositional history



Geological framework

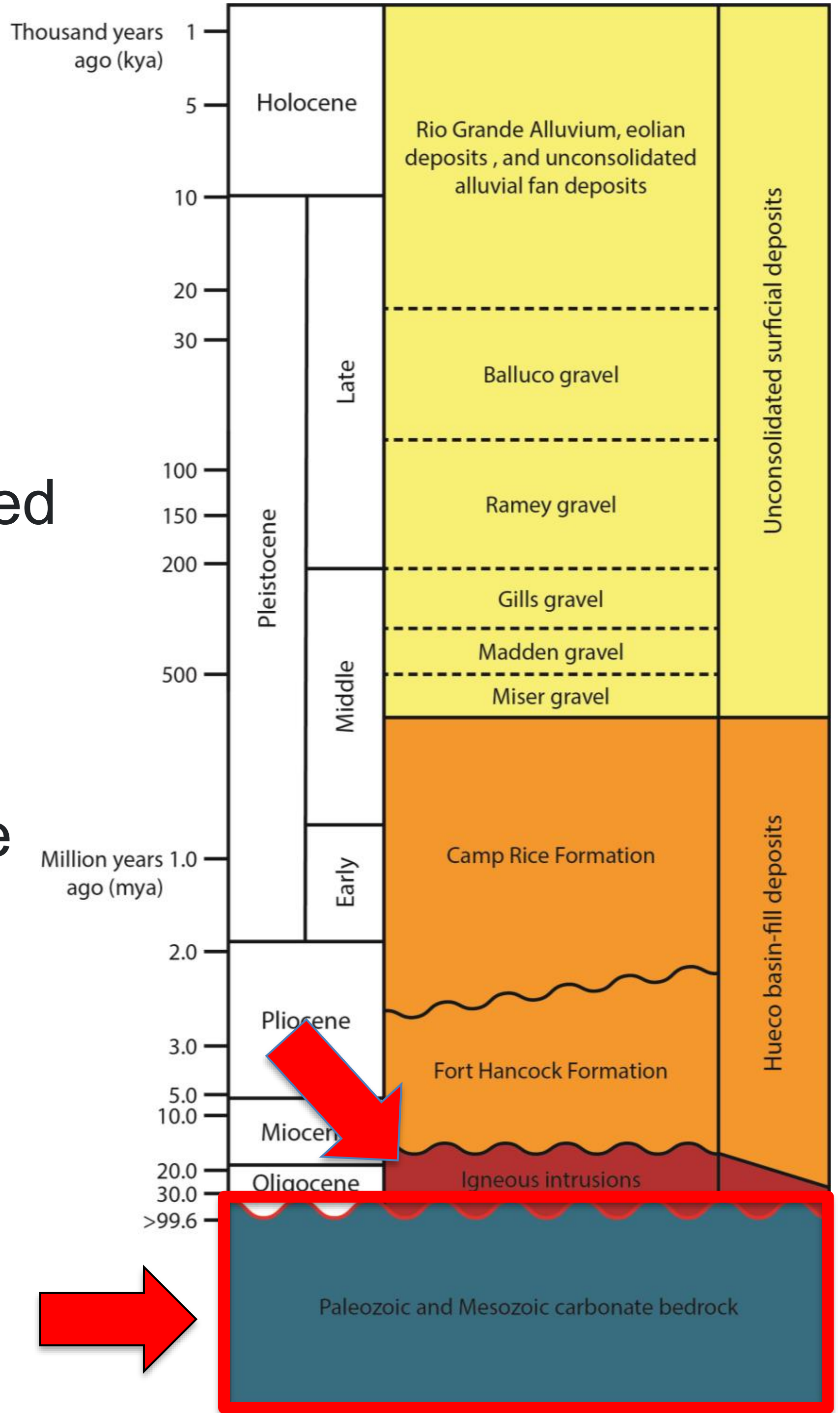
- **Tectonic History**
  - *Precambrian-Early Jurassic* – Early deformation created areas of structural weakness. Several cycles of compressional and extensional tectonics reactivated faults
  - *Late Cretaceous-Eocene* – Laramide uplift reactivated many of the faults within the Chihuahua basin
  - *Late Eocene* – extensional tectonics created the Rio Grande Rift, the origin of the Hueco and Tularosa basins



Assessment
Objective
Geology
Water quality

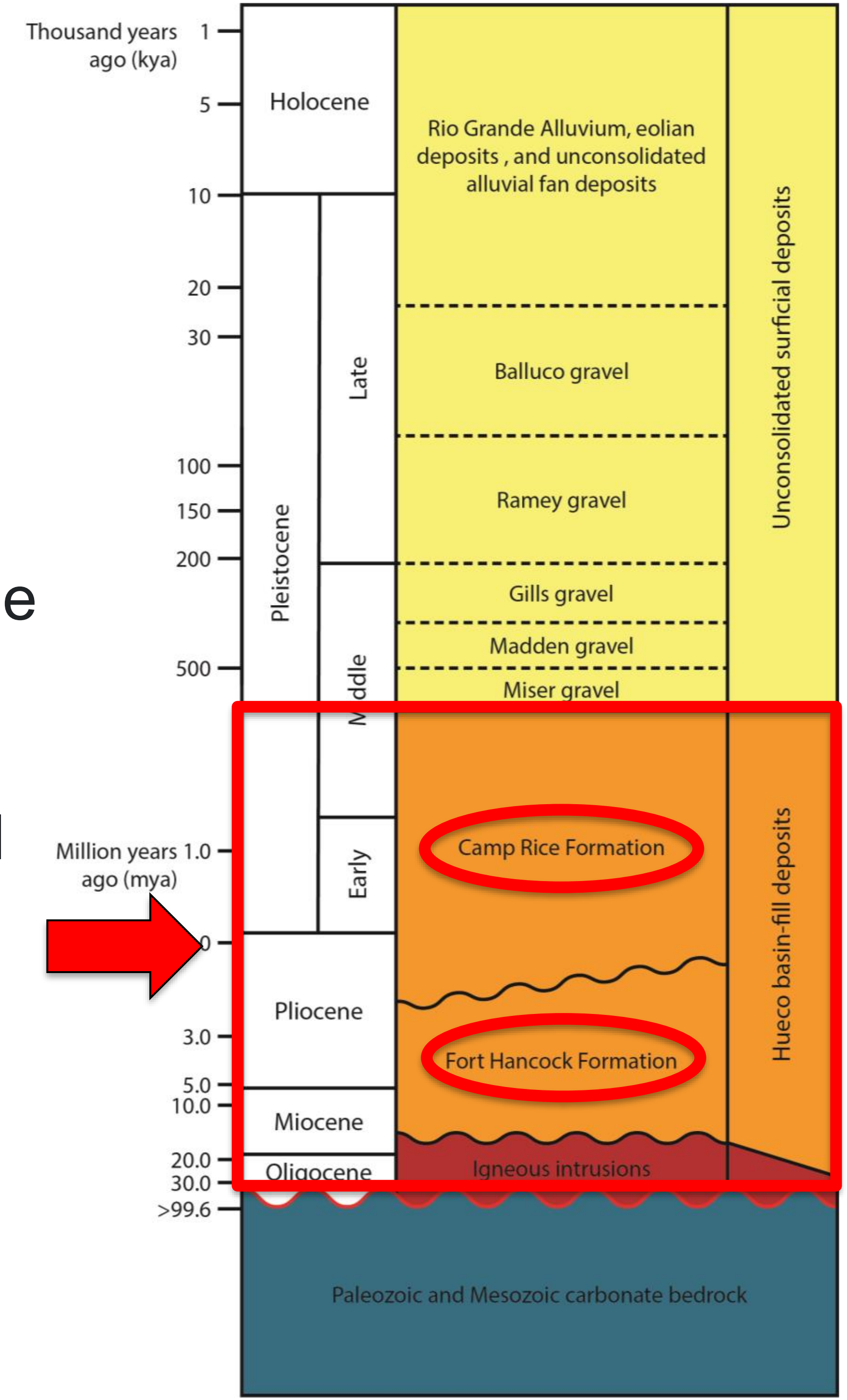
Geological framework

- **Paleozoic and Mesozoic bedrock**
  - Primarily marine carbonates and shales
  - Contains a series of large-scale sequences delineated by uniformities
  - *Permian Hueco Limestone* - marine limestone, dolomitic limestone, and shale
  - *Cretaceous Campgrande Formation* - thick evaporite overlain by interbedded limestone, sandstone, conglomerates, and shale
- **Igneous intrusions**
  - Late Eocene–Oligocene extensional tectonics
  - Fine-grained andesite and other mineralologies



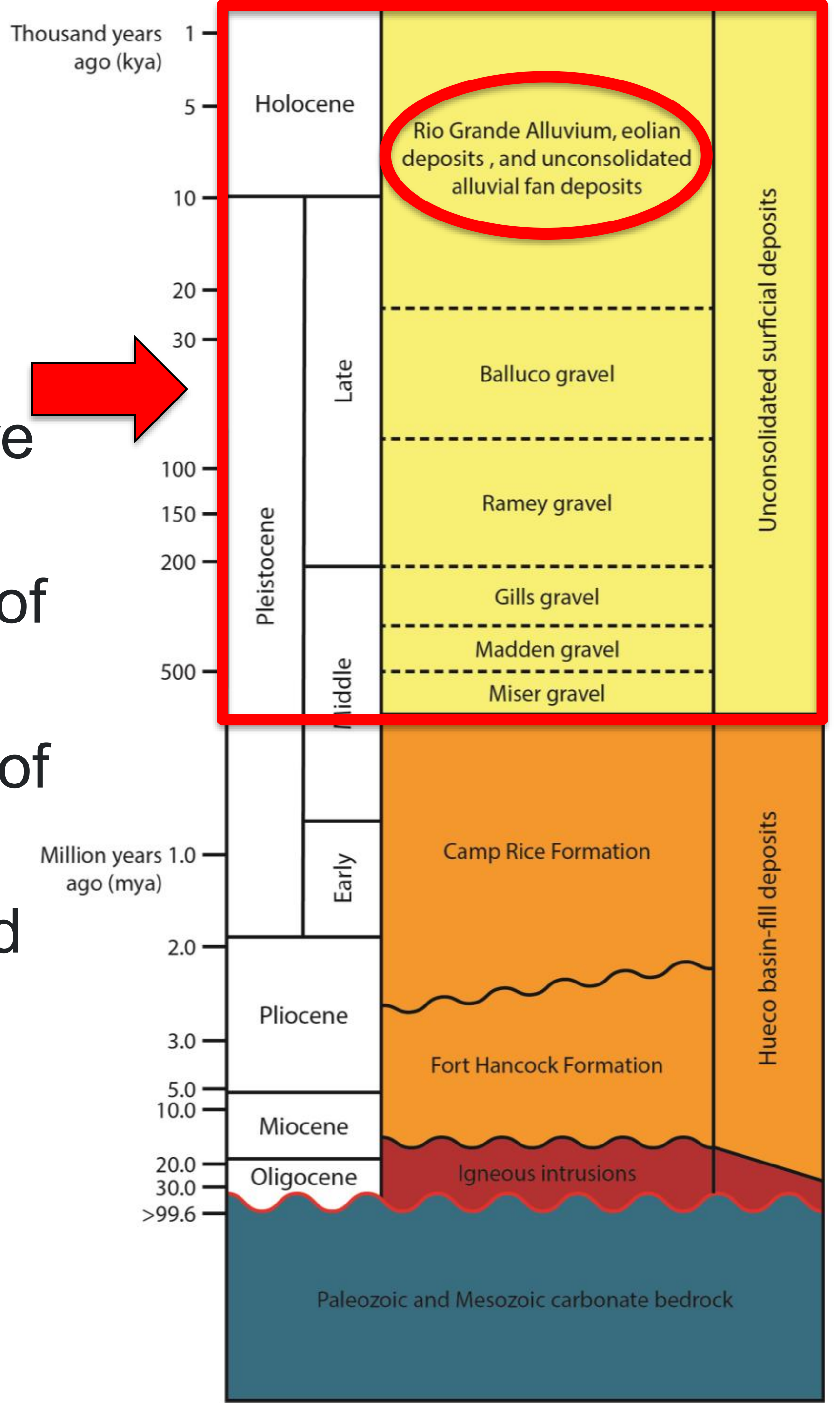
Geological framework

- **Hueco basin-fill deposits**
  - Primary focus of this study
  - Unconsolidated to poorly consolidated siliciclastic sediments deposited in fluvial, alluvial, and lacustrine environments
  - *Miocene–Pleistocene Fort Hancock Formation* - interbedded sand, silt, and mud deposited in alluvial and lacustrine environment
  - *Pliocene–Pleistocene Camp Rice Formation* - sand and gravel deposits deposited in a braided river environment

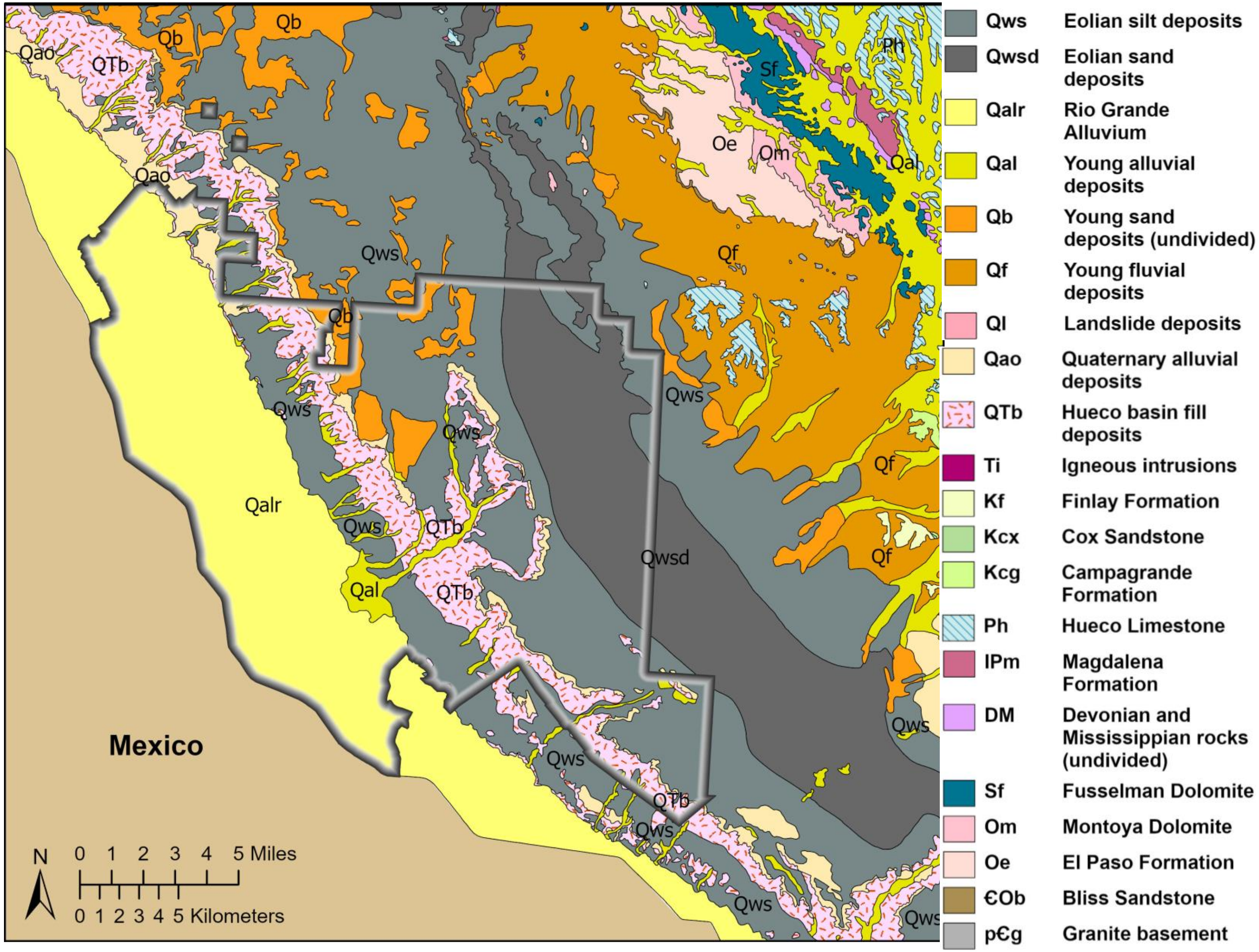


Geological framework

- **Unconsolidated surficial deposits**
  - Unconfined units found at or near the surface that are extensively pumped for groundwater
  - Six Middle–Late Pleistocene gravel beds consisting of reworked younger sediment
  - Eolian deposits are common in the eastern portions of the study area
  - *Rio Grande Alluvium* – sand and clay beds deposited by the modern Rio Grande. Primary aquifer used by agricultural water producers in the area.



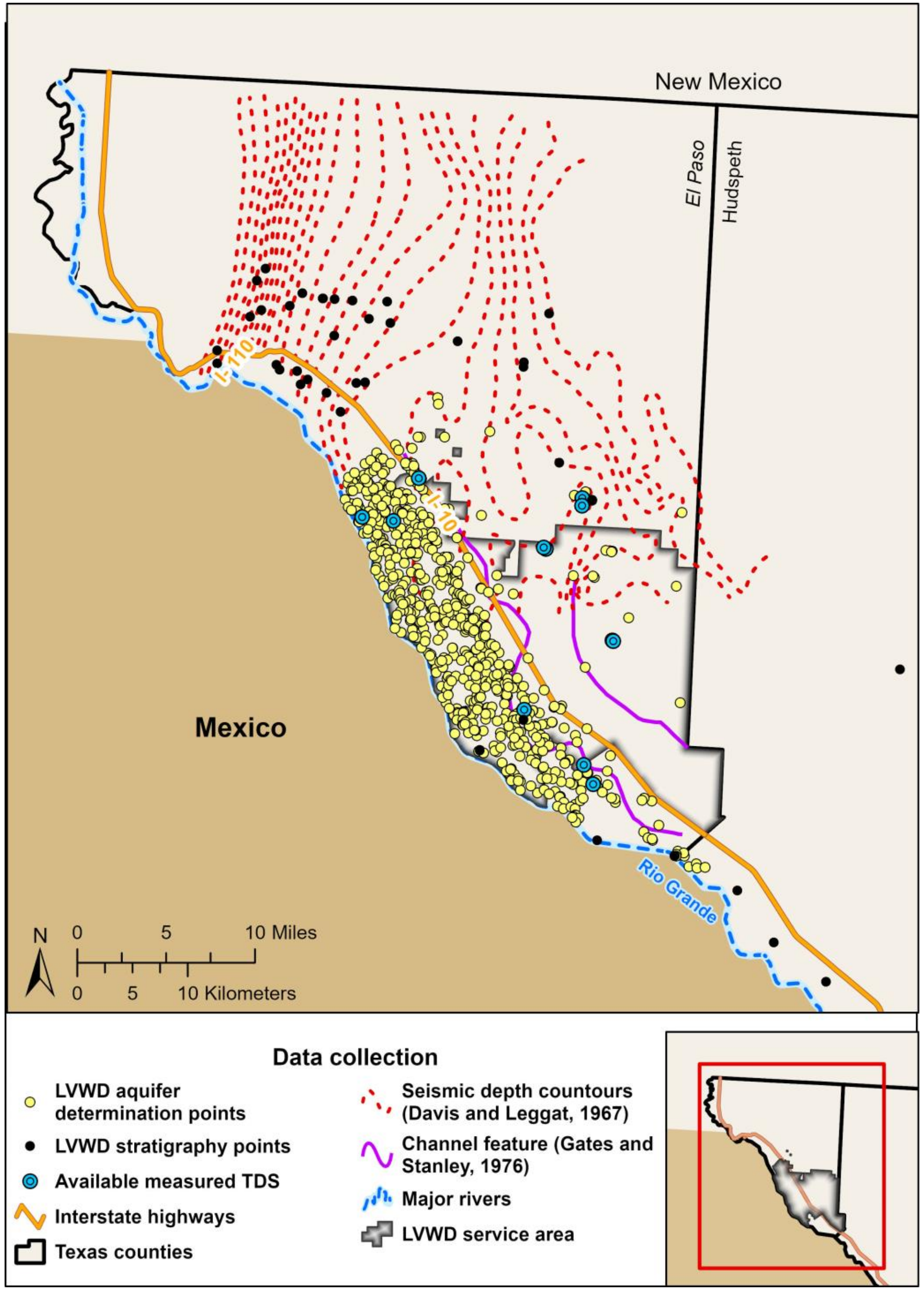
Geological framework



- The heterogenous beds that dominate the subsurface commonly pinch-out or grade into different facies
- Western portion of the study area is dominated by the Rio Grande Alluvium
- Eastern portions are covered by eolian sediment

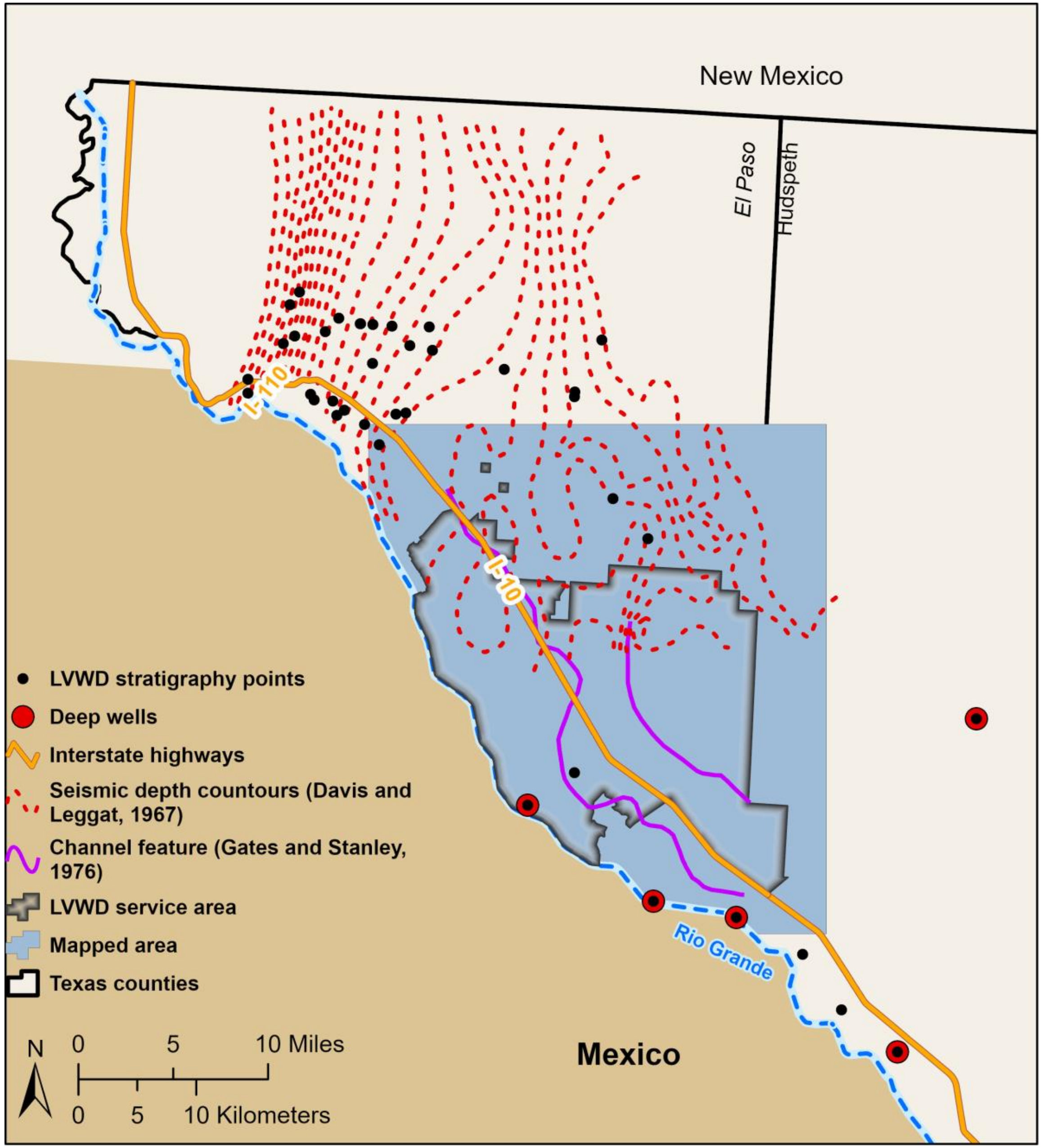
Data availability

- Geophysical well logs and drillers logs were used to define the tops of stratigraphic units
- Most wells in the area are shallow wells used for irrigation and were not used
- 39 geophysical logs were used for interpretation, but only 7 were within the mapped area
- Additional data subsurface data was needed to create stratigraphic surfaces



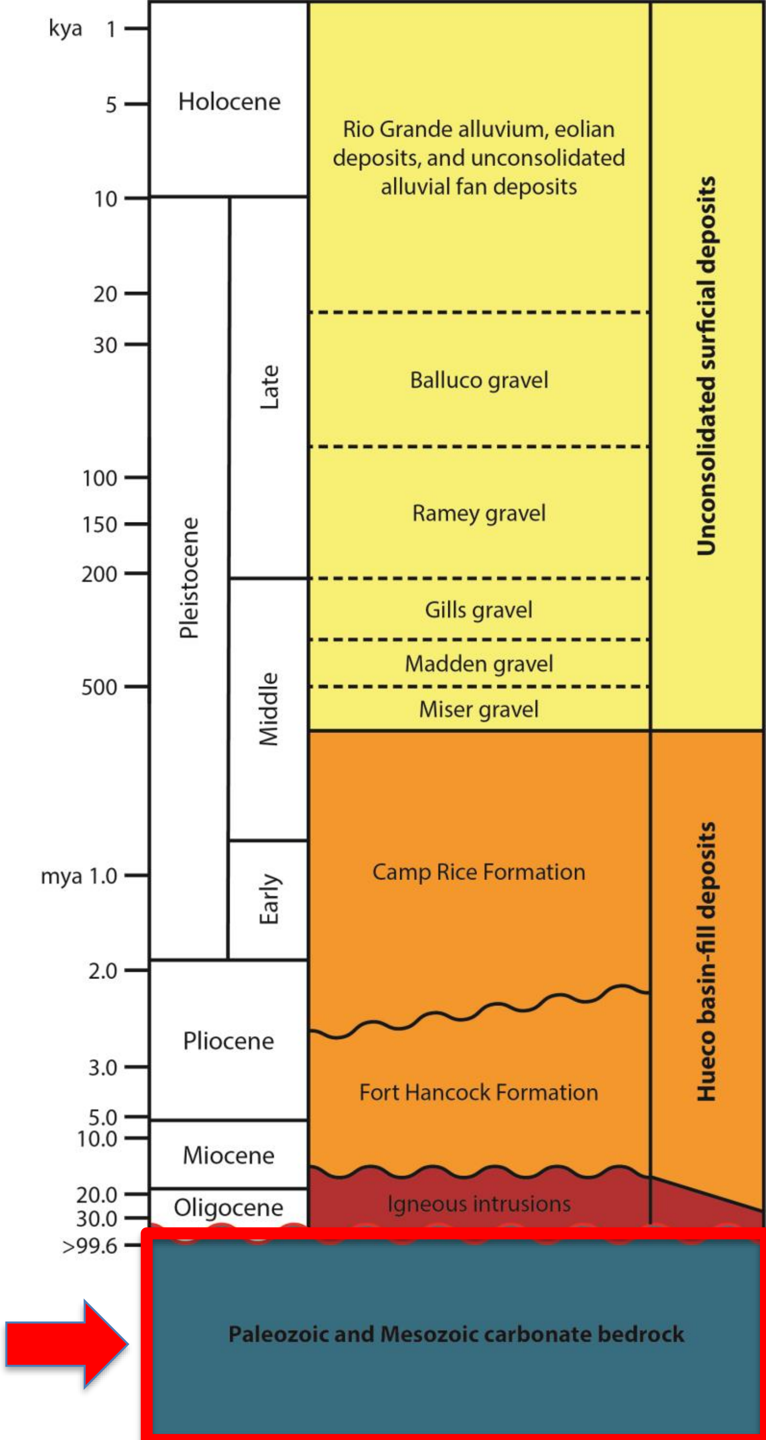
Additional datasets

- Davis and Leggat (1967): Seismic interpretation of the top of the carbonate bedrock
- Gates and Stanley (1971): Airborne geophysical survey identifying channel feature in the basin fill deposits
- Hadi (1991): Regional structural study



Top of Paleozoic and Mesozoic carbonate bedrock

- Mapped unit contains Permian Hueco Group and several Mesozoic-age units
- Few wells in the area penetrate to this depth (6 logs used for interpretation, only 4 in study area)
- Carbonate units are low resistivity due to high salinity
- Subtle variations in the resistivity and spontaneous potential logs may indicate marly units
- Few porous beds – fracture porosity
- Due to the lack of well data, seismic depth contours were used to fill in areas where there was no well data



Assessment

Objective

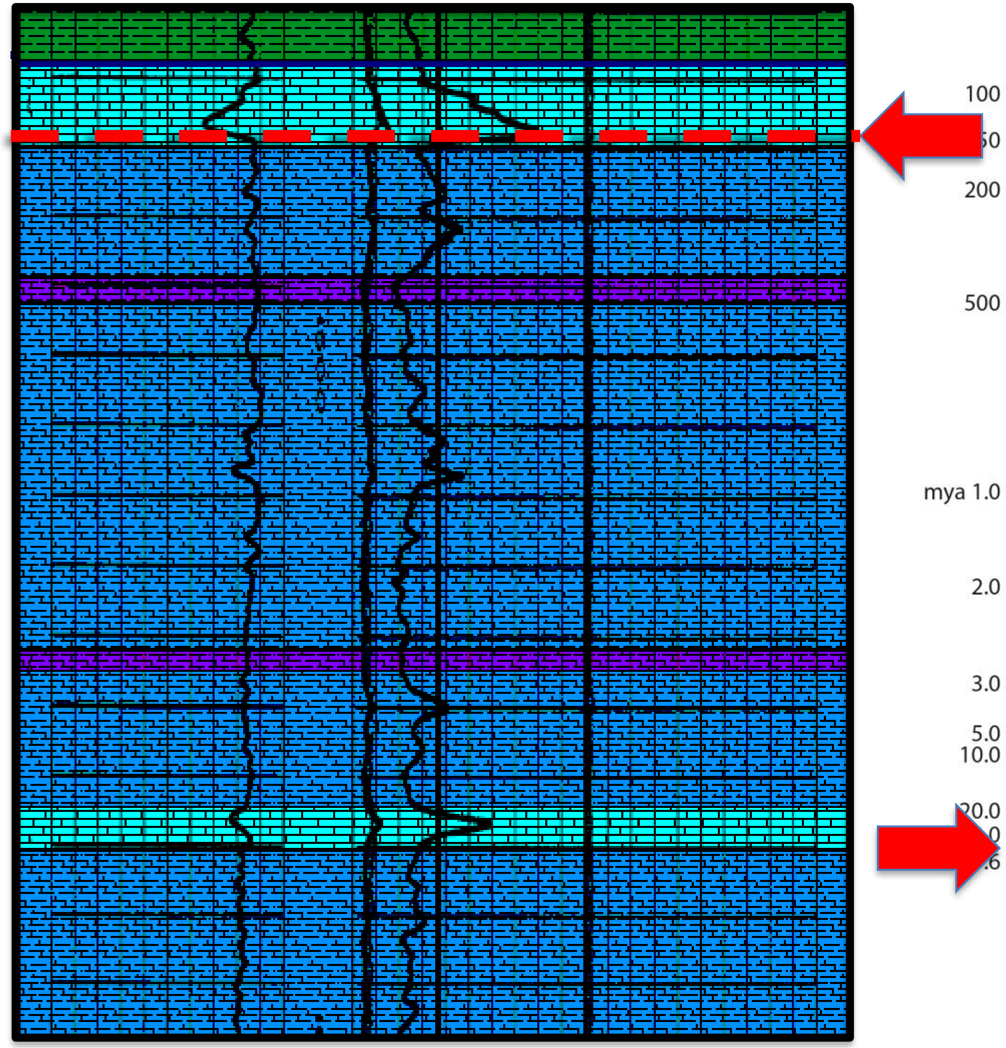
Geology

Water quality

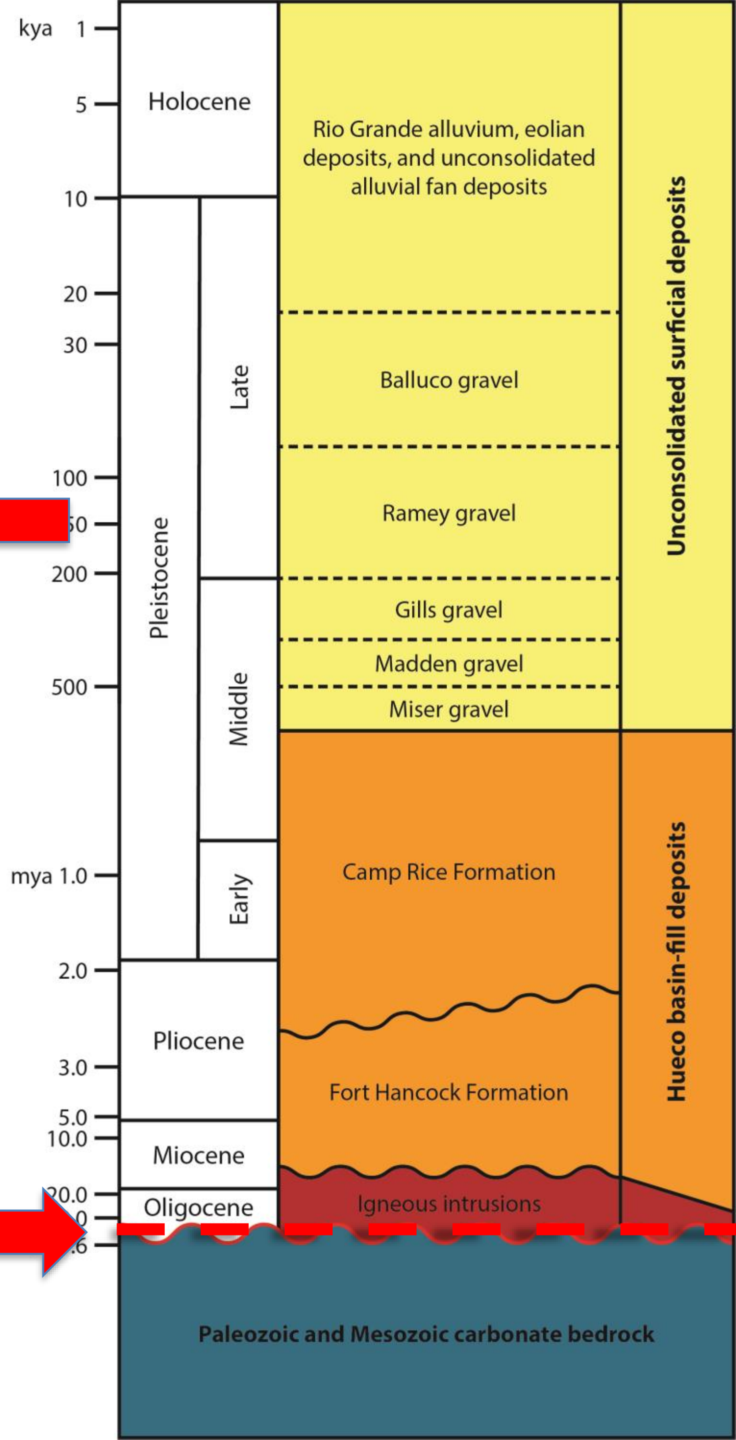
Top of Paleozoic and Mesozoic carbonate bedrock

- Top of the unit challenging to identify due to suppressed resistivity signature
- Higher resistivity bed at contact (reworked ?)
- Stable caliper compared to upsection units

Example Mesozoic section



- Clay
- Limestone
- Limestone and shale
- Carbonate mud



Assessment
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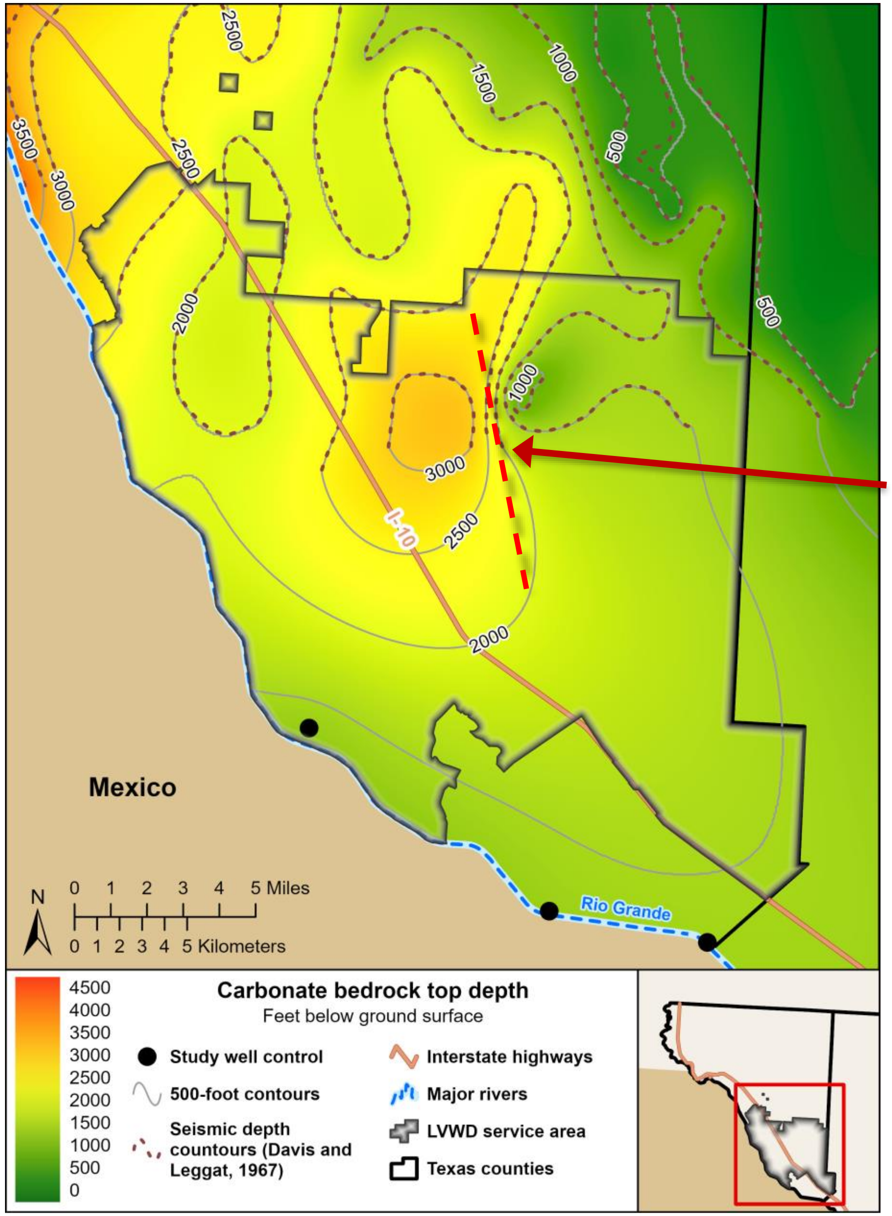
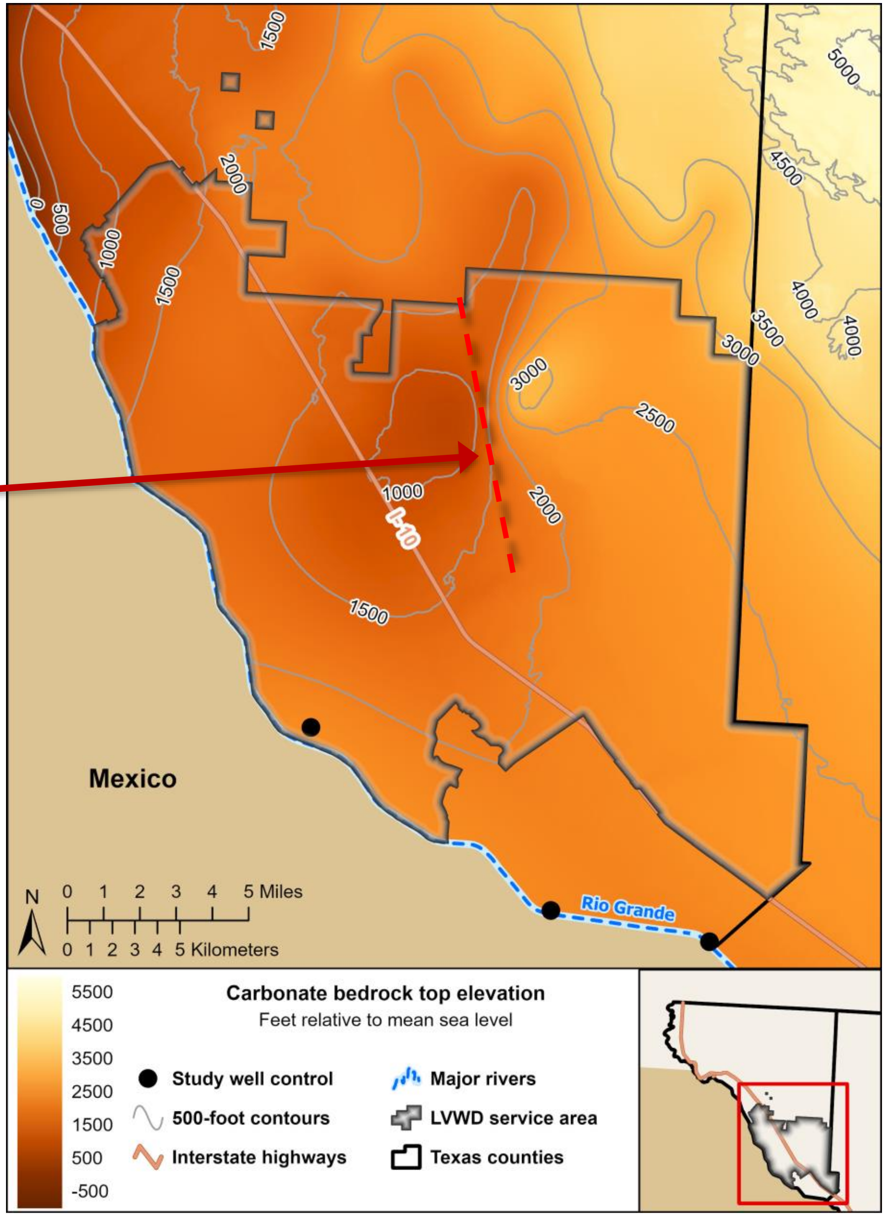
Top of Paleozoic and Mesozoic carbonate bedrock

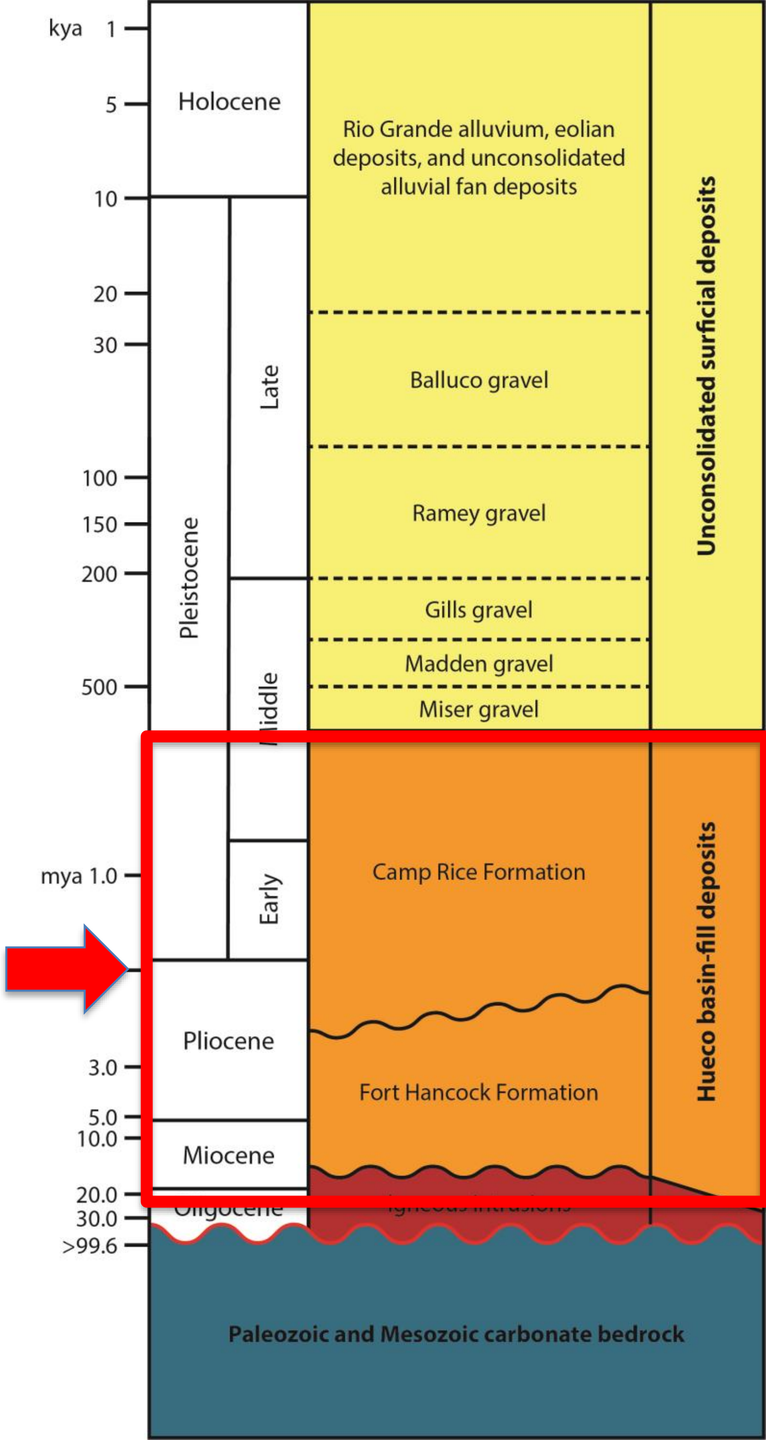


Clint Fault



Top of Hueco basin-fill deposits

- Camp Rice and Fort Hancock formations mapped as one unit due to lack of well control
- 39 geophysical well logs used in study, but only 6 within study area
- Airborne geophysical study identified channel feature – Camp Rice Formation
- Sand beds are laterally discontinuous throughout the study area
- Resistivity is variable across study area due to the complex hydrogeology and laterally discontinuous sand beds



Assessment

Objective

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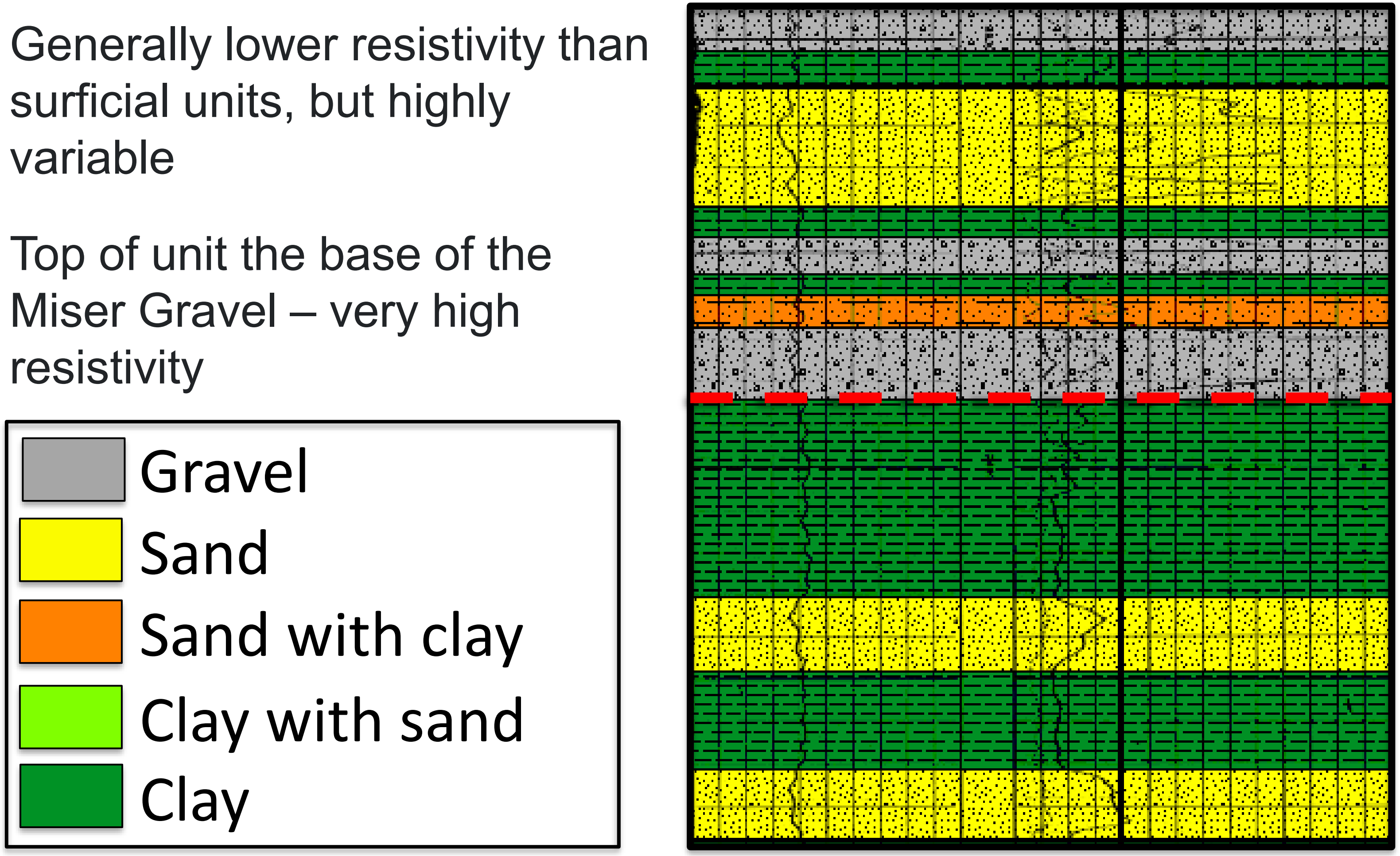
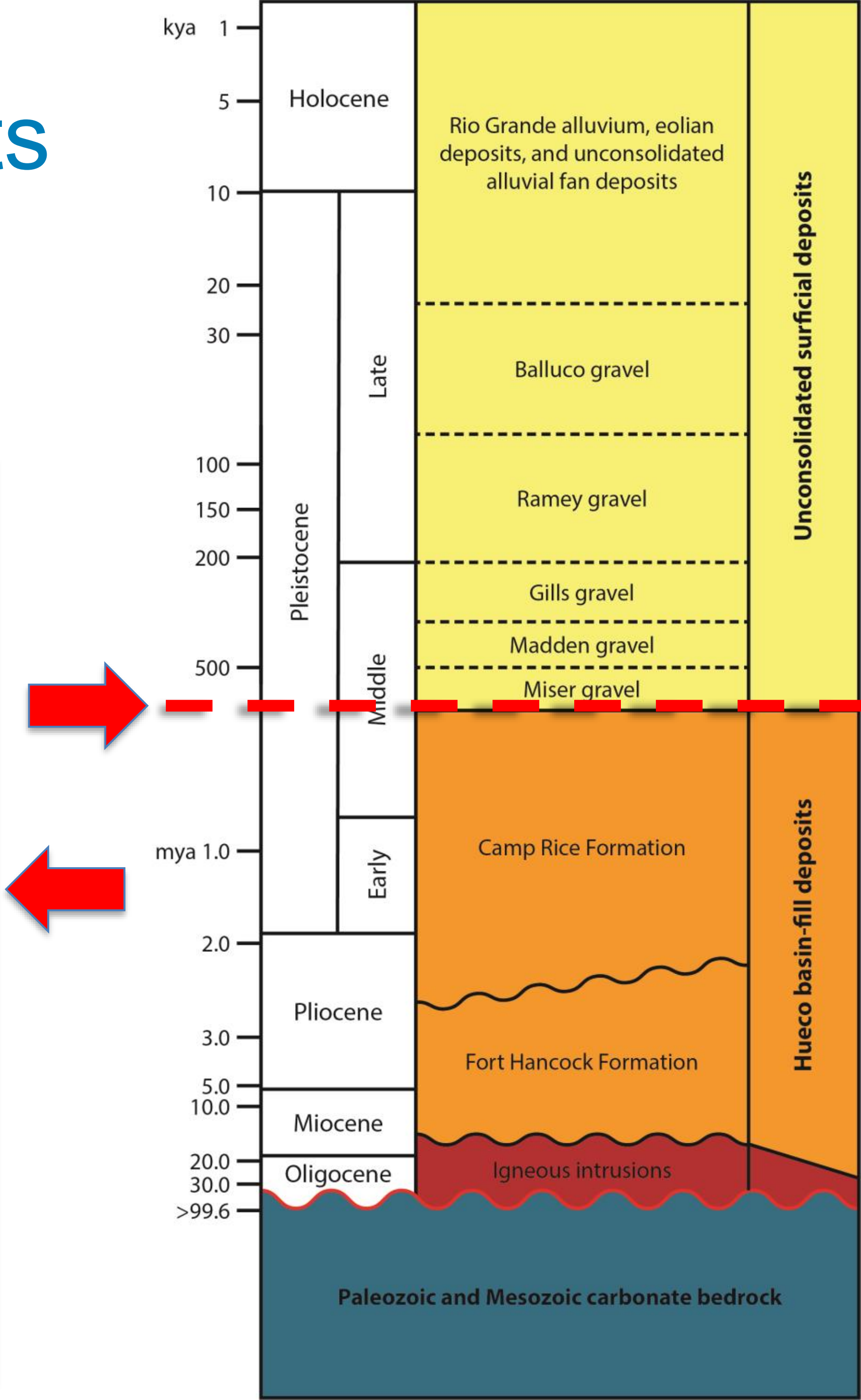
Water quality

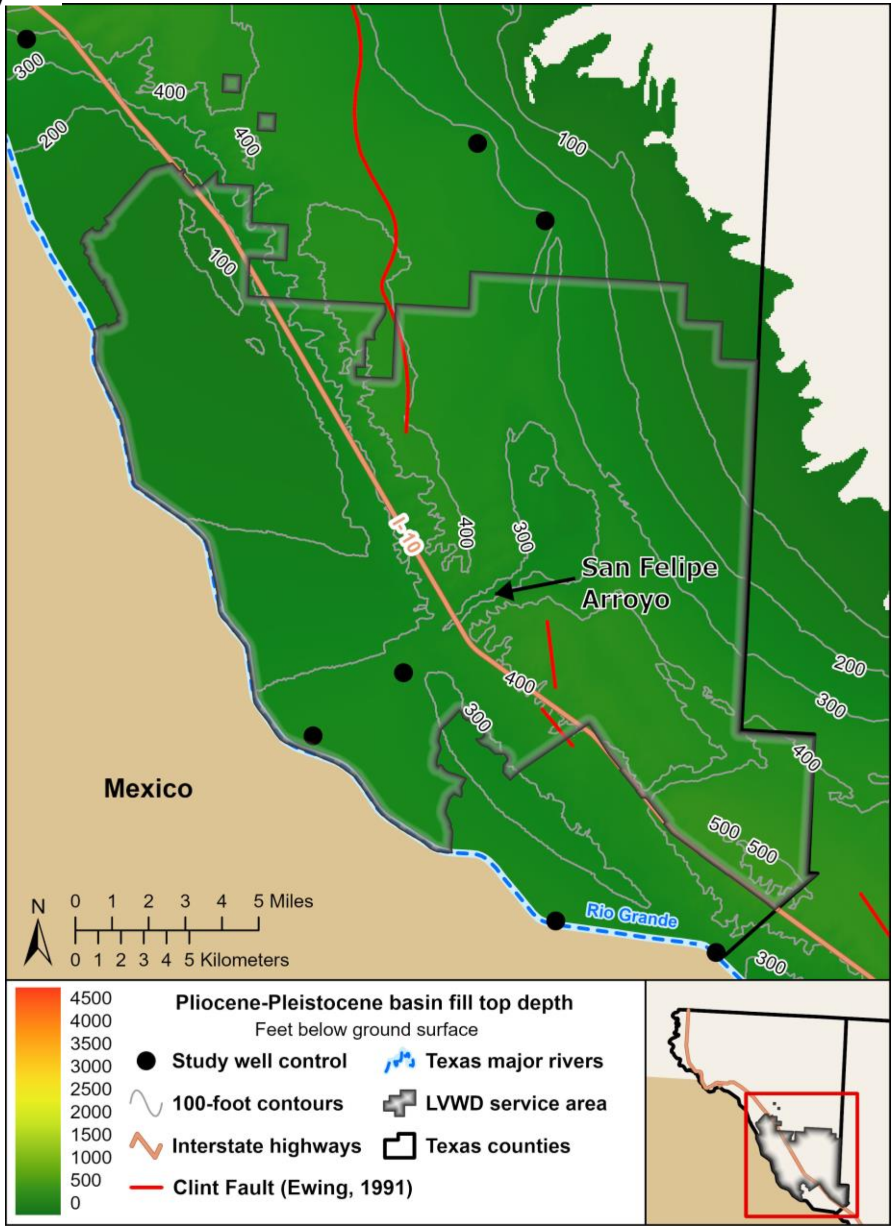
Top of Hueco basin-fill deposits

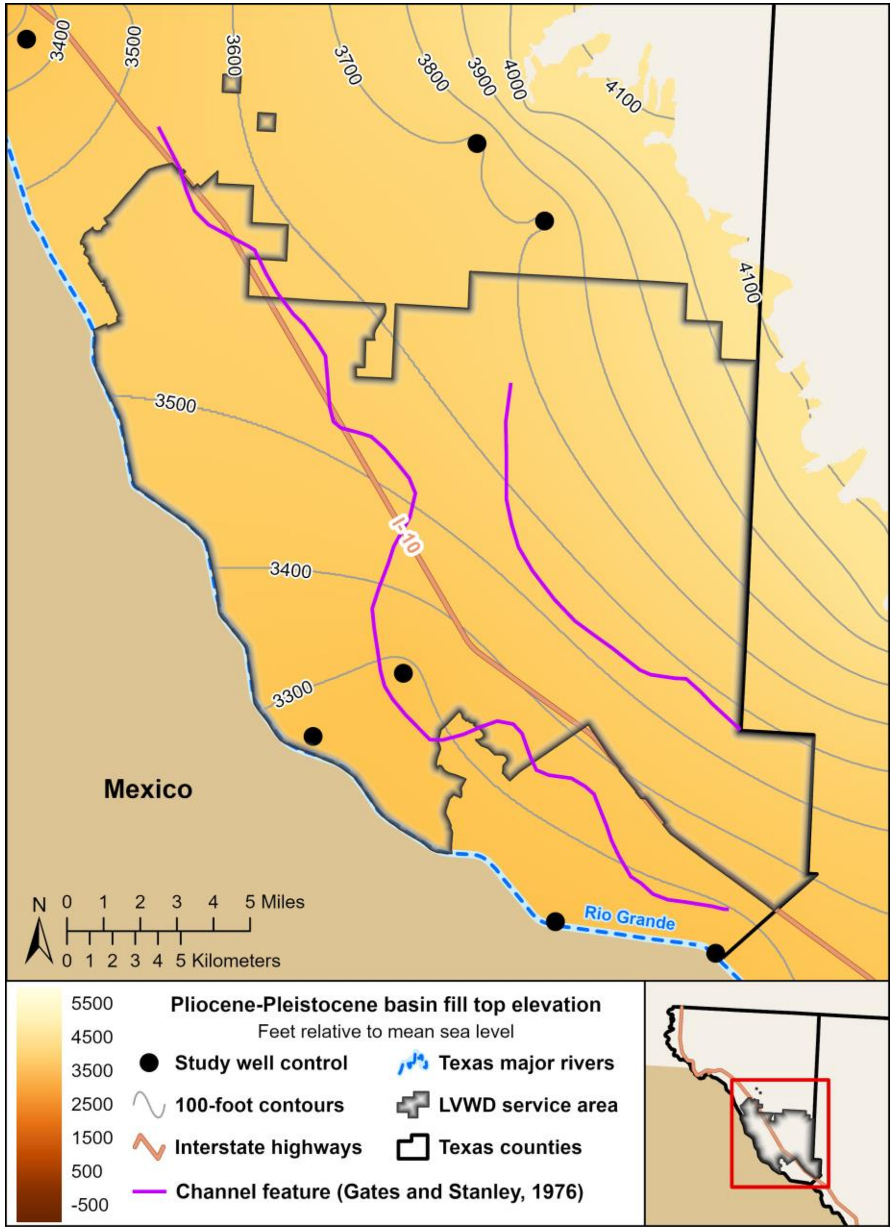
- Lithology of the basin-fill deposits and the overlying surficial units similar
- Generally lower resistivity than surficial units, but highly variable
- Top of unit the base of the Miser Gravel – very high resistivity



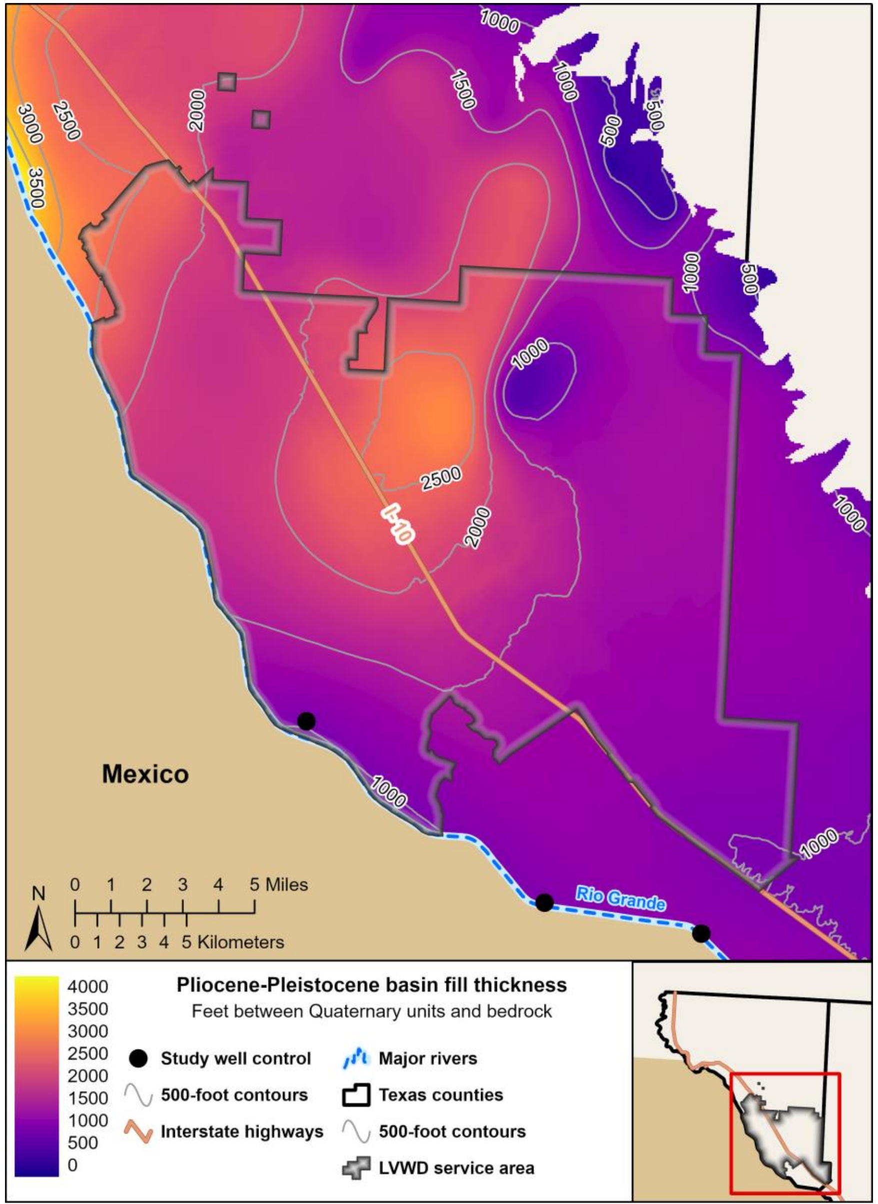


Top of Hueco basin-fill deposits

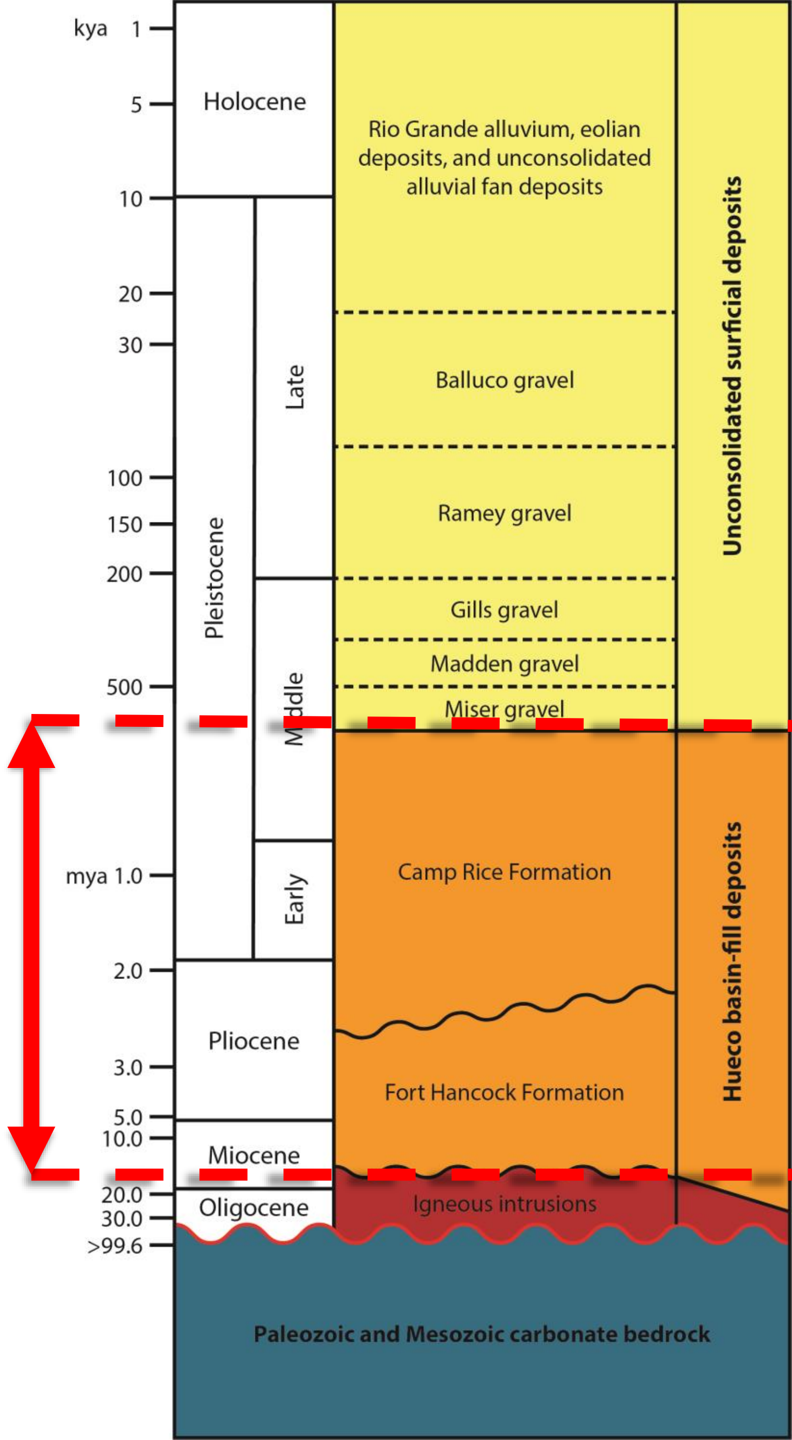




Thickness of Hueco basin-fill deposits

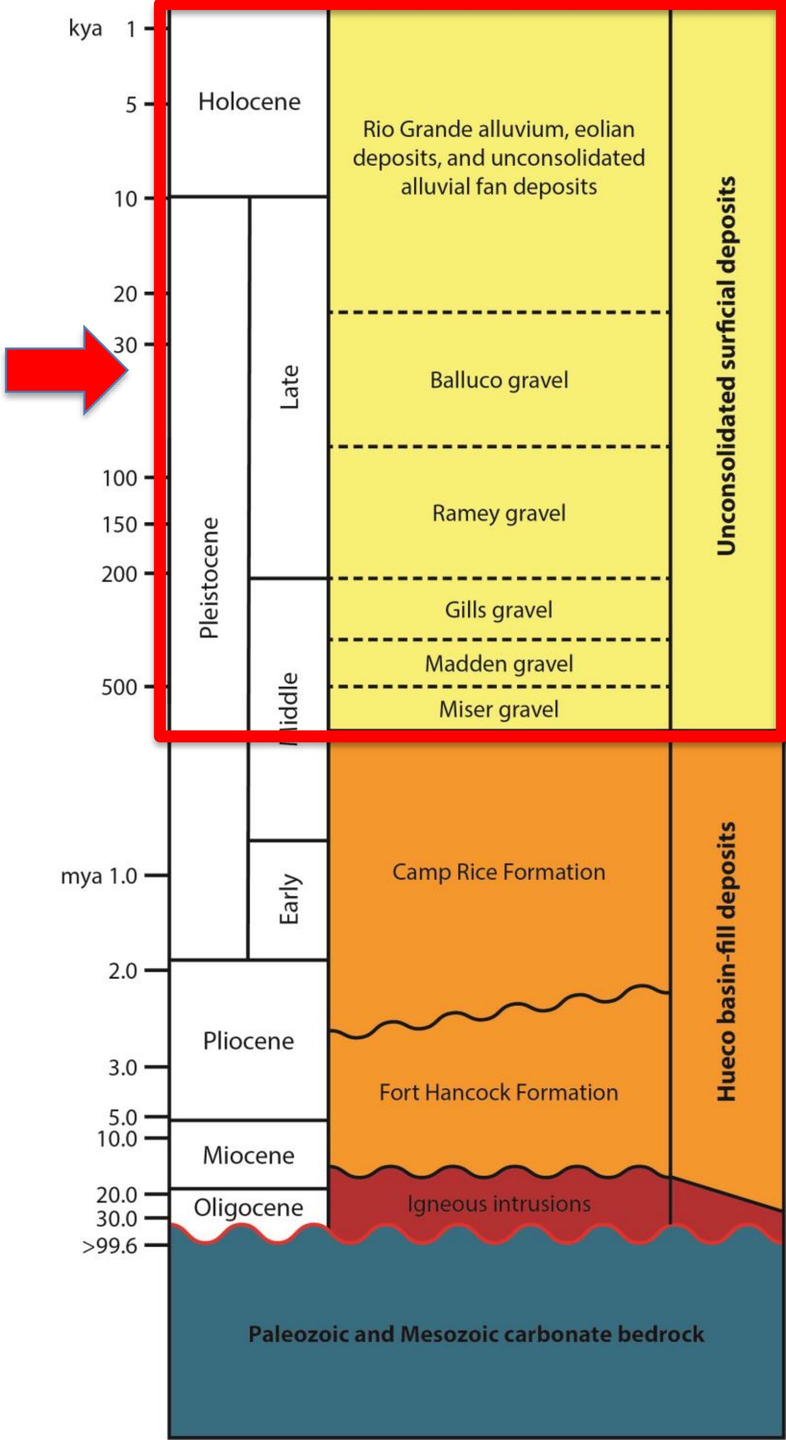


- Ranges from 249 to 3,865 feet
- The thickest portion of the unit is in the center of the study area
- Variations in thickness caused by the paleogeography during deposition



Surficial Deposits

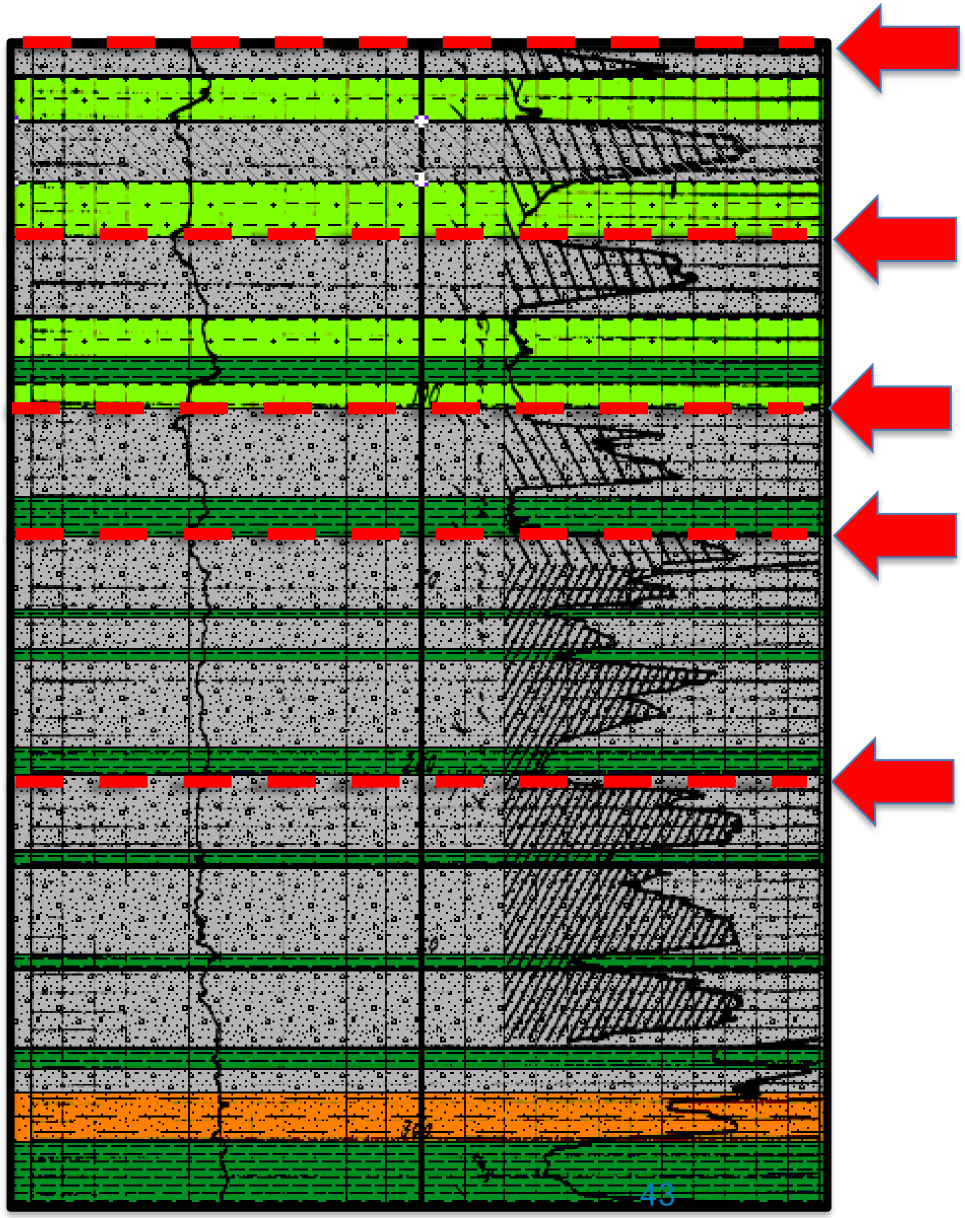
- Contains Pleistocene to modern the Rio Grande Alluvium, gravel beds and eolian deposits
- Rio Grande Alluvium similar in geophysical logs to underlying basin-fill deposits
- Pleistocene gravel beds are continuous across study area
- Eolian deposits have highly variable resistivity signatures

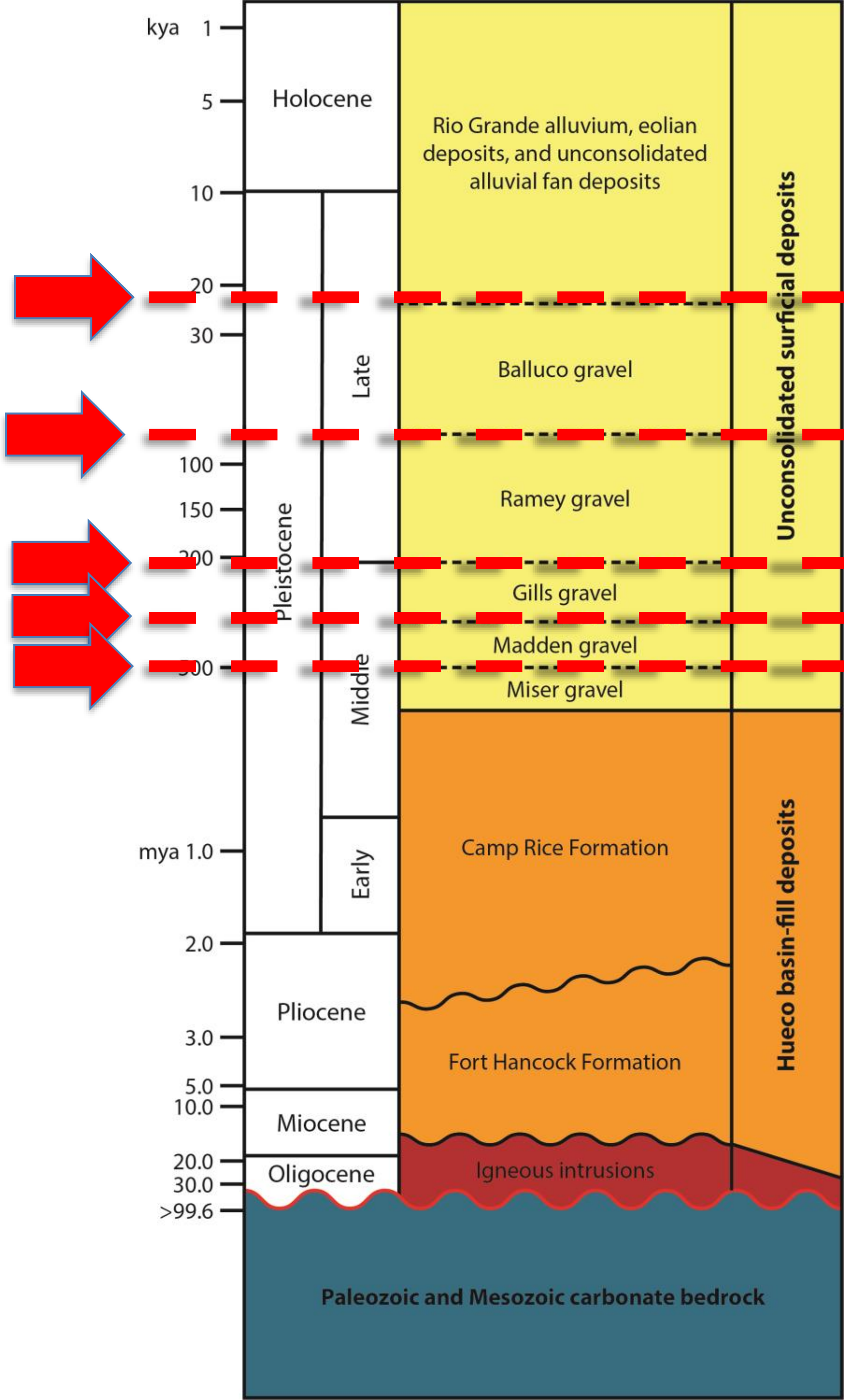


Surficial deposits

- Rio Grande Alluvium primarily sand with high resistivity signature
- Gravel beds identifiable by significant SP signature and very high resistivity that commonly overscales on logs

Gravel
Sand
Sand and clay
Clay





Assessment

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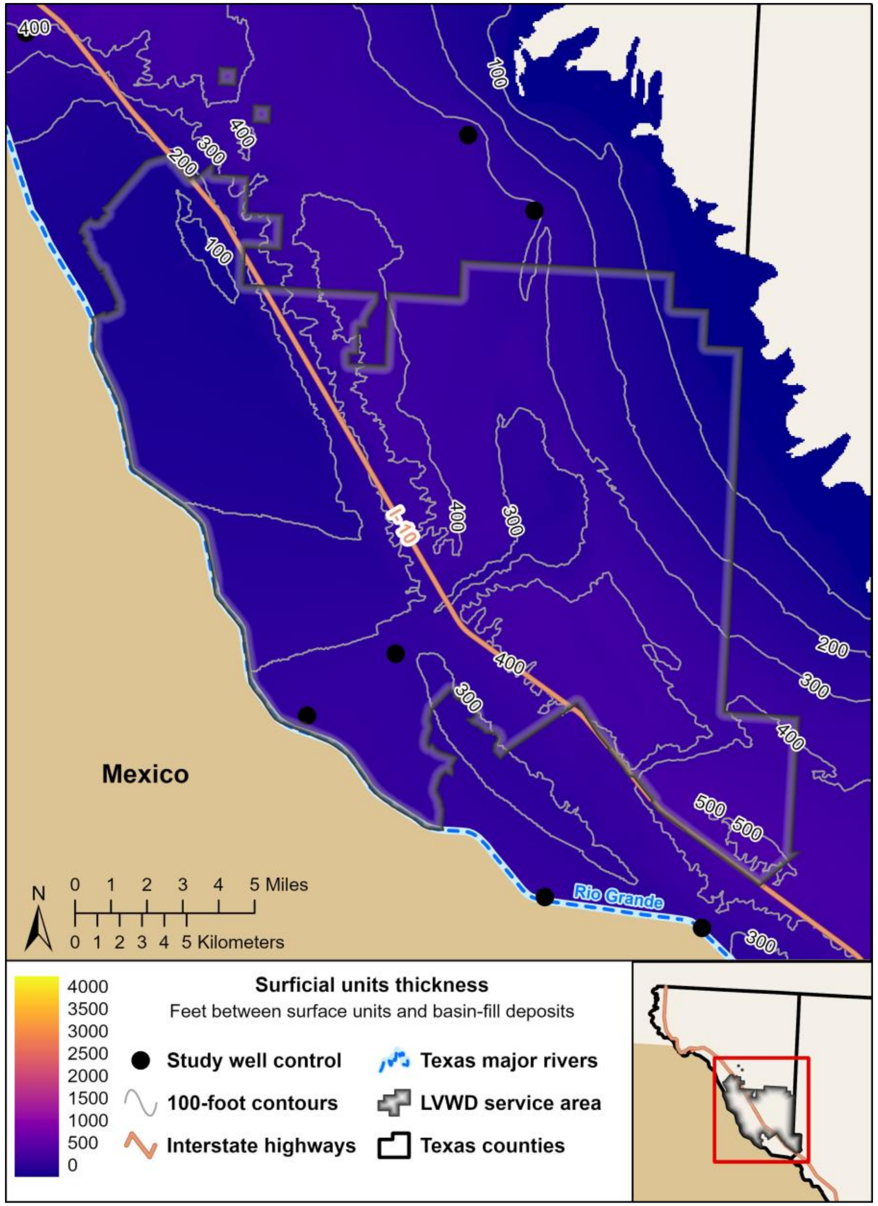
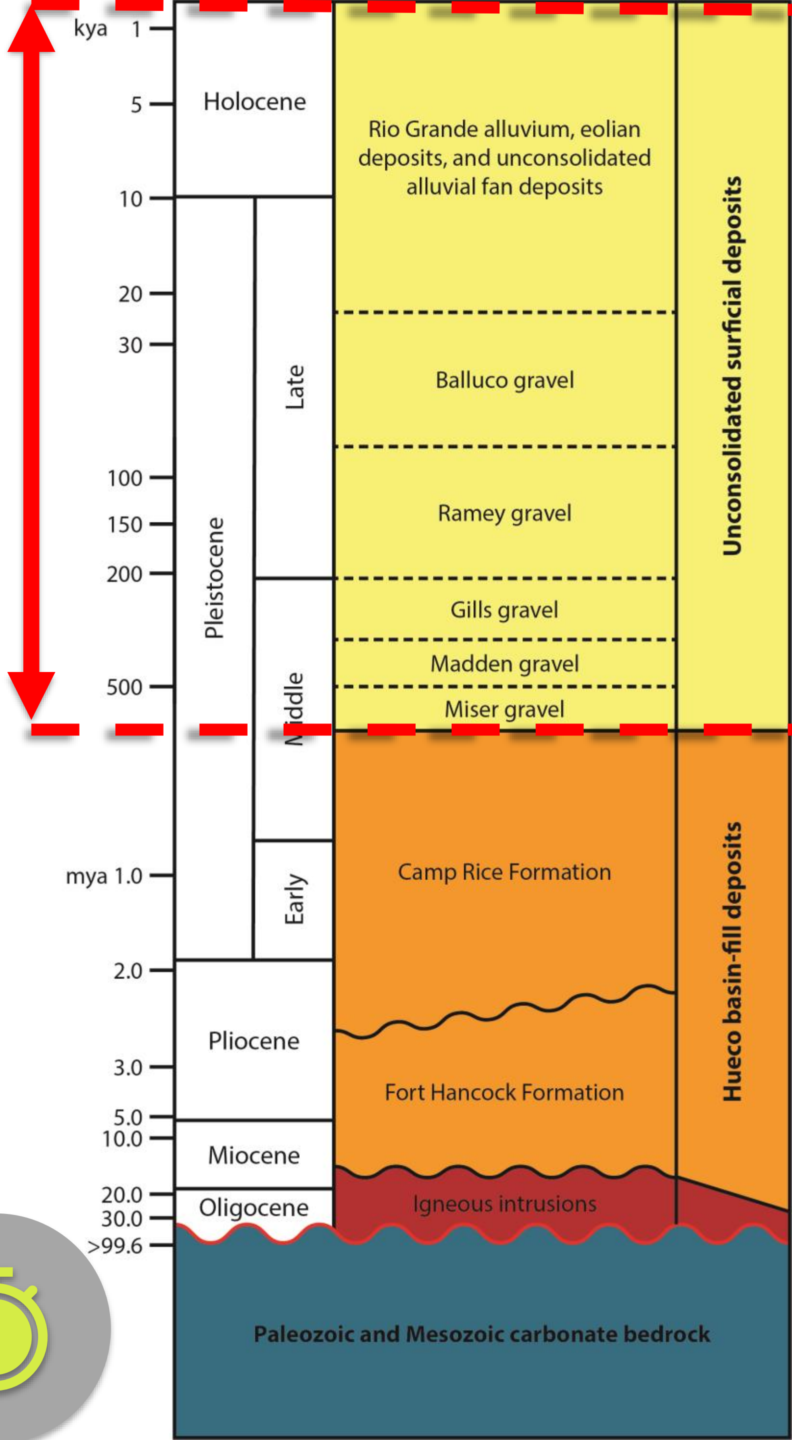
Thickness of Surficial deposits



- Up to 567 feet thick
- Most of the Rio Grand Alluvium is less than 200 feet thick
- Thickest portion of the surficial deposits contain all 5 gravel beds and eolian deposits
- Eolian deposits and gravel beds pinch out to the east toward the Hueco Mountains



Introduction

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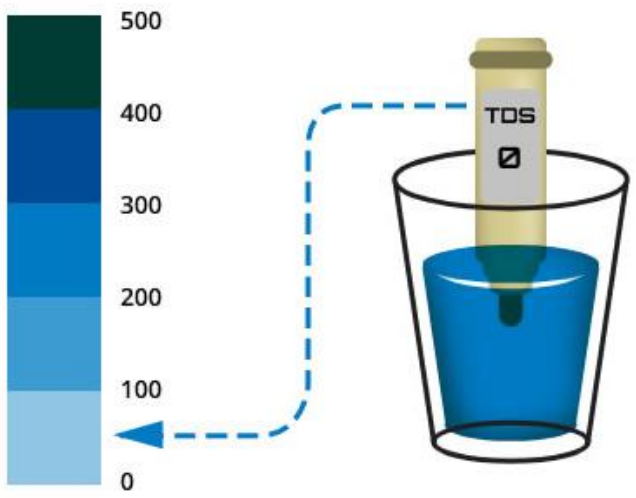
Methods

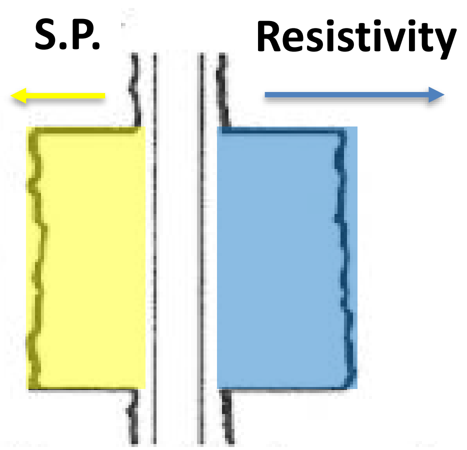
- **What?** Native groundwater salinity or total dissolved solids (TDS) in milligrams per liter
  - fresh water (0 to 999)
  - slightly saline water (1,000 to 2,999)
  - moderately saline water (3,000 to 9,999)
  - very saline water (10,000 to 34,999)
  - brine (>35,000)

- **Why?** Salinity is an important water quality parameter and has implications for an ASR project:
  - designing a well or infiltration basin
  - planning operations and establishing a buffer volume
  - water treatment requirements

Method

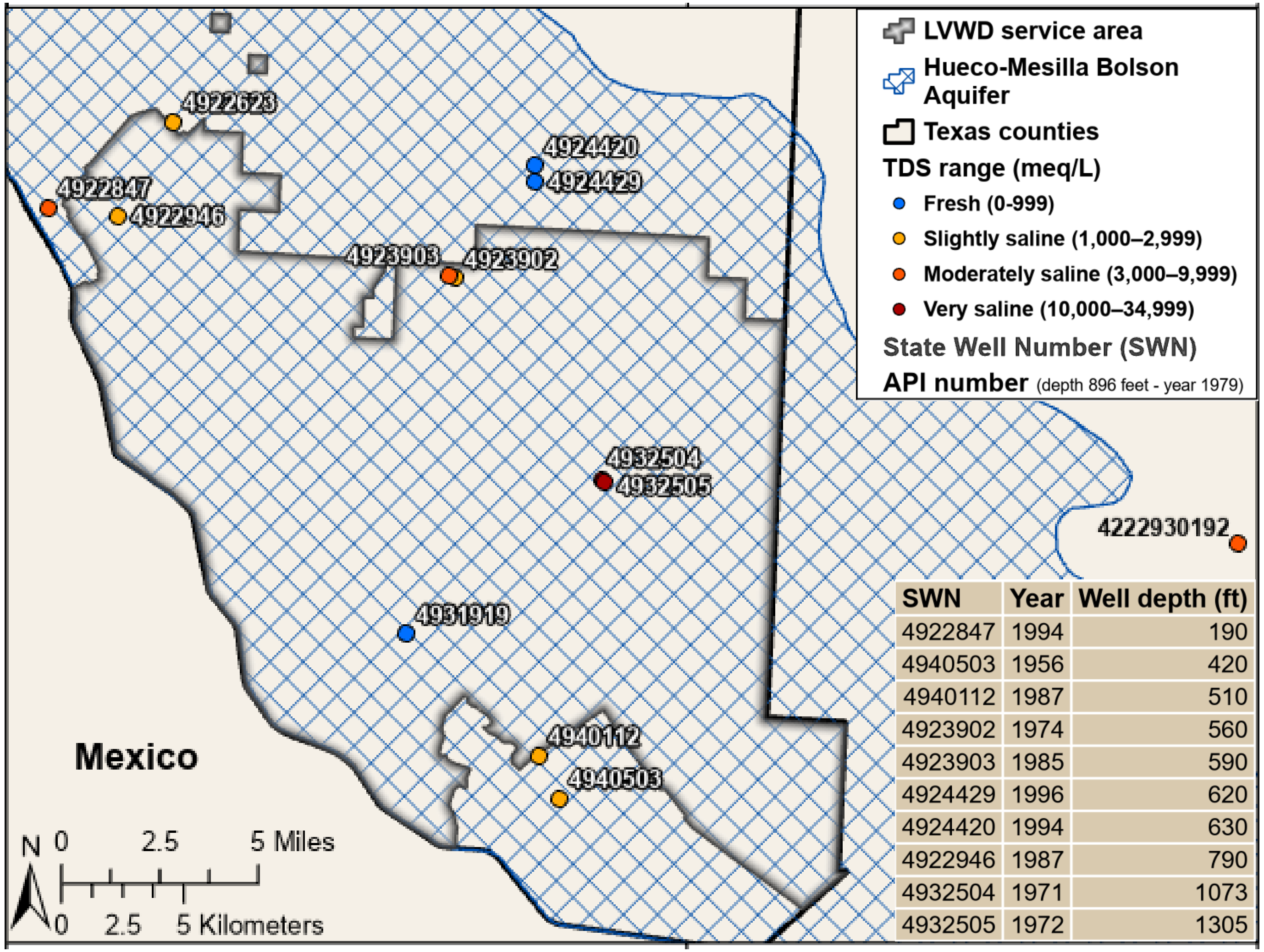
- **How?**
  - TDS collected values from available measured water quality data
    - Most measured water quality samples come from water wells
  - TDS calculated from geophysical well logs
    - Values calculated using the relationships between TDS and formation resistivity





Results - measured water quality

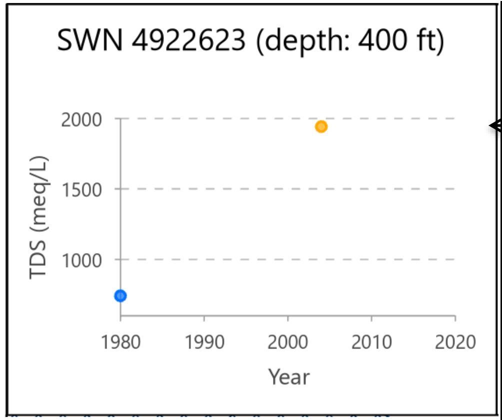
- In general, the Hueco Bolson is characterized by a thin freshwater zone underlain by slightly saline groundwater
- Hueco Basin Fill deposits available measurements: 11 wells — insufficient data
- No pattern of salinity levels and location can be identified

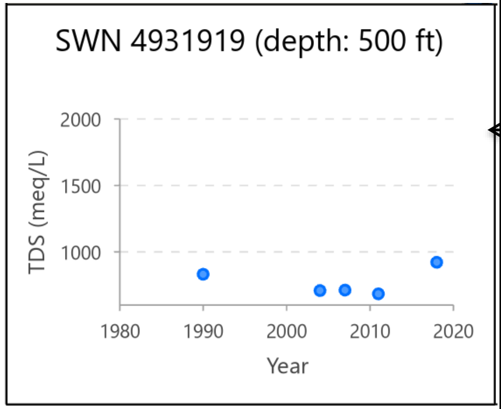


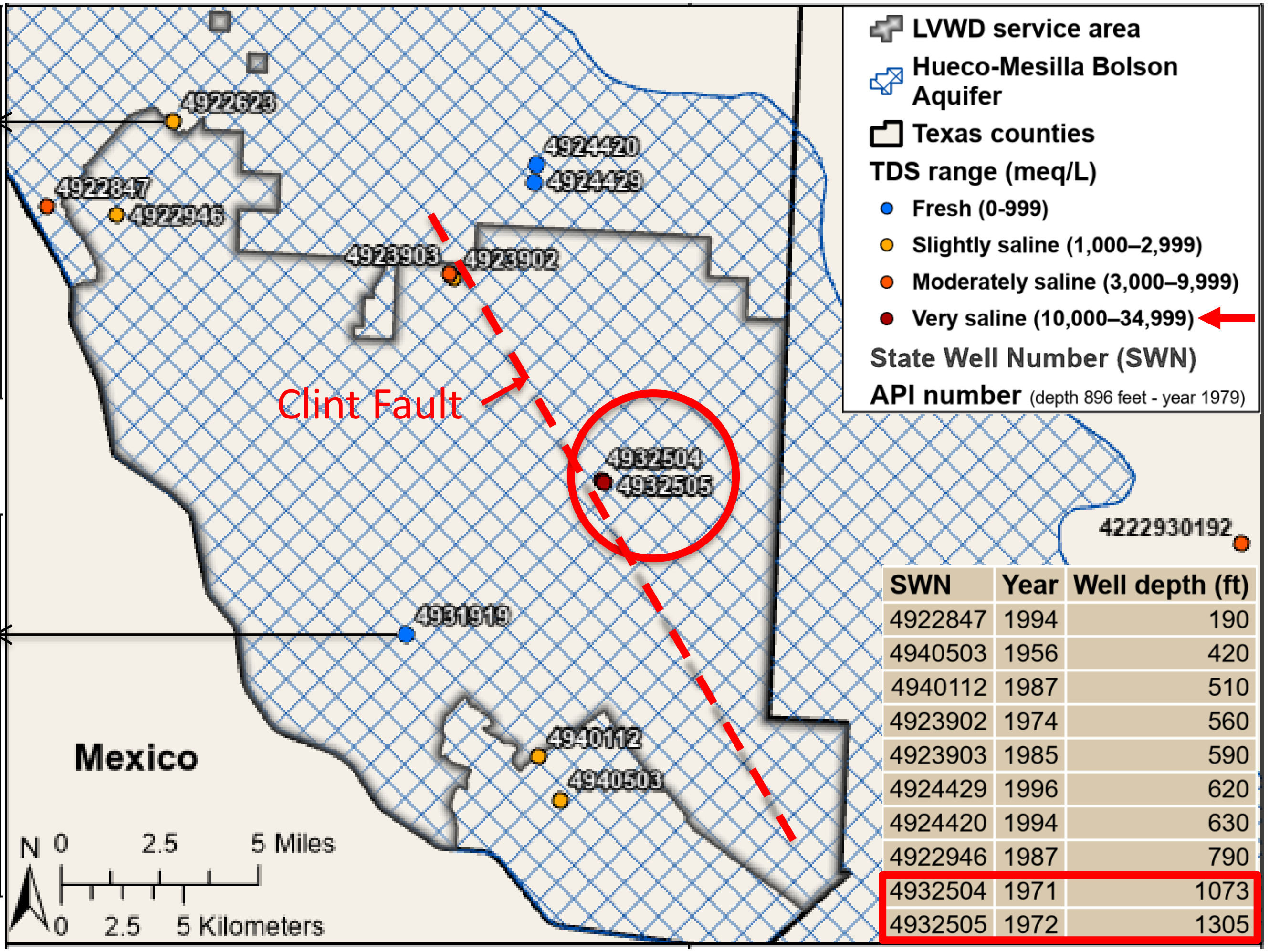
SWN	Year	Well depth (ft)
4922847	1994	190
4940503	1956	420
4940112	1987	510
4923902	1974	560
4923903	1985	590
4924429	1996	620
4924420	1994	630
4922946	1987	790
4932504	1971	1073
4932505	1972	1305

Results - measured water quality

- The deepest wells:
  - had the highest TDS concentration
  - Industrial
- Only 2 wells had multi samples over the years







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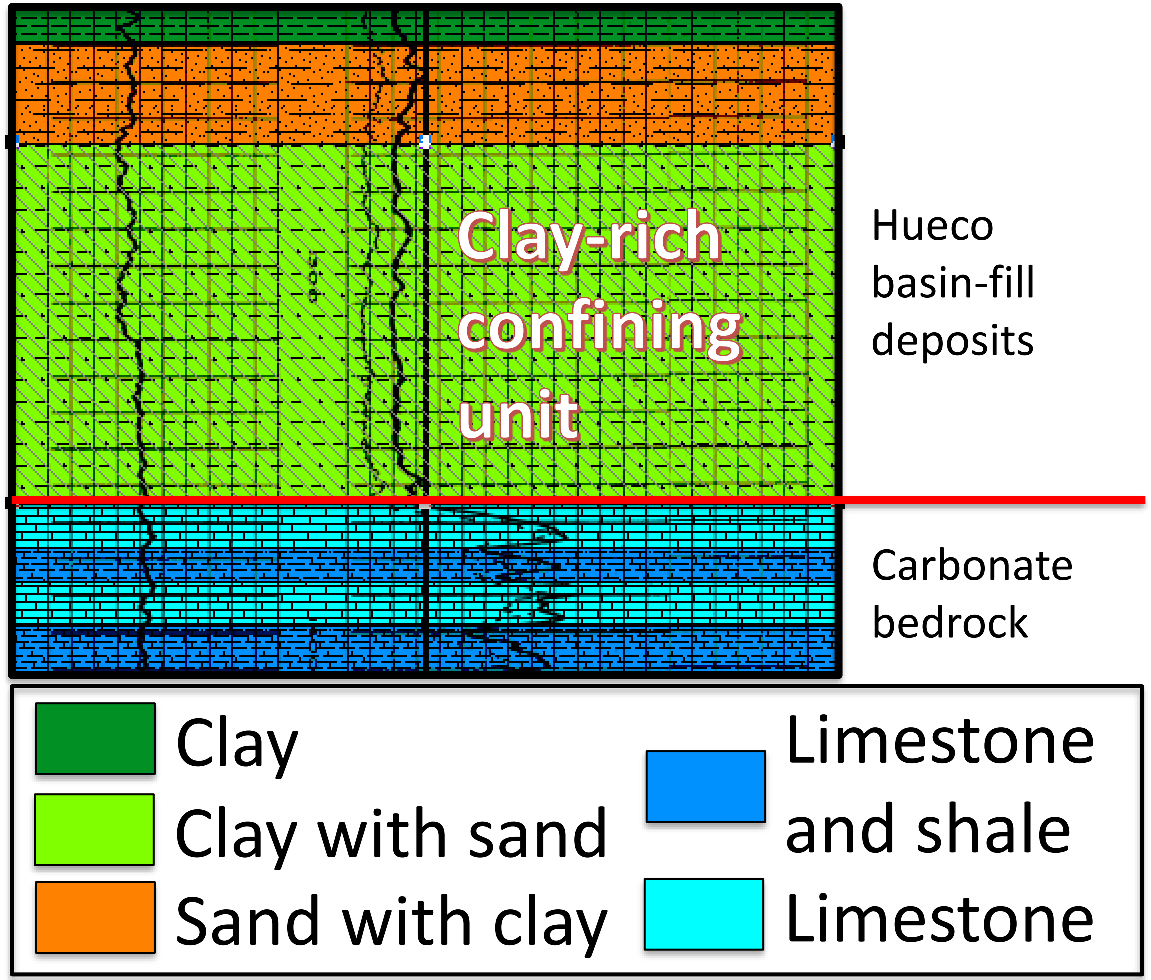
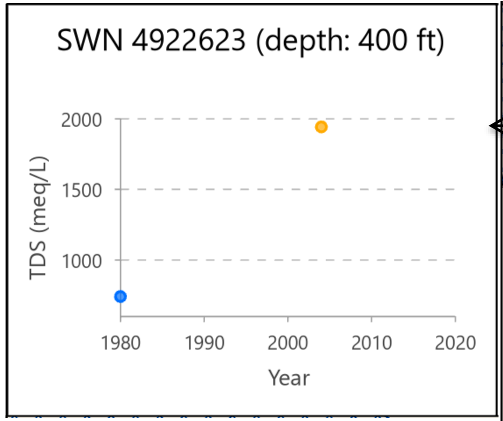
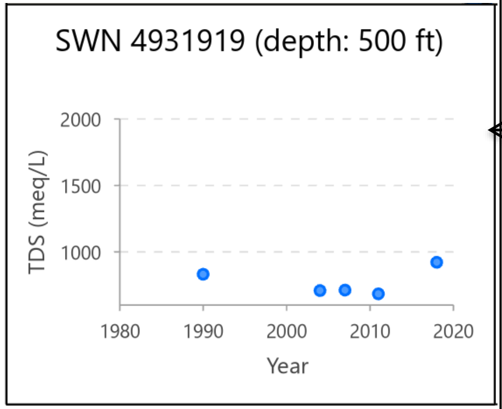
Results - measured water quality

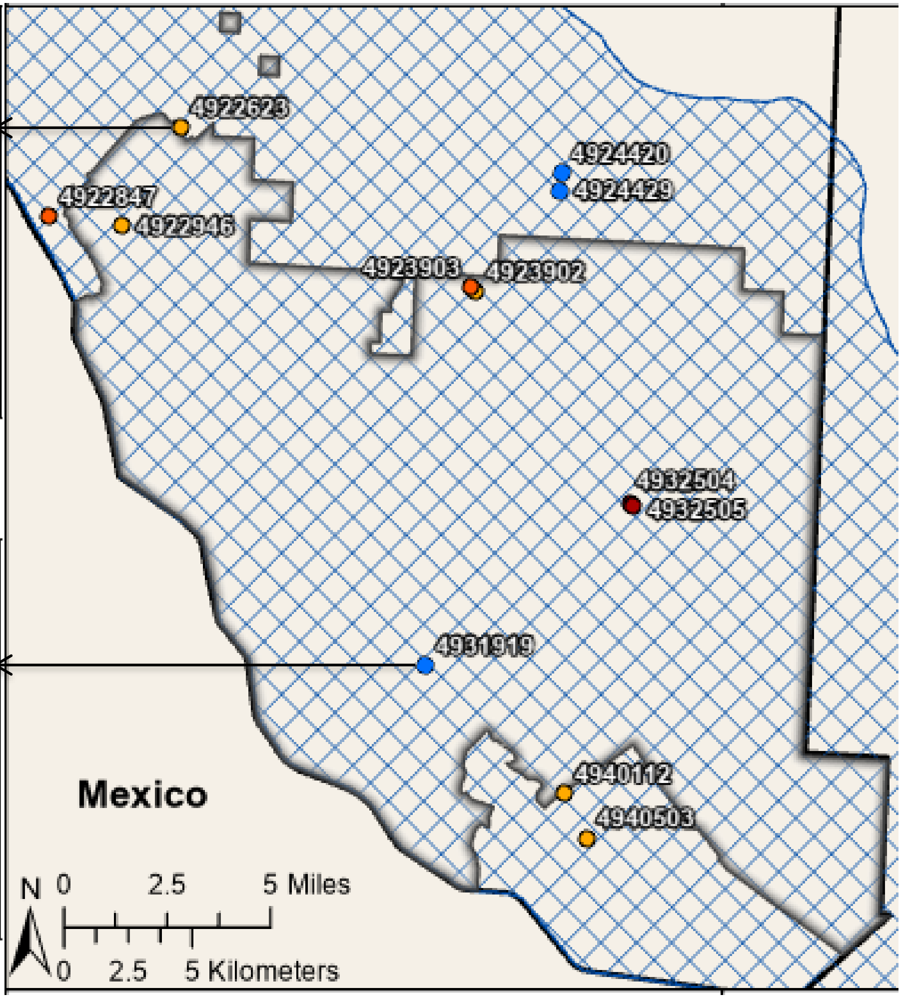




Irrigation _ drill year: 1980

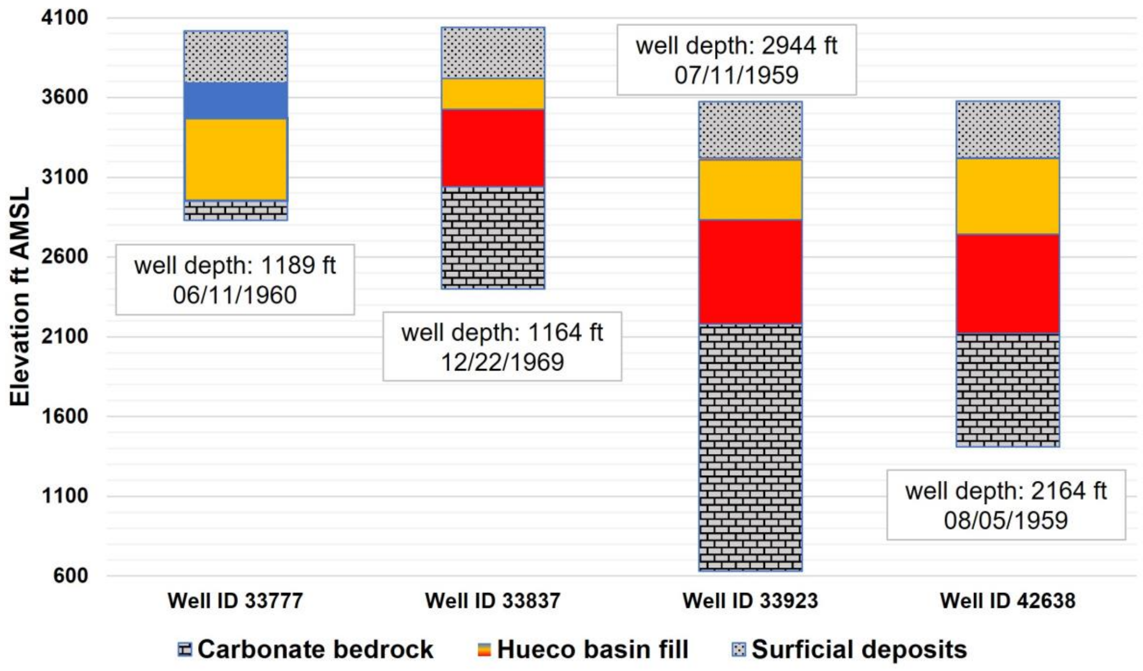


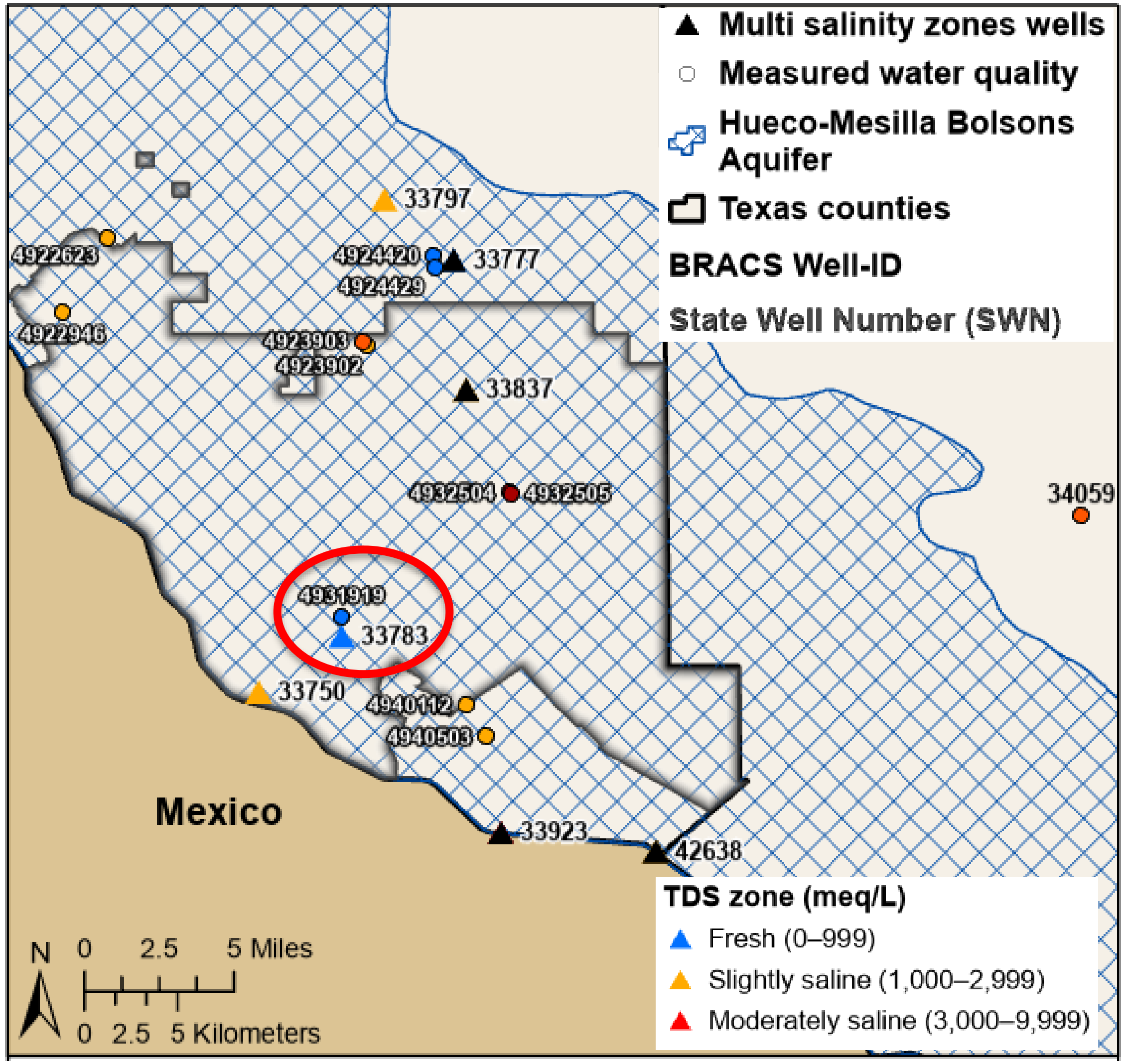
PWS _ drill year: 1990



Calculated TDS

- Geophysical well logs:
  - provide additional TDS data
  - Identify multi-TDS zones over depth
- Alger-Harrison method using resistivity values was determined to provide the most accurate results

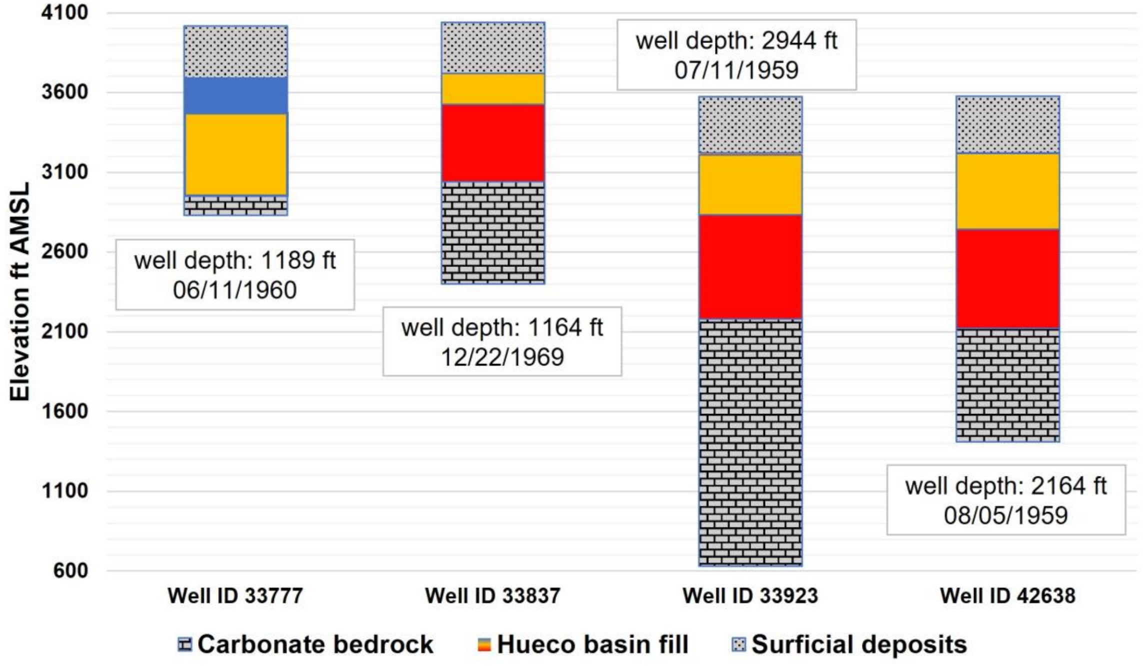


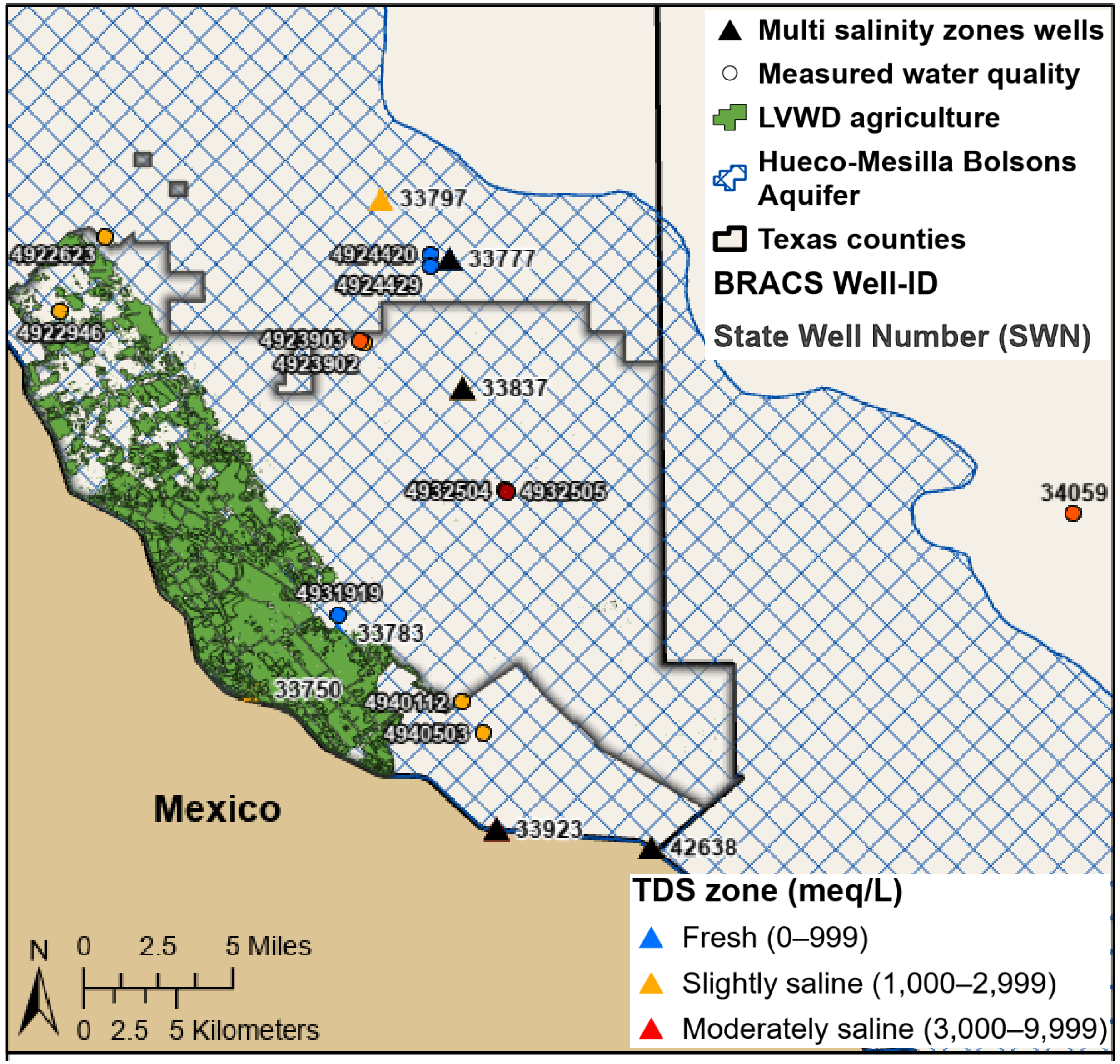


Well ID	Well depth (ft)	Log run date
33750	495	6/22/1961
33783	1099	7/28/1953
33797	1908	6/11/1959

Results - calculated TDS

- With these additional samples some patterns can be identified
  - Salinity increases with depth in general
  - Areas in proximity to major faults often have higher salinity (upconing)
  - Areas in proximity to major irrigation or municipal wells have higher salinity





Introduction **Assessment** **Discussion** **Conclusion**

ASR/AR suitability

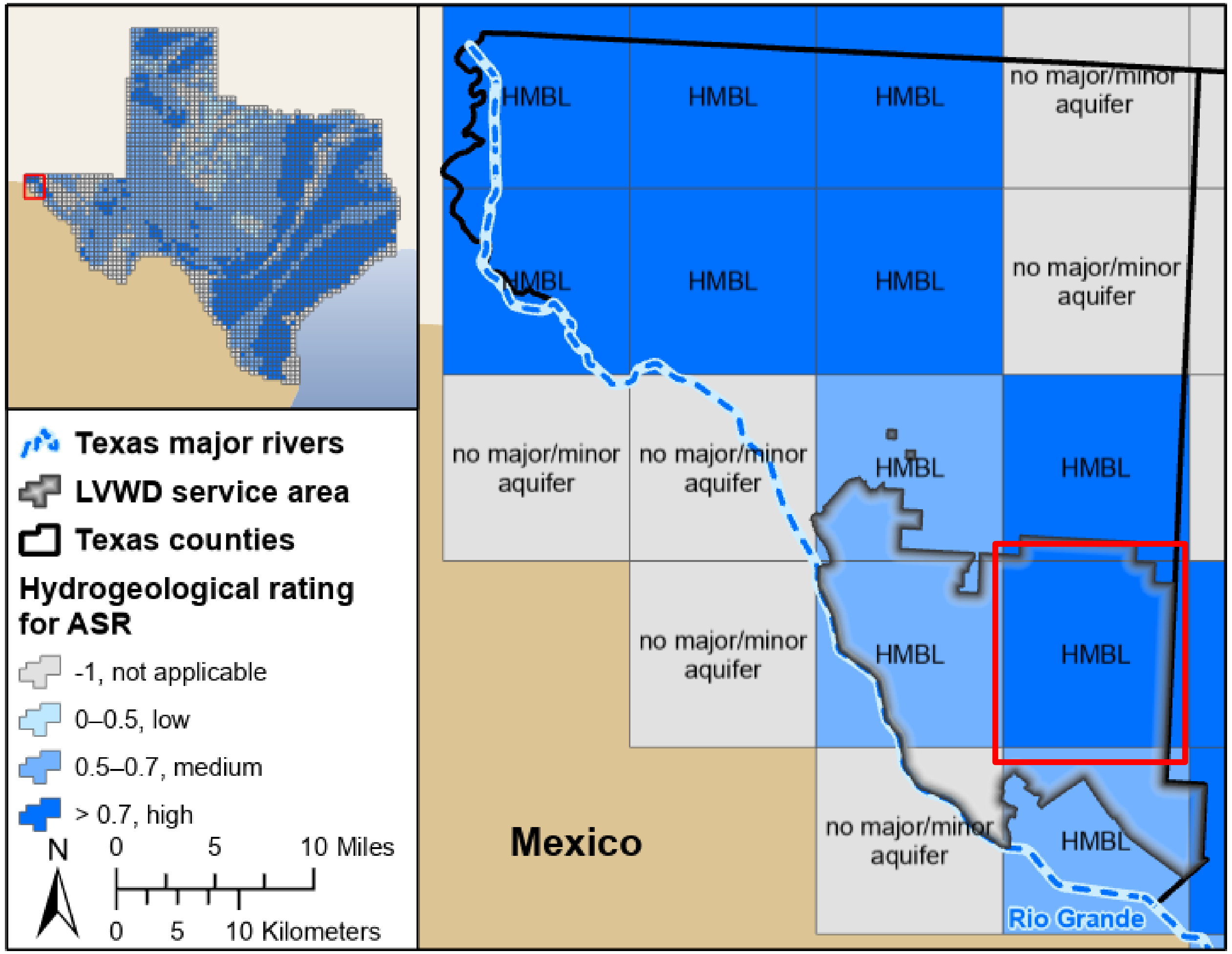
Infrastructure

Permitting

Screening categories

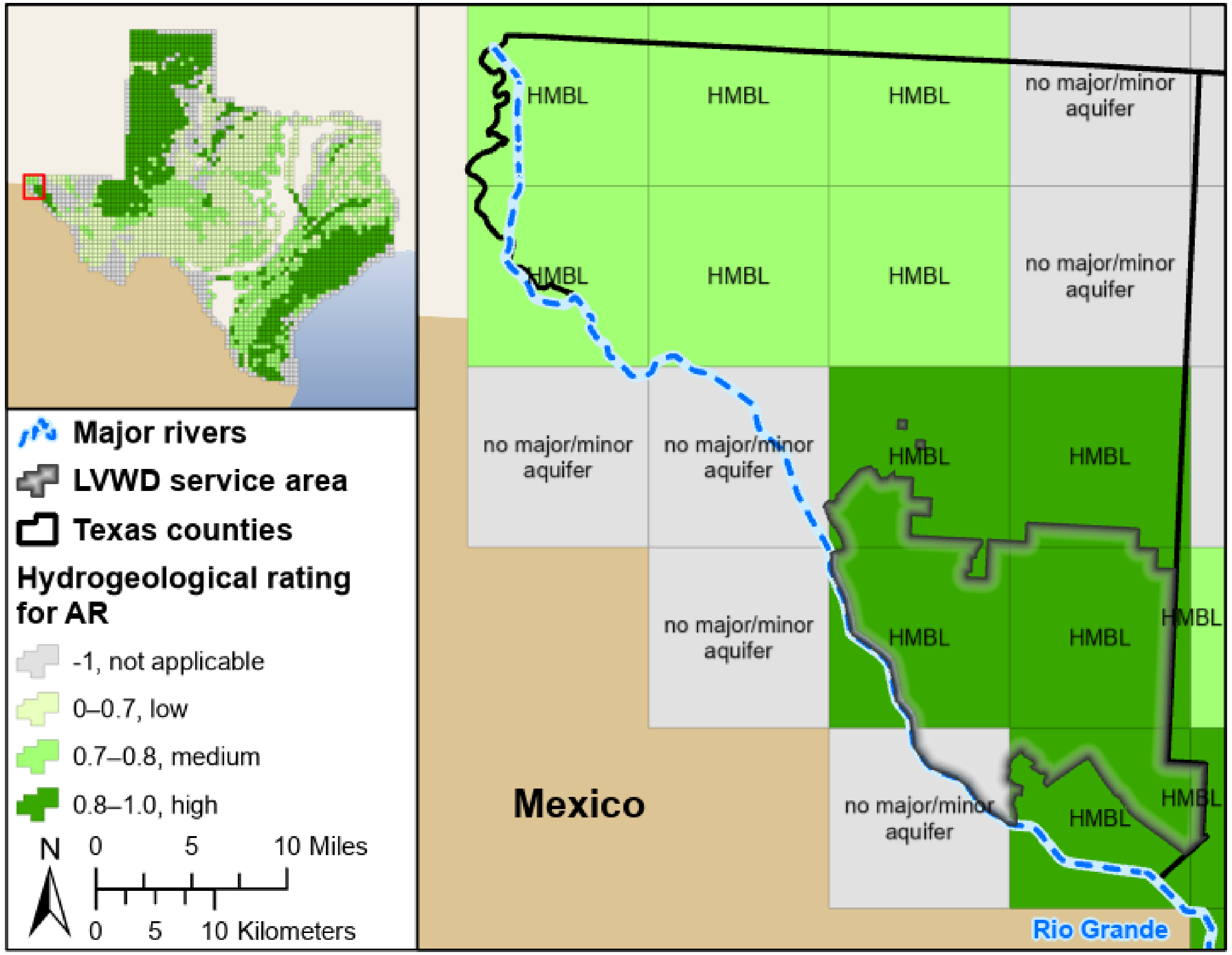
Hydrogeological suitability

- Medium (0.5-0.7) to high (> 0.7) suitability score for ASR projects
- Same score for all parameters except for water quality (TDS) and available draw up
  - Water quality:
    - Shallow fresh saline interface due to excessive use
    - Not contamination — irrigation return flows not considered
    - Most-saline wells are in high suitability cells
    - Lumped aquifers and large grid size — Site specific study is required
  - Draw up
    - Expected near streams and under agricultural lands



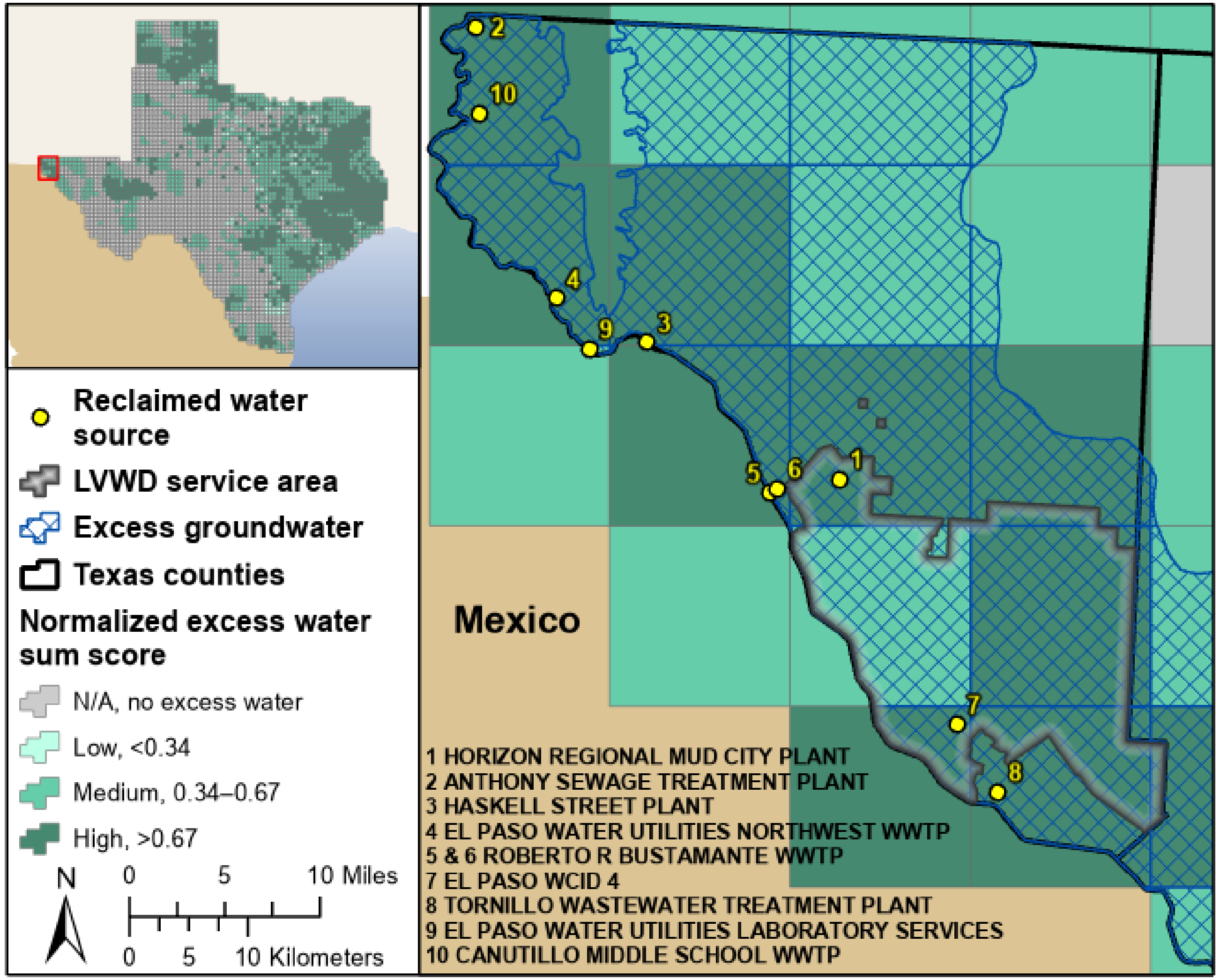
Hydrogeological suitability

- High (0.81 – 0.82) suitability score for AR projects
- Same score for all parameters except for depth to water table and vertical hydraulic conductivity
  - Water table depth
    - directly related to surface elevation
    - Rio Grande flood plain more than 300 feet lower in elevation than eastern portion of study area
  - Vertical hydraulic conductivity
    - Challenging to make generalizations due to complex stratigraphy



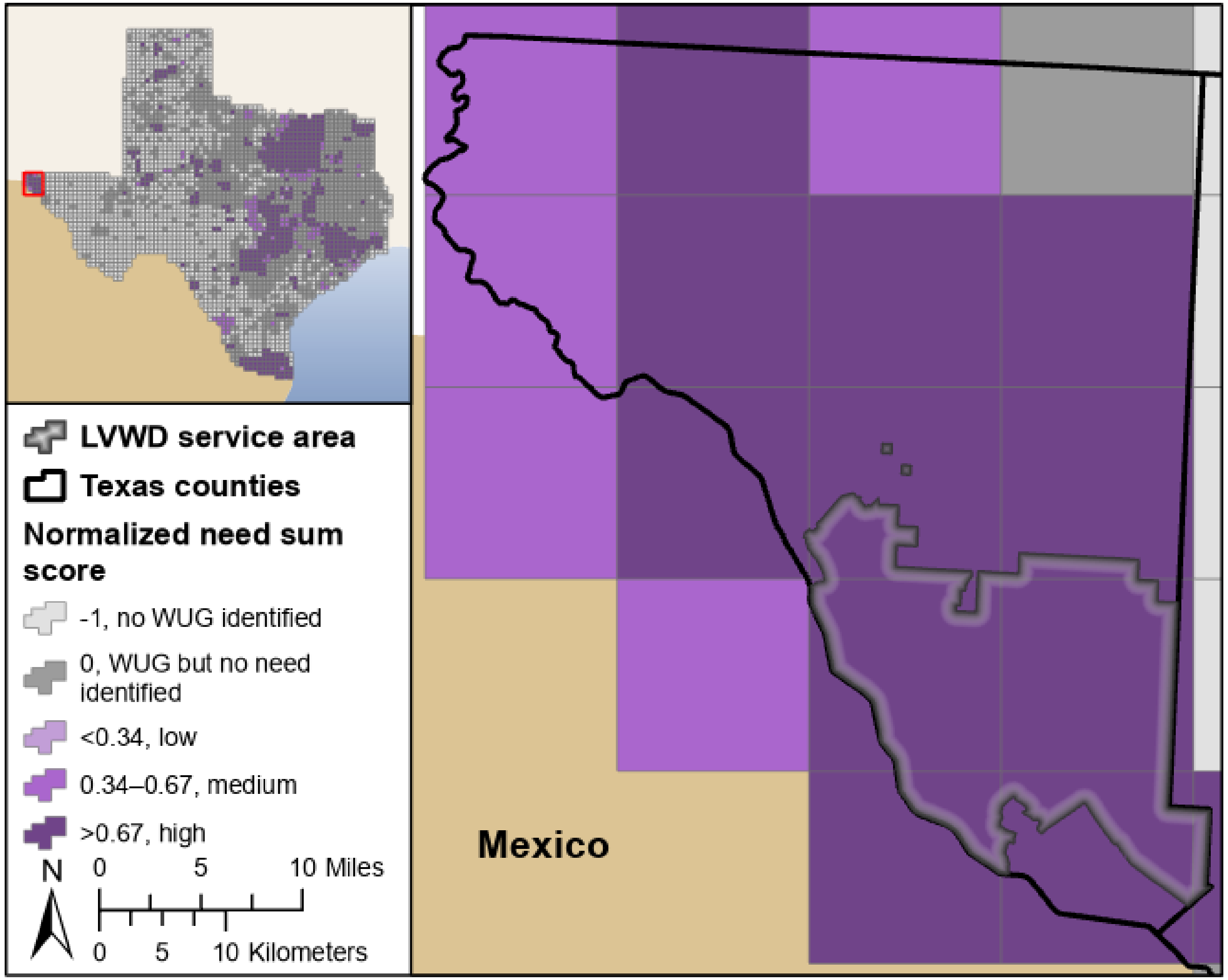
Excess water supply suitability

- Medium (0.34-0.67) to high (>0.67) suitability for ASR and AR
- No potential excess surface water
- Potential excess Hueco-Mesilla Bolsons Aquifer groundwater minimal
- Potential excess reclaimed water — most feasible for a project



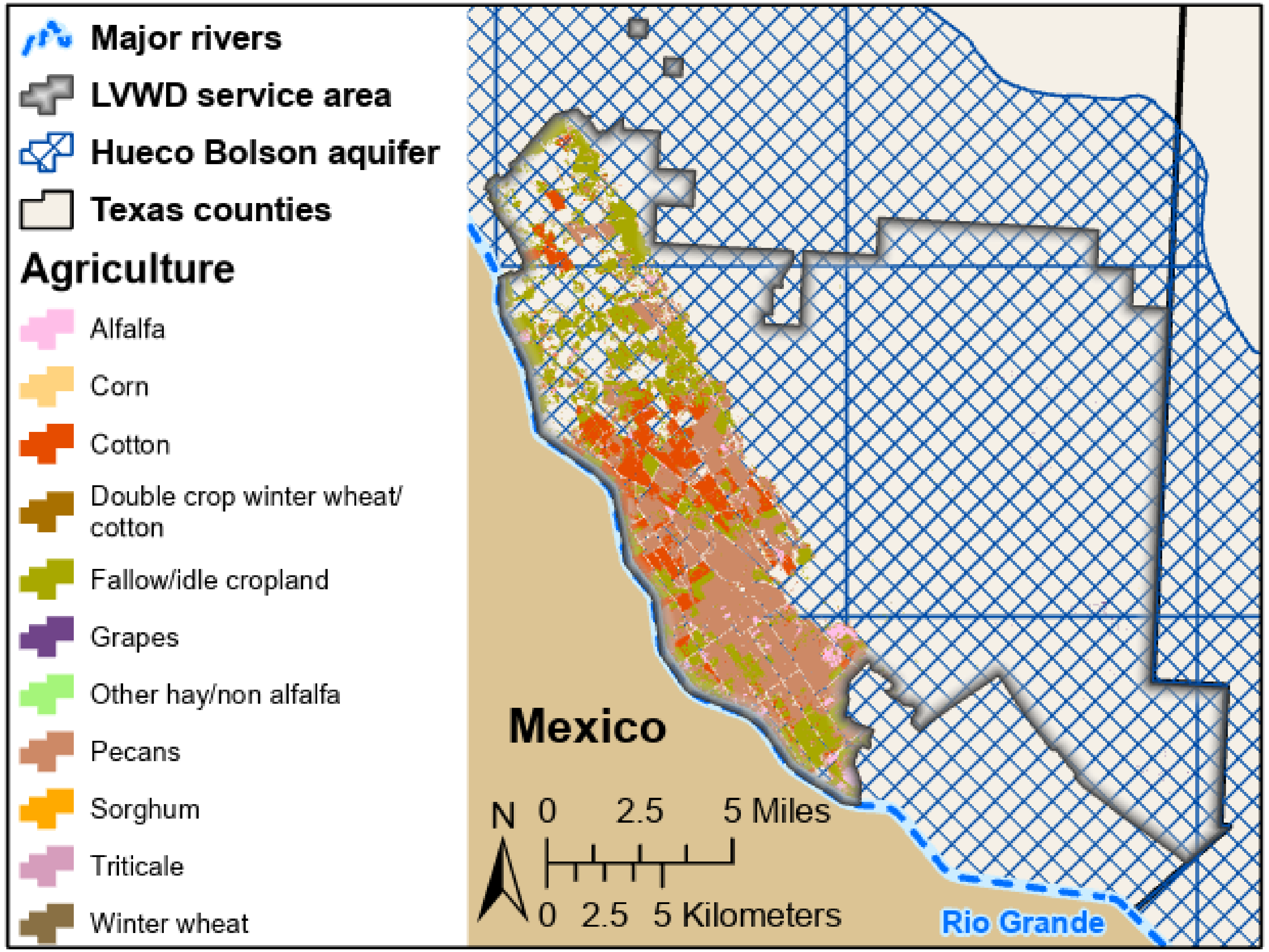
Water needs suitability

- High (>0.67) suitability for ASR and AR
- Survey considered municipal, steam electric and manufacturing needs
- All needs in study area related to municipal needs

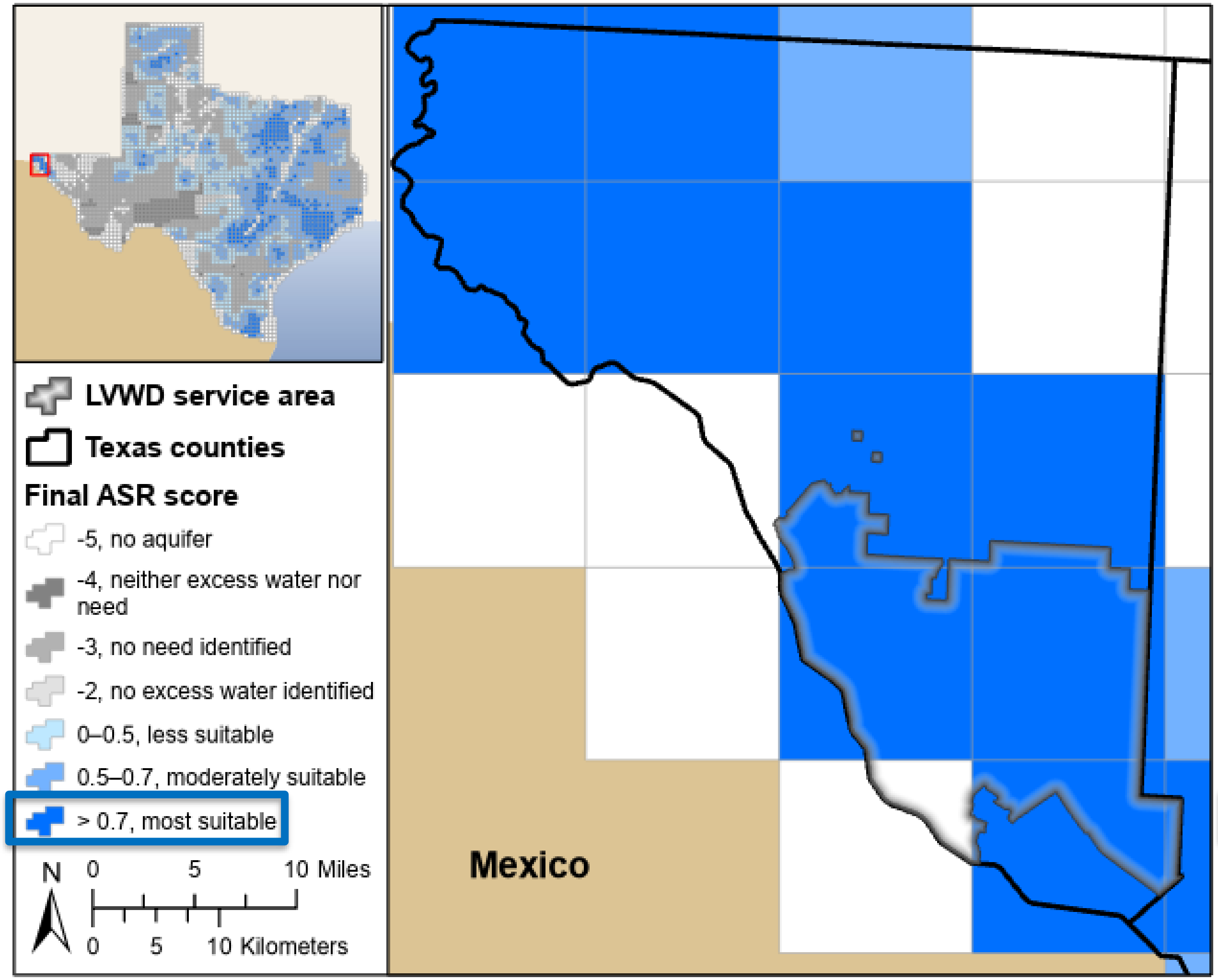


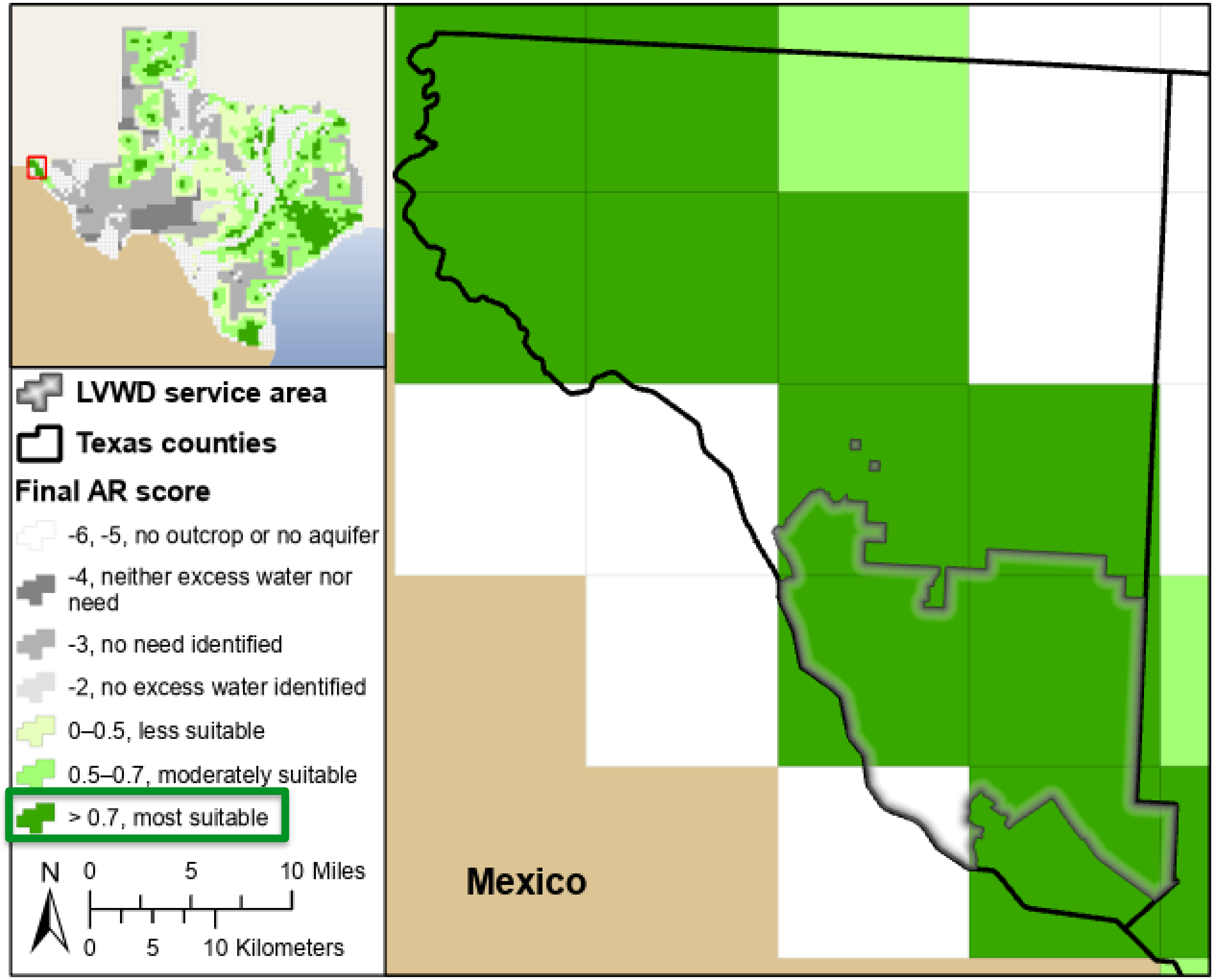
Water needs suitability

- Irrigation needs
  - Not considered in the survey
  - Available on county level in the State Water Plan
  - Estimated based on agricultural lands comparison
  - Used 2022 Cropland Data from USDA
- Result: LVWD has 68% of El Paso County agricultural lands — 68% of the county's irrigation needs



Final suitability rating





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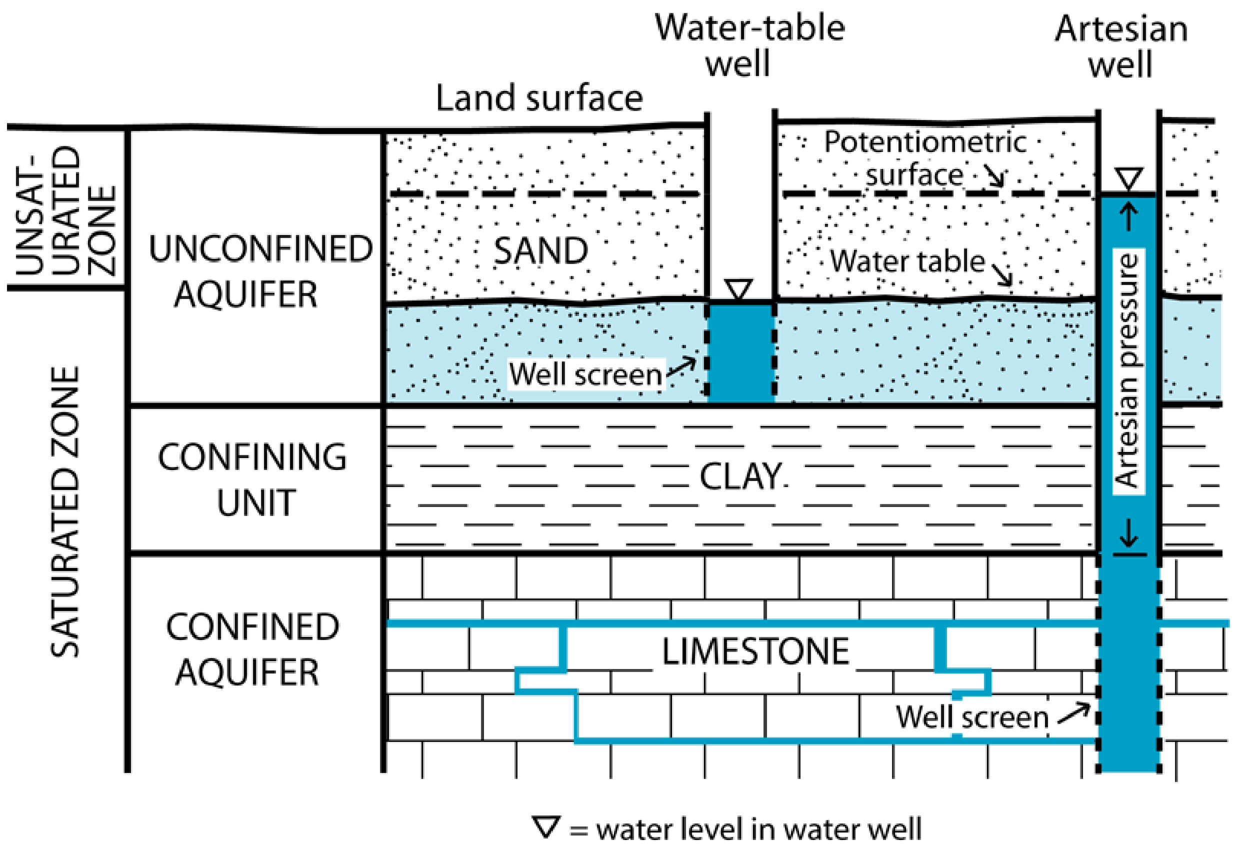
Well construction

- Design of a well must consider several factors including:
  - Goal of the project
  - Depth and thickness of the aquifer
  - Lithology and mineralogy of the target aquifer
  - Geochemistry of both the source and native groundwater

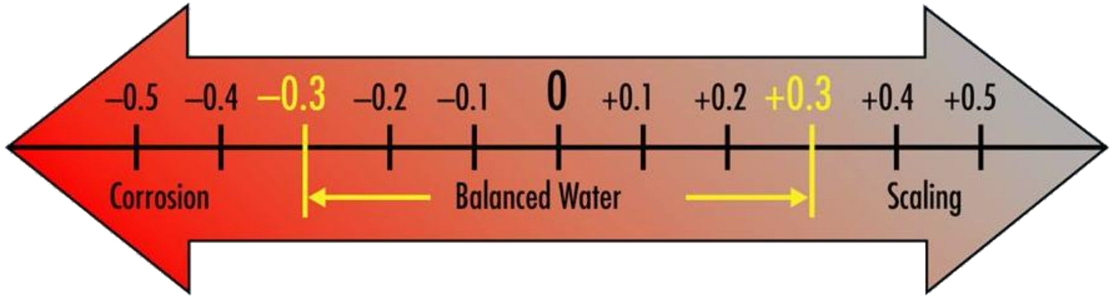


From the Indiana Geological and Water Survey

Well construction

- Langelier Saturation Index (LSI)
  - calculated using measured pH, Tf, Cf, Alkalinity, and TDS
  - shows whether water will be encrusting (positive) or corrosive (negative)
  - corrosive water will cause well casings and screens to deteriorate
  - accumulation of mineral deposits can negatively impact well performance

$$LSI = pH + \log\left(\frac{K_a \cdot \gamma_{Ca^{2+}} \cdot [Ca^{2+}] \cdot \gamma_{HCO_3^-} \cdot [HCO_3^-]}{\gamma_{H^+} \cdot K_{sp}}\right)$$



Well construction

- Hueco basin-fill groundwater is highly variable and has LSI values ranging from -1.12 to 0.72
- No definitive pattern of LSI seen
- Most saline wells in the study area have the highest incrusting values
- Additional testing will be needed to develop an ASR or AR project
- LVWD will need to be adaptable to changes in operational conditions

Langelier Saturation Index

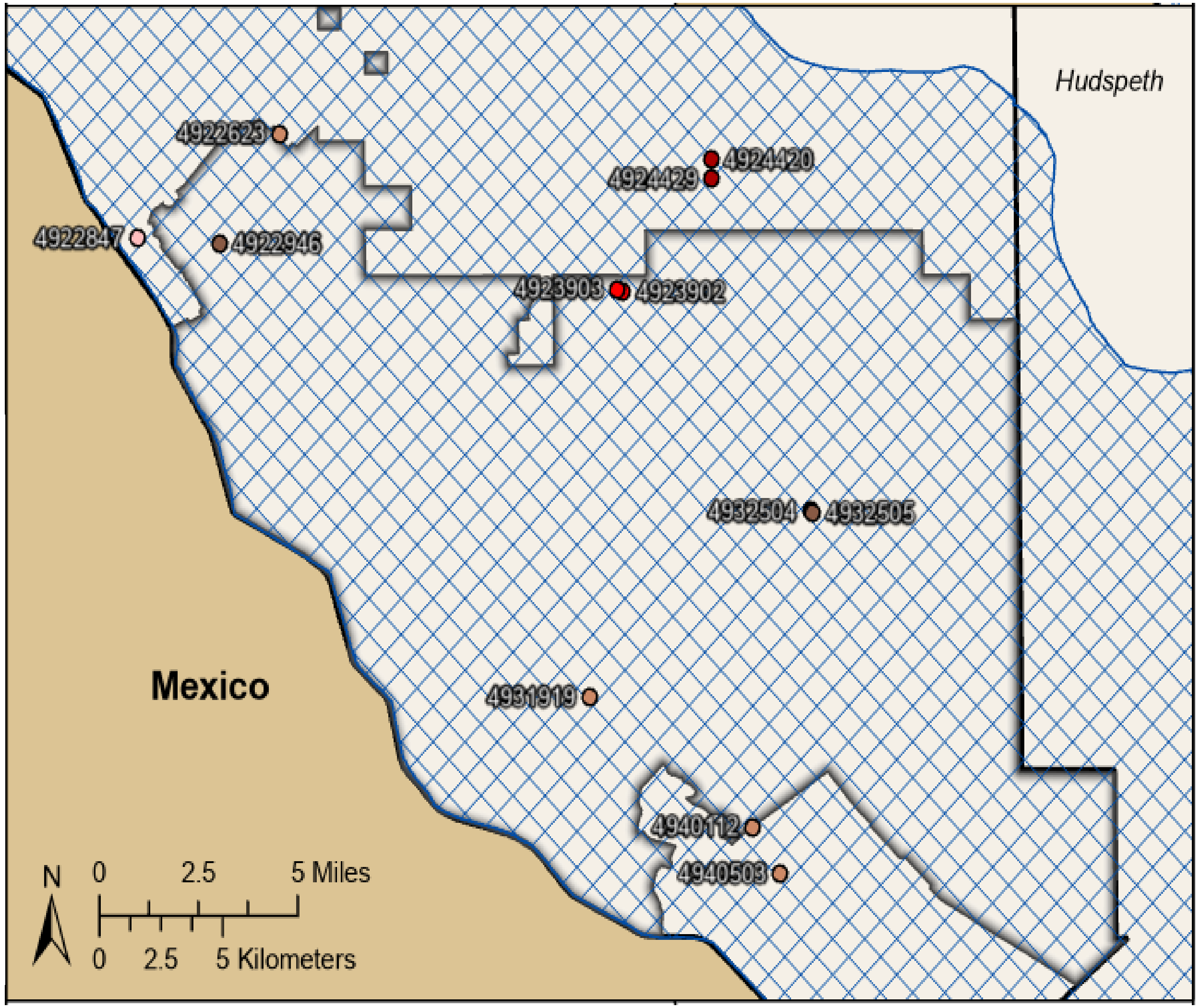
- -1.0 – -1.5
- -0.5 – -0.99
- 0 – -0.49
- 0–0.49
- 0.5–0.99

Hueco-Mesilla Bolsons Aquifer

Texas counties

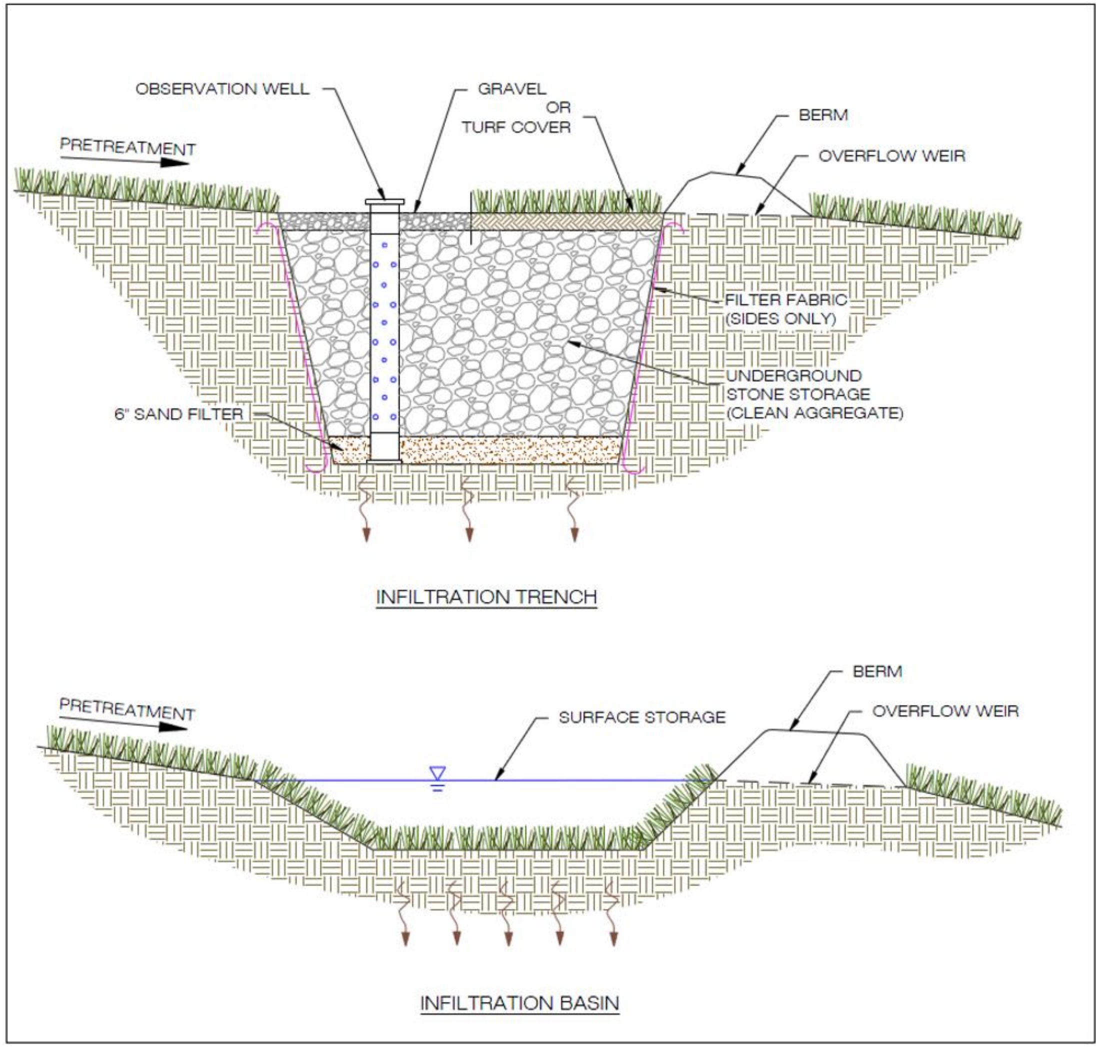
LVWD service area

State Well Number (SWN)



Basin construction

- Design of an infiltration structure well must consider several factors including:
  - Goal of the project
  - Infiltration and Soil Properties
  - Hydraulic conductivity
  - Geometry of the intake and confining structures
  - Location of potential contaminants



From the Virginia Department of Environmental Quality

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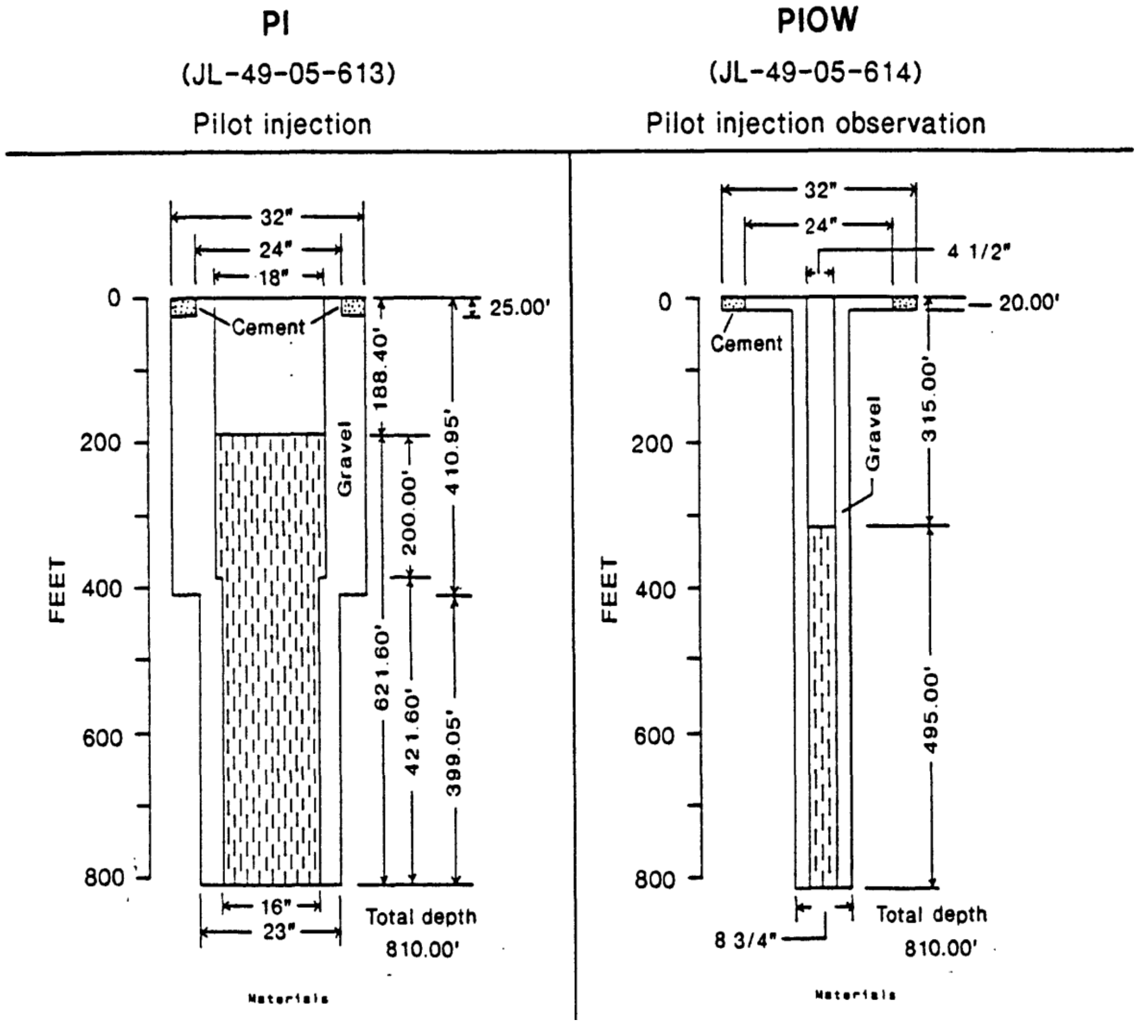
Reclaimed water

- El Paso Water (EPW) completed an ASR pilot project from 1981–1983 using advanced treated wastewater
- Project fully operational in 1985
- Wells had problems with corrosion and screen plugging – 6-month rehabilitation cycle
- Transitioned to surface infiltration basins (AR)
- Recently working on a surface infiltration system called an “enhanced arroyo” to allow additional reclaimed water recharge



Reclaimed water

ASR Permitting

- All ASR injection and recovery wells in Texas must be authorized by TCEQ UIC
- Currently there is no established regulatory path for authorizing an ASR system using reclaimed water
- Could be considered on a case-by-case basis and would require coordination with several TCEQ programs
- SB 2885 – directs TCEQ to consider the use of reclaimed water for Class V injection wells as part of an ASR project

Reclaimed water

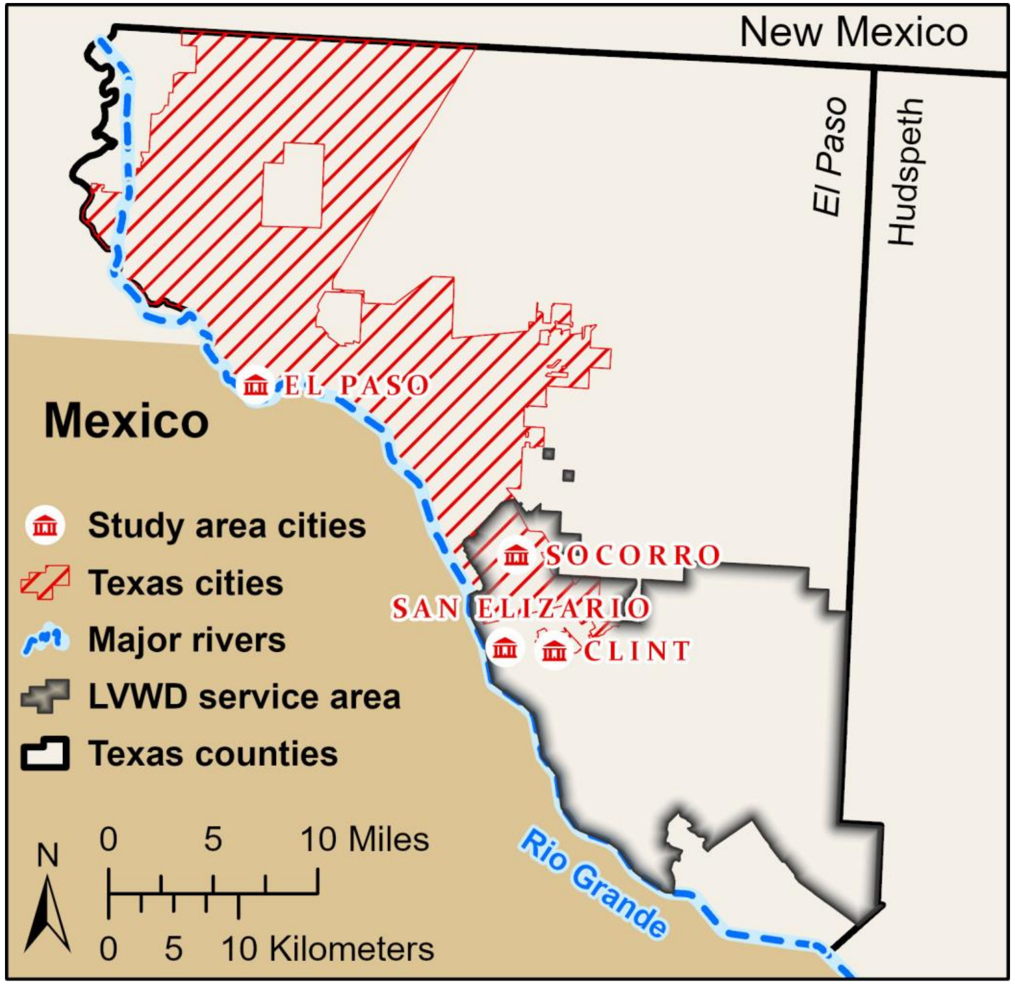
AR Permitting

- TCEQ can permit disposal of municipal treated wastewater adjacent to waters in the state through a Texas Land Application Permit (TLAP)
- AR could be permitted process as an “Alternative reclaimed water system” under 30 Texas Administrative Code § 210.41
- A TLAP could be used in conjunction with several types of AR structures such as drip dispersal systems and basins
- Depending on the type of infiltration structure, different requirements may be needed

Introduction Assessment Discussion Conclusion

Key takeaways

- The LVWD is interested in diversifying their water supply and currently planning to build a new WWTP
- Due to declining water levels in the Hueco Bolson aquifer, the district is interested in ASR or AR to recharge the aquifer
- ASR and AR projects can be used to provide drought resilience and maximize efficiency of water infrastructure



TEXAS WATER DEVELOPMENT BOARD

Key takeaways

- **The Hueco basin-fill deposits are relatively shallow and contain sand beds suitable for ASR or AR, making them an ideal target for a project**
- **The Surficial deposits, while containing large sand and gravel beds are unconfined and extensively pumped for agriculture, making AR possible, but not ideal**
- **Based on both the engineering complexities of using reclaimed water and complex geochemistry of the area, an AR project using infiltration basins is likely the best option for the district**

Next steps for LVWD

- LVWD is also interested in potentially drilling production wells: Recently worked with UTEP on preliminary study
- Several test wells in the area near the proposed wastewater plant: Including electrical resistivity, spontaneous potential, fluid conductivity, and pump tests
- Potential geophysics could be performed: seismic surveys, passive seismic, airborne electromagnetic

Questions?

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