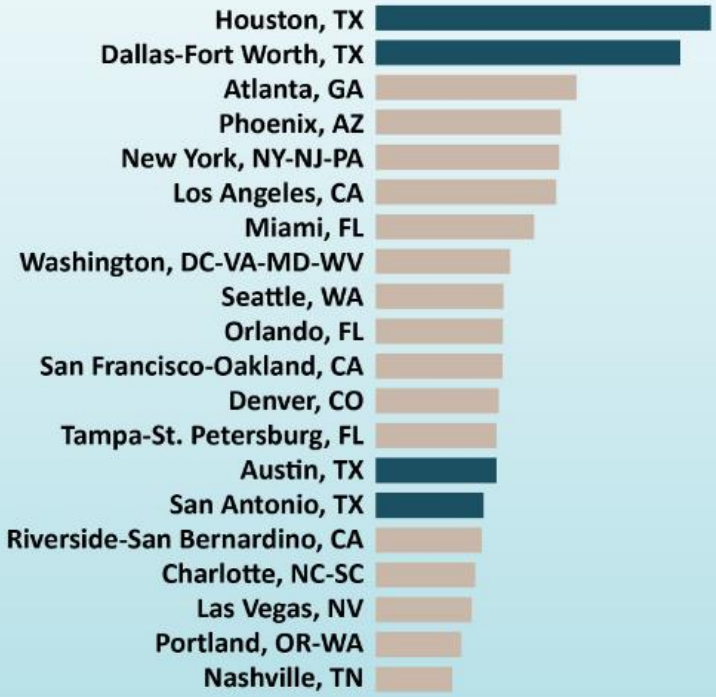
ASR Feasibility: Can We Make it Work?

PART 1 – Surface water supply and demand

J. Wolfe and J. Jeong
Blackland Research and Extension Center
Temple, Texas

TEXAS Keeps Getting Bigger

Lone Star State Metro Areas Lead U.S. in Population Gain



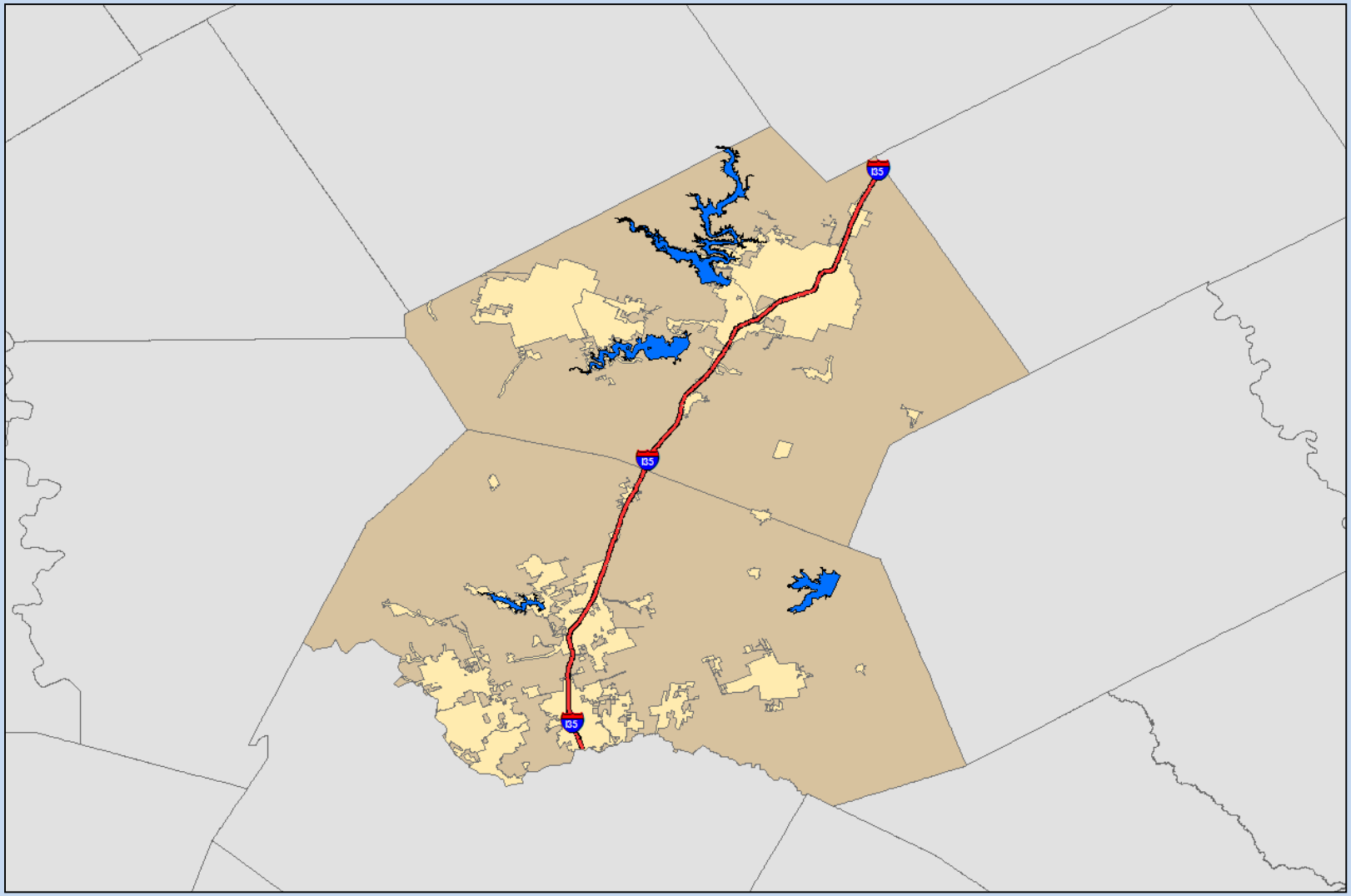
	Numeric Population Change from July 1, 2014 to July 1, 2015
Houston, TX	**159,083**
Dallas-Fort Worth, TX	**144,704**
Atlanta, GA	95,431
Phoenix, AZ	87,988
New York, NY-NJ-PA	87,186
Los Angeles, CA	85,671
Miami, FL	75,231
Washington, DC-VA-MD-WV	63,793
Seattle, WA	60,714
Orlando, FL	60,409
San Francisco-Oakland, CA	60,152
Denver, CO	58,474
Tampa-St. Petersburg, FL	57,412
Austin, TX	**57,395**
San Antonio, TX	**51,285**
Riverside-San Bernardino, CA	50,444
Charlotte, NC-SC	47,186
Las Vegas, NV	45,655
Portland, OR-WA	40,621
Nashville, TN	36,435

United States Census Bureau

U.S. Department of Commerce
Economics and Statistics Administration
U.S. CENSUS BUREAU
census.gov

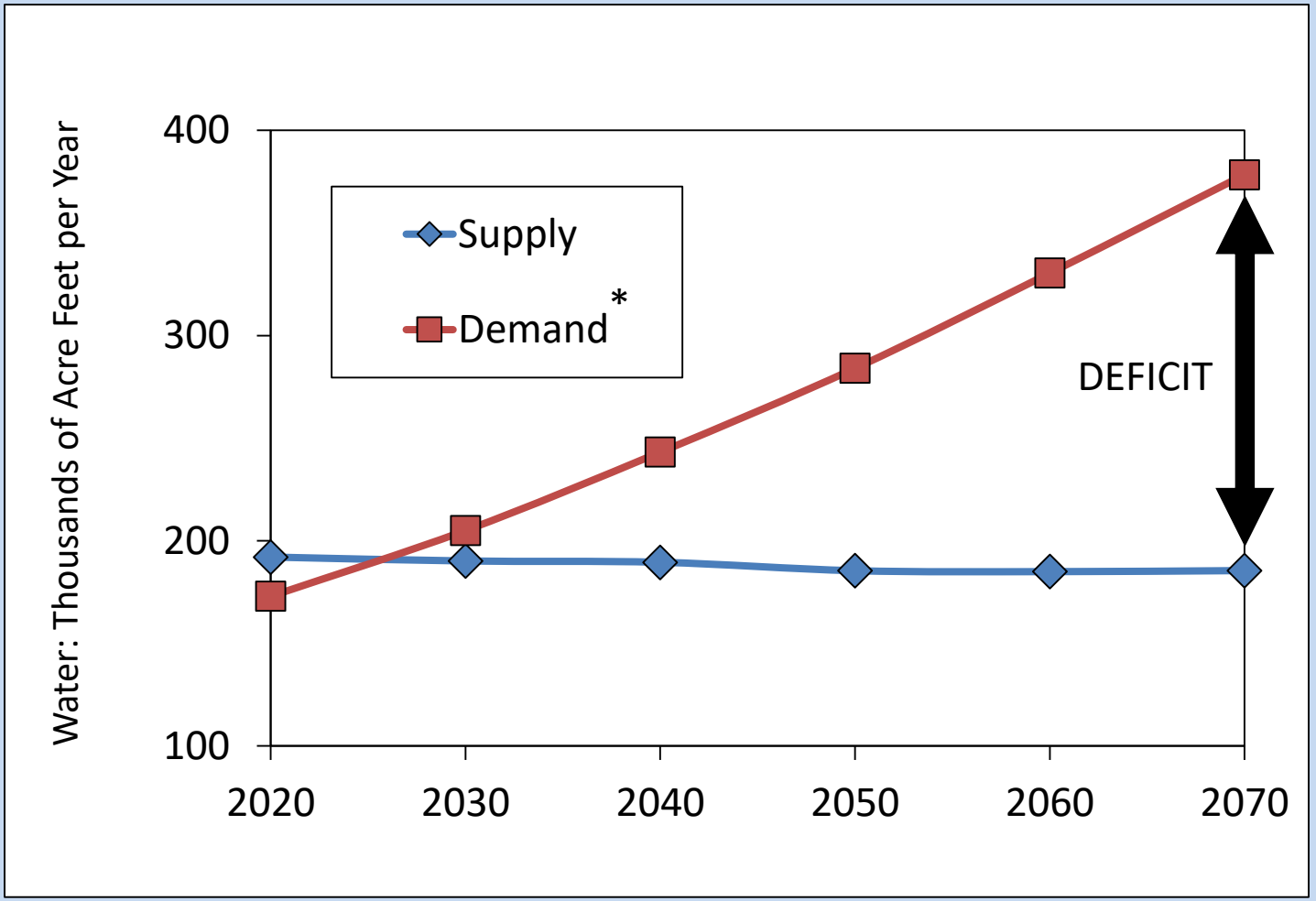
Source: Vintage 2015 Population Estimates
Some metro area titles have been abbreviated.
Metro areas are delineated by the Office of Management and Budget as of February 2013.

I35 Growth Corridor



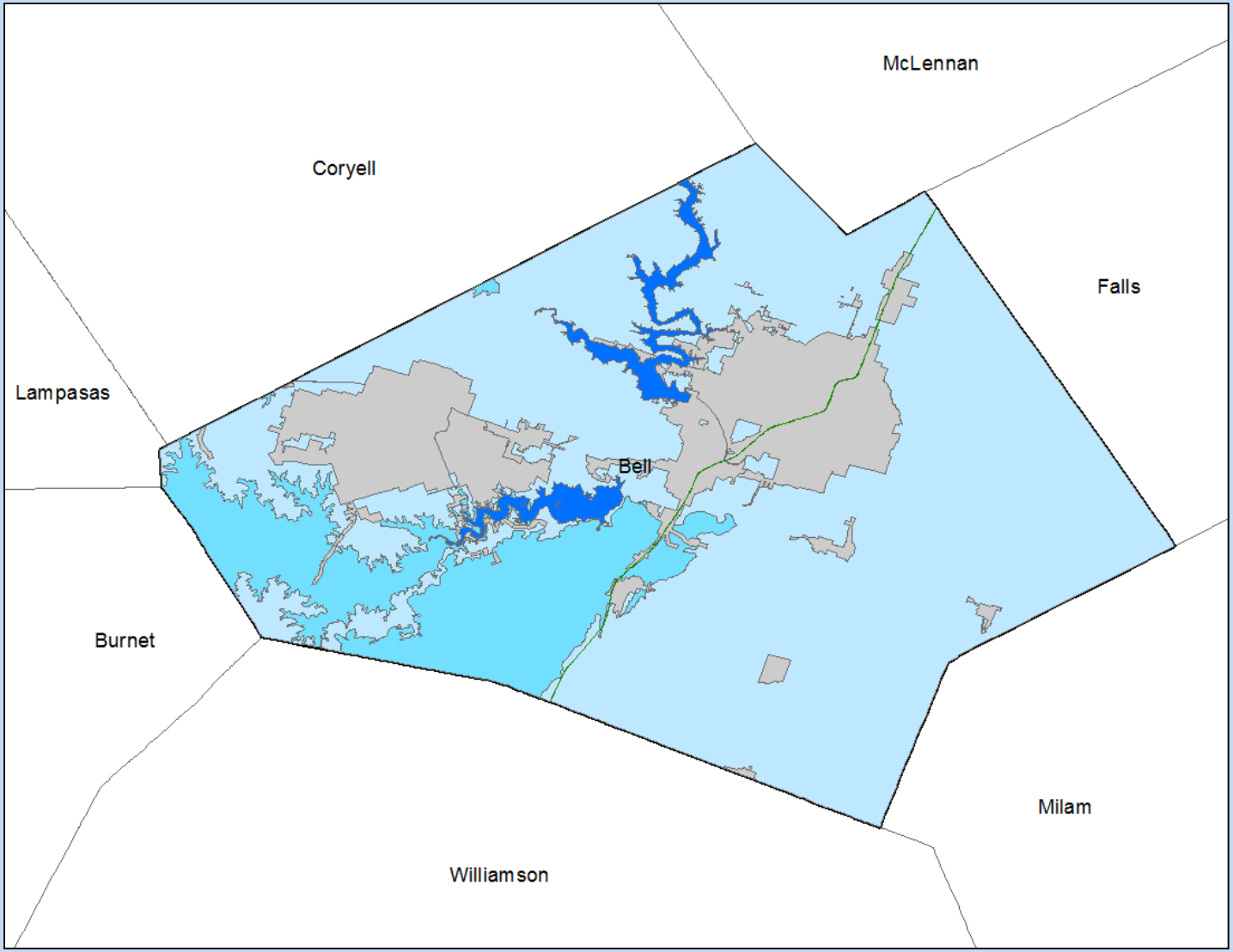
Projected water supply and demand

(Bell and Williamson Counties)



* Considering municipal, electric power, and mining sectors (TWDB, 2017)

Surface and Ground Water Sources



Aquifer Storage and Recovery (ASR)

Texas Water Development Board

Technical Note 15-04

AQUIFER STORAGE AND RECOVERY IN TEXAS: 2015

by

Matthew Webb

Texas Water Development Board

Report 358

Groundwater Availabilit
Northern Segment of the
Aquifer, Texas

by
Ian C. Jones, Ph.D., P.G.

December 2003

SUMMARY REPORT
for the
DEVELOPMENT OF A REGIONAL PLAN
FOR AQUIFER STORAGE AND RECOVERY
AND OFF CHANNEL STORAGE IN THE
GOLDEN CRESCENT REGION OF TEXAS

Submitted by:

THE CITY OF VICTORIA TEXAS

GBRA

Port of Victoria, Texas

Submitted to
Texas Water Development Board

Final Report

October 2014

TWDB Contract No. 1348321576

HOUSE RESEARCH ORGANIZATION
Texas House of Representatives

focus REPORT

Addressing water needs using aquifer storage and recovery

According to state water planners, large volumes of water storage will be needed to achieve cost-effective, sustainable, and reliable water supplies to meet projected future demands for Texas. Water storage traditionally has involved building new surface water reservoirs, often by damming rivers and streams, but policymakers increasingly are looking to another method known as aquifer storage and recovery (ASR). ASR involves collecting drinking water during wet periods and storing it underground in an aquifer through an injection well from which it can be drawn for use during periods of peak demand.

While surface reservoirs continue to feature prominently in the 2017 state water plan, adopted in May by the Texas Water Development Board (TWDB), many consider ASR to be more resistant than reservoirs to loss of water through evaporation, the expense of obtaining land for a reservoir, and destruction of wildlife habitat and private property. At the same time, some say a principal challenge to widespread implementing of ASR is a legal and regulatory framework for water policy that is not well adapted to this technology.

A few Texas municipalities have employed ASR for a number of years. According to the state water plan, by 2070 the volume of water available in Texas through ASR is projected to be 152,000 acre-feet per year, more than triple the amount estimated in the 2012 plan.

This report provides an introduction to ASR in Texas, including a history of ASR projects and a review of the regulatory structure that has evolved around the technology, including enactment of a new state law in 2015. It also examines uses for ASR, questions about the degree to which it could replace traditional, aboveground reservoirs, and some remaining challenges to its widespread implementation.

This report provides an introduction to ASR in Texas, including a brief history of ASR projects and a review of the regulatory structure that has evolved around the technology.

Number 84-8

An Assessment of Aquifer Storage and Recovery in Texas

Report
by
Malcolm Pirnie, Inc
ASR Systems, LLC
Jackson, Sjoberg, McCarthy & Wilson, LLP

In Cooperation with
El Paso Water Utilities Board
City of Kerrville, Texas
San Antonio Water System

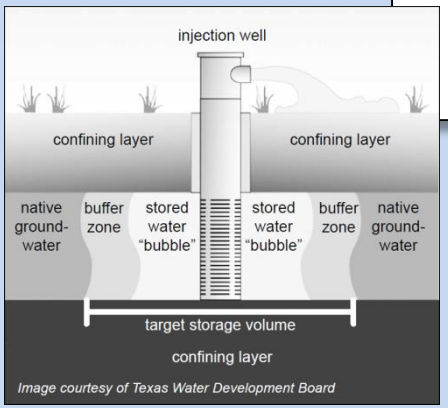
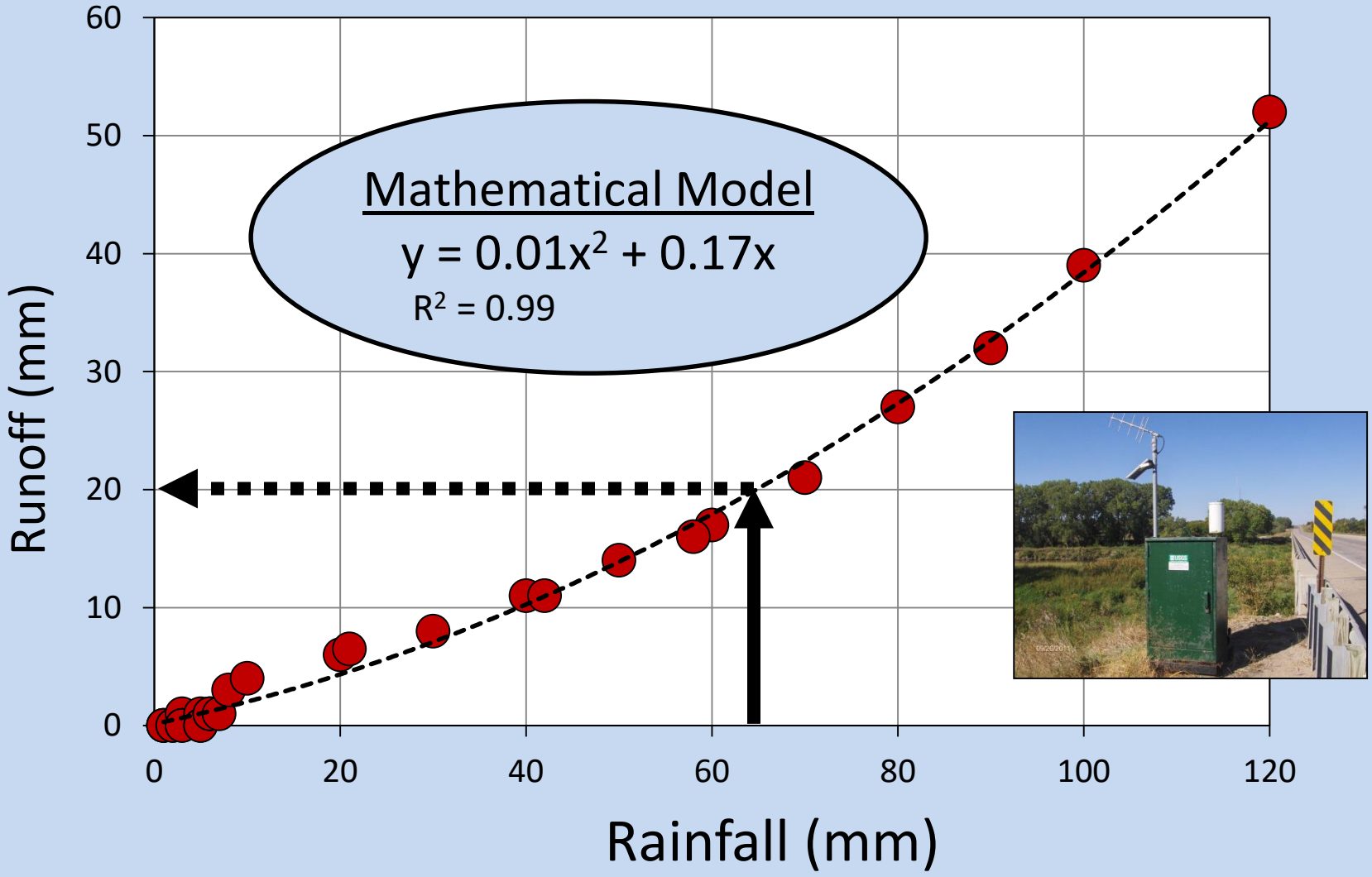


Image courtesy of Texas Water Development Board

Modeling: A tool for answering questions

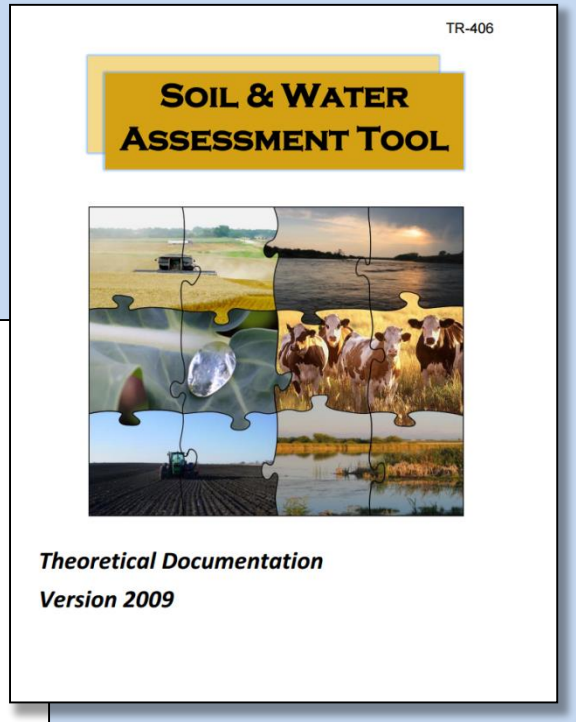
U. S. Army Corp of Engineers, Water Research Laboratory, Vicksburg, MS

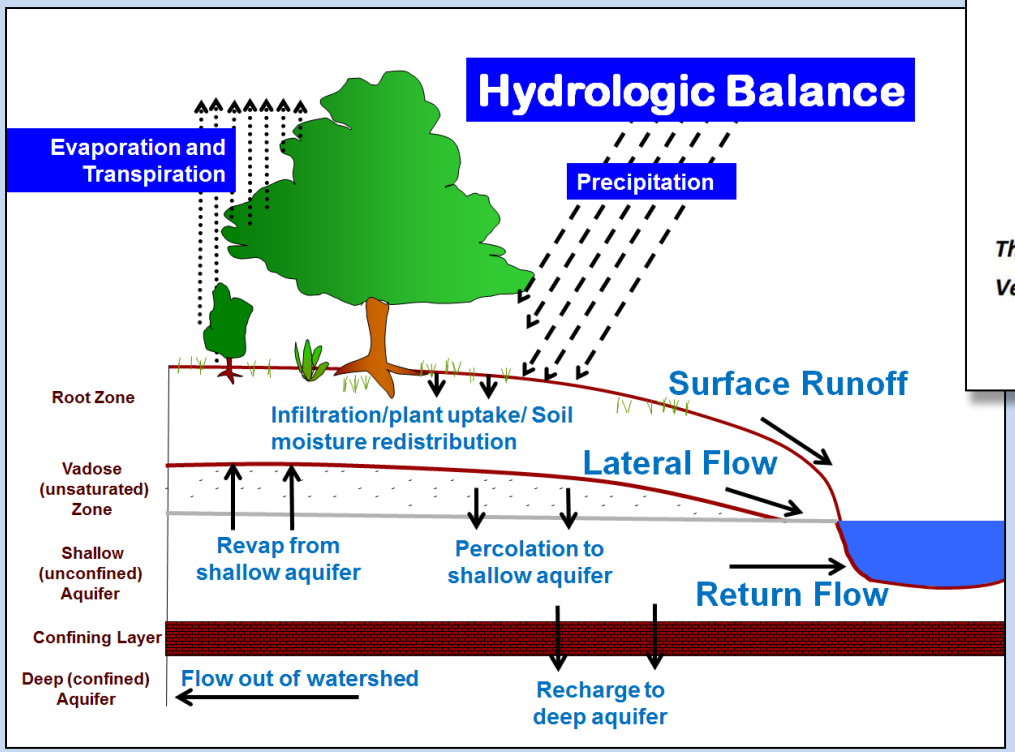
Modeling: A tool for answering questions



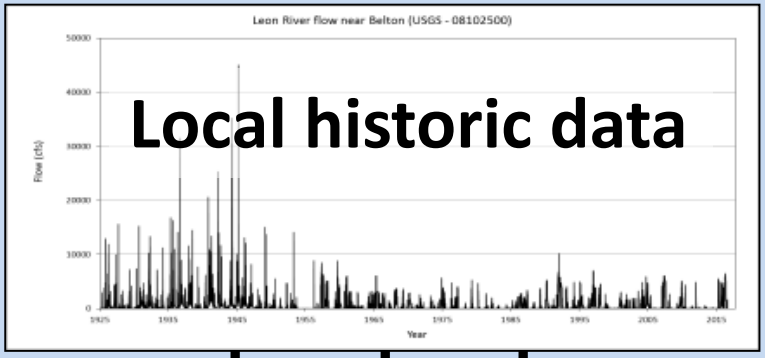
Soil and Water Analysis Tool (SWAT)

- USDA/ARS Hydrology model
- Computes hydrology and water quality
- Considers land management practices





Surface Water: Peeking into the future



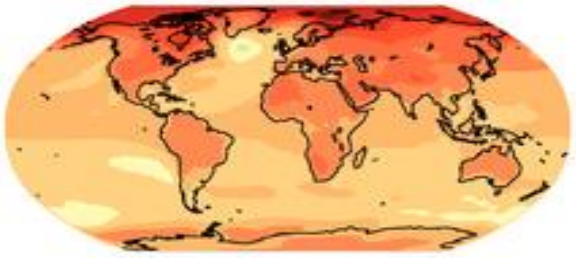
- *Precipitation*
- *Temperature*
- *Solar radiation*
- *Wind speed & direction*
- *Humidity*
- *Surface flows*

Surface water models

Soil & Water Assessment Tool | SWAT

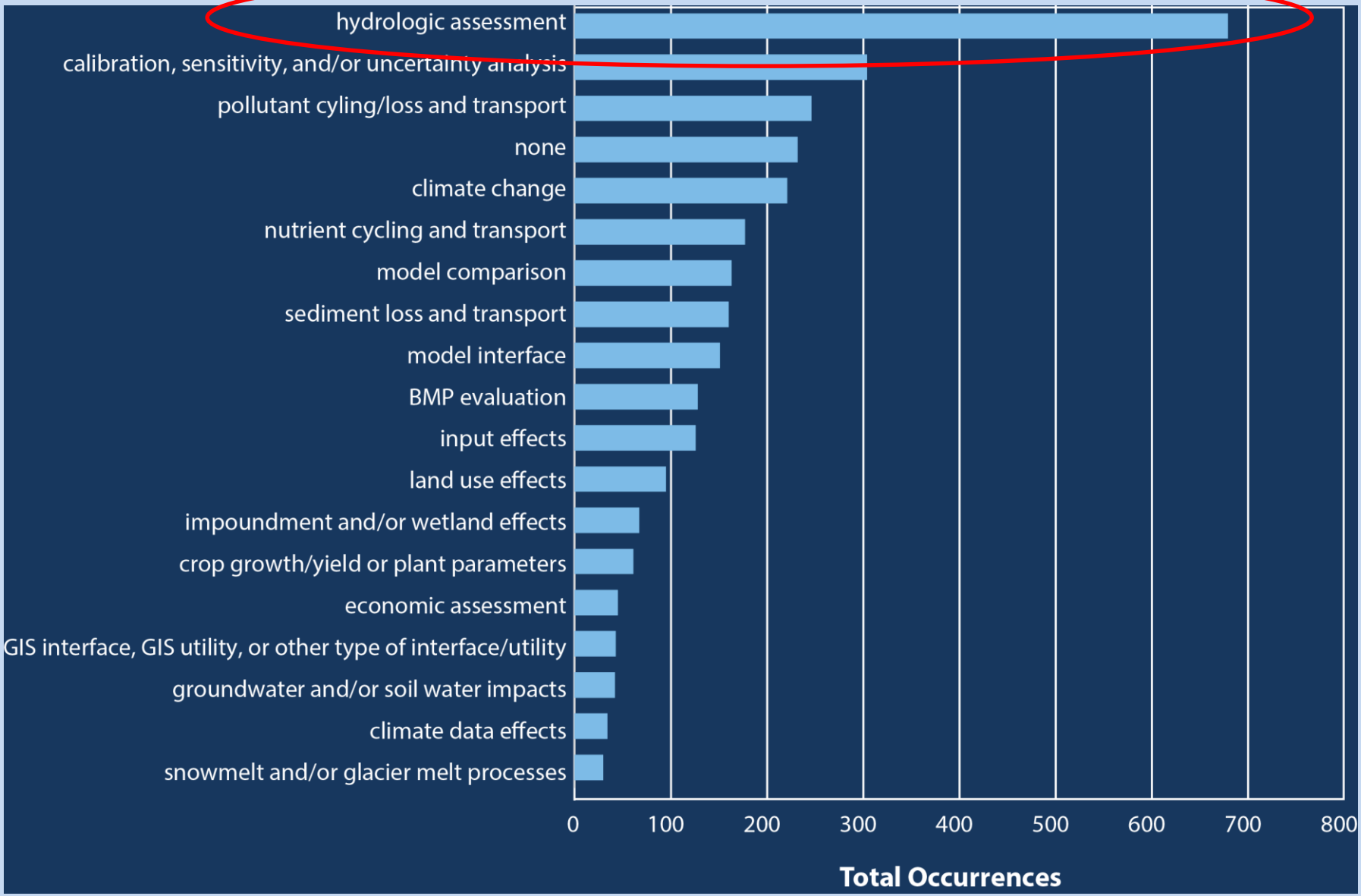
- ***Water quantity***
- *Water quality*
- *Constituent fate*

Global climate models



- *Downscaling*
- *Bias correction*
- ***Multiple scenarios***
- ***Probabilistic terms***

Research using SWAT

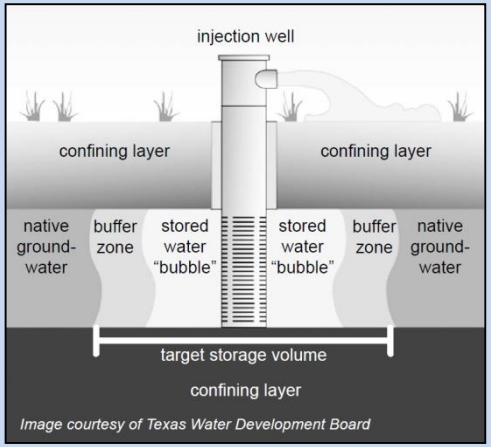


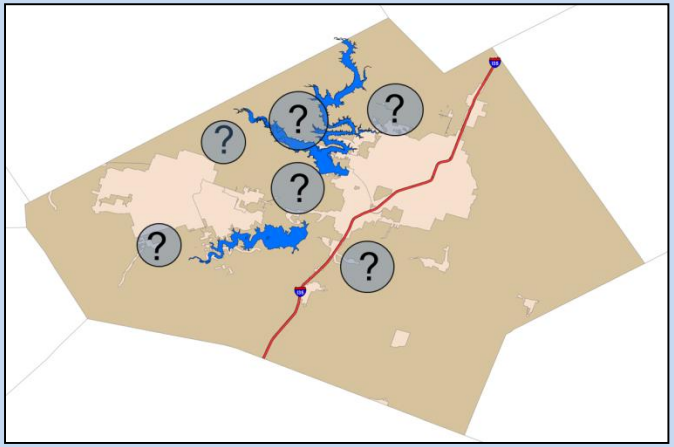
Is ASR feasible for Bell County?

- Will there be enough surface water available to apply ASR?
  - Given projected growth and water demands
  - Given local historical weather and stream flows

Surface water modeling can answer this question, but…

- Will our local aquifer characteristics support ASR?





ASR Feasibility: Can We Make it Work?

PART 2 – Groundwater Considerations

Gretchen Miller, Associate Professor

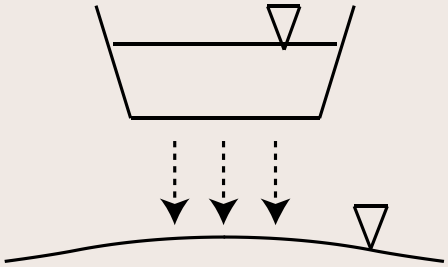
Zachry Department of Civil Engineering

Texas A&M University

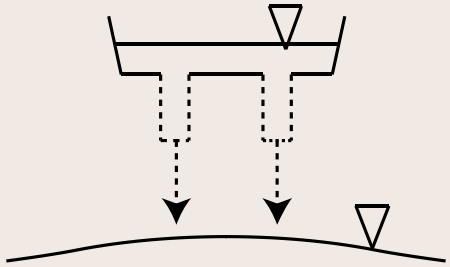
ENGINEERING
TEXAS A&M UNIVERSITY

Is ASR the right technique?

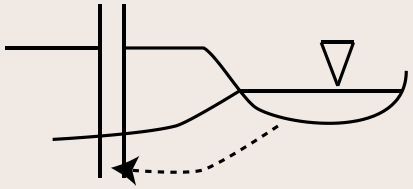
Infiltration Basins



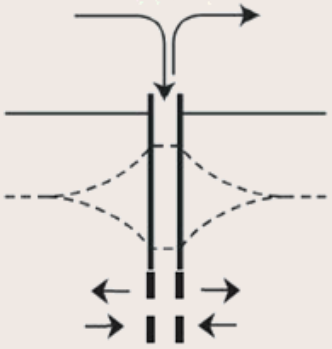
Dry Wells



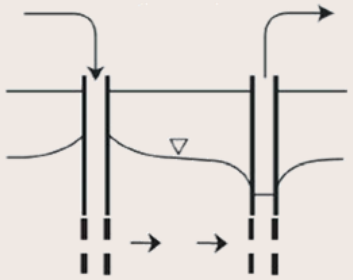
Bank Filtration



Aquifer Storage and Recovery (ASR)



Aquifer Storage, Transfer and Recovery (ASTR)



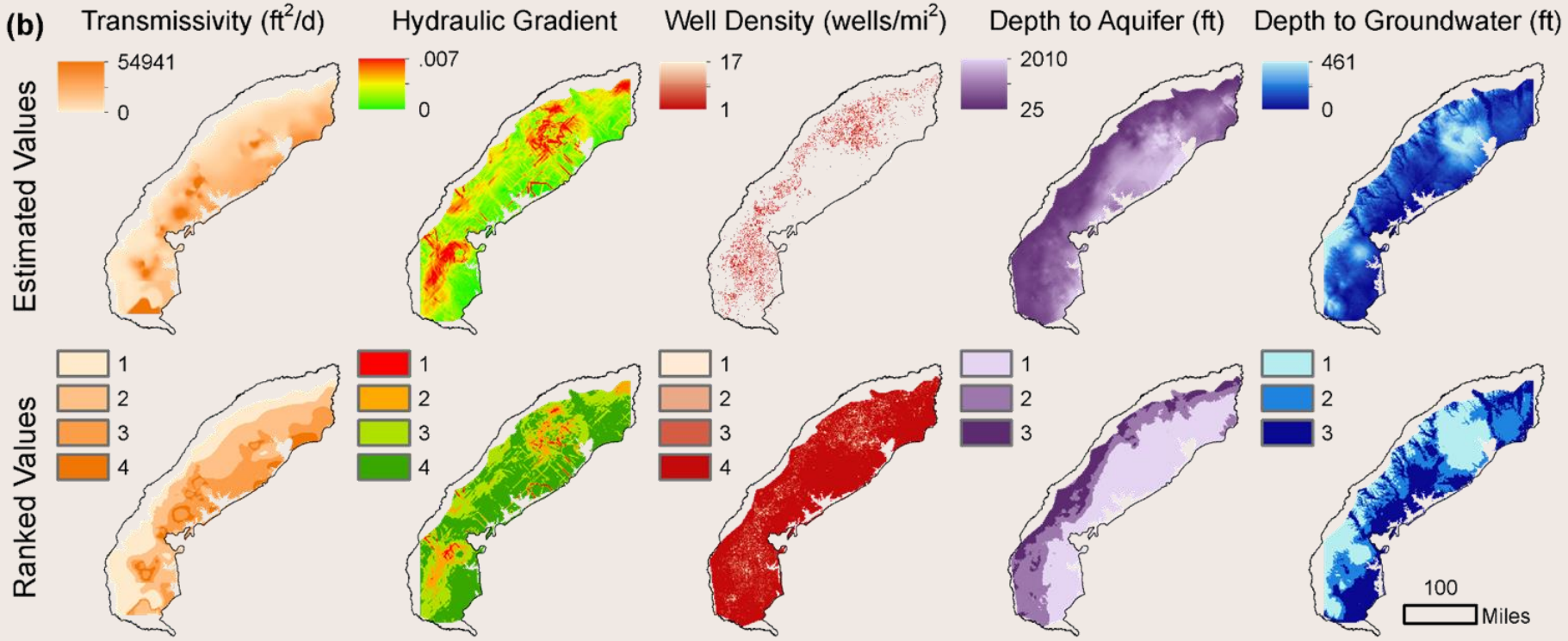
What makes an aquifer good for ASR*?

Criterion		More Desirable	Less Desirable
1: Transmissivity		50,000 - 80,000 gpd/ft	<8,000, >40,000 gpd/ft
2: Gradient and Direction		Natural gradients only	Strong artificial gradients present
3: Recharge Water Quality	Chloride TDS	<50 mg/L <100 mg/L	>200 mg/L >450 mg/L
4: Native Water Quality	Chloride TDS	<400 mg/L <700 mg/L	>6000 mg/L >10,000 mg/L
5: Plugging Potential	Total Iron Diss. Oxygen	<0.3 mg/L <1.5 mg/L	>1 mg/L >3 mg/L
7: Interfering Uses	Well Proximity Source Prox.	>5 mi >1 mi	<0.25 mi <0.25 mi
7: Aquitard Leakance		$< 1.2 \times 10^{-7}$ d^{-1}	$>1.2 \times 10^{-6}$ d^{-1}

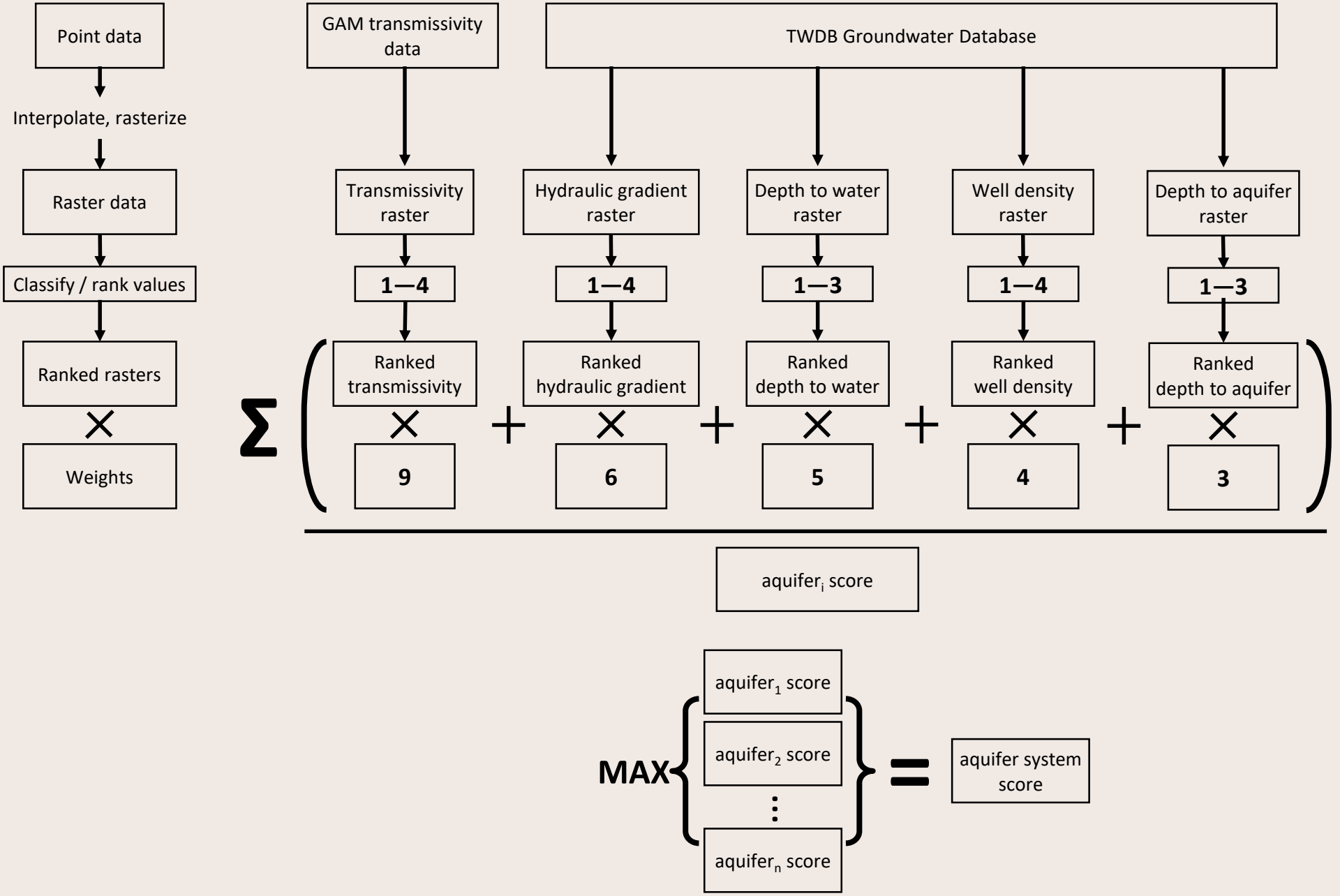
***One example assessment. Not written in (lime)stone.**

From Maliva and Missimer (2010) *Aquifer Storage and Recovery and Managed Aquifer Recharge Using Wells: Planning, Hydrogeology, Design, and Operation*. Example from Florida ASR study conducted by CH2M Hill

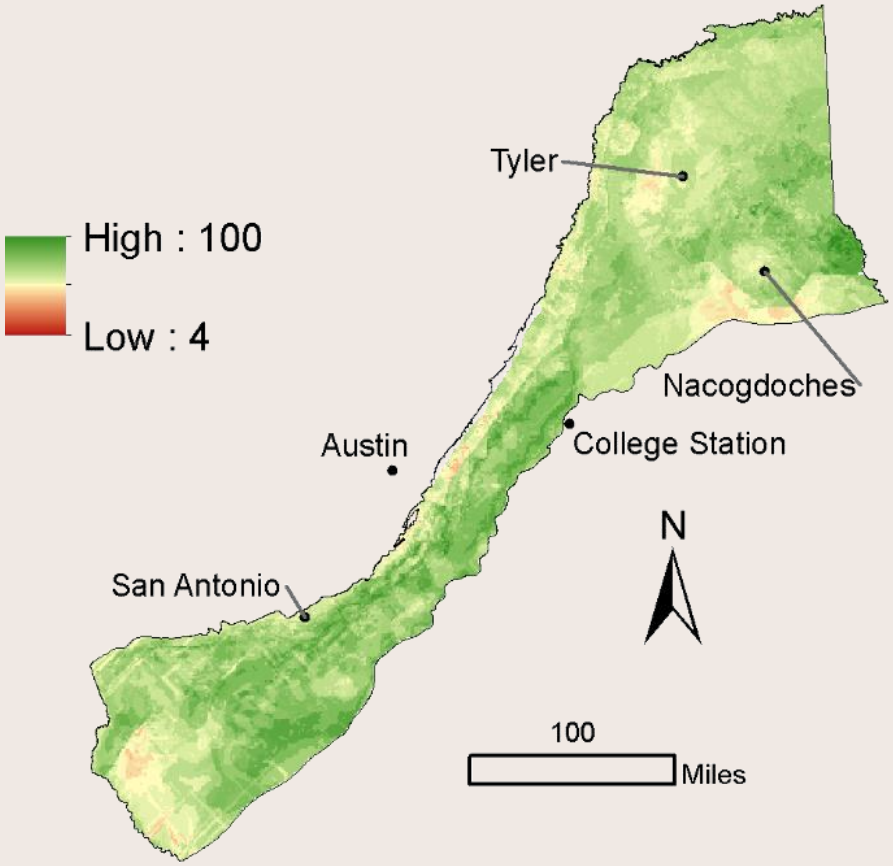
How do locations compare for ASR? Gulf Coast Example

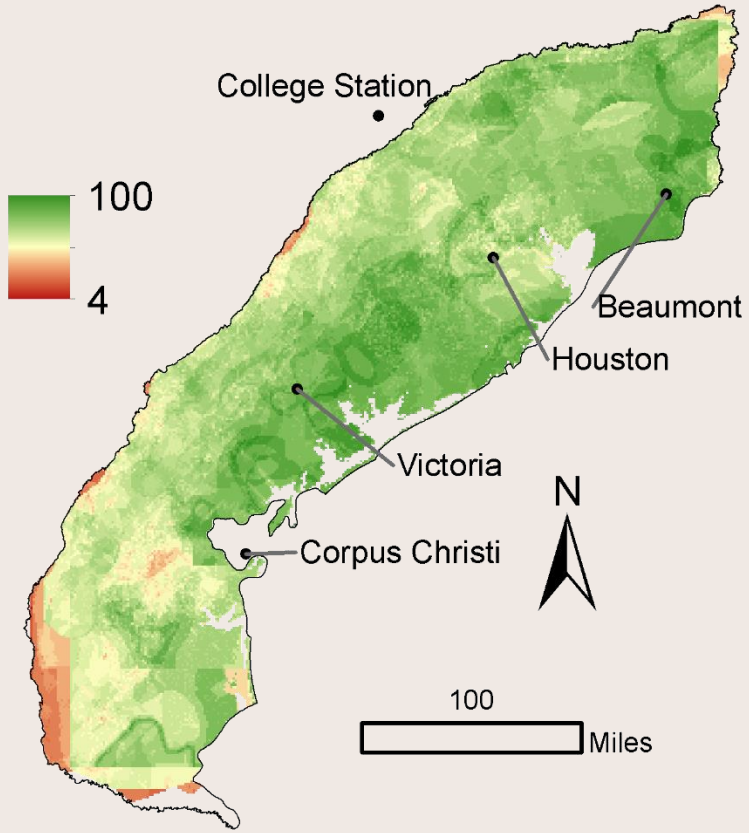


Smith et al. (2017). Assessing aquifer storage and recovery feasibility in the Gulf Coastal Plains of Texas, *Journal of Hydrology: Regional Studies*, doi:10.1016/j.ejrh.2017.10.007. (Open access)


Point data
Interpolate, rasterize
Raster data
Classify / rank values
Ranked rasters
Weights
GAM transmissivity data
TWDB Groundwater Database
Transmissivity raster
Hydraulic gradient raster
Depth to water raster
Well density raster
Depth to aquifer raster
1—4
1—4
1—3
1—4
1—3
Ranked transmissivity
Ranked hydraulic gradient
Ranked depth to water
Ranked well density
Ranked depth to aquifer
9
6
5
4
3
aquifer$_i$ score
MAX
aquifer$_1$ score
aquifer$_2$ score
aquifer$_n$ score
aquifer system score

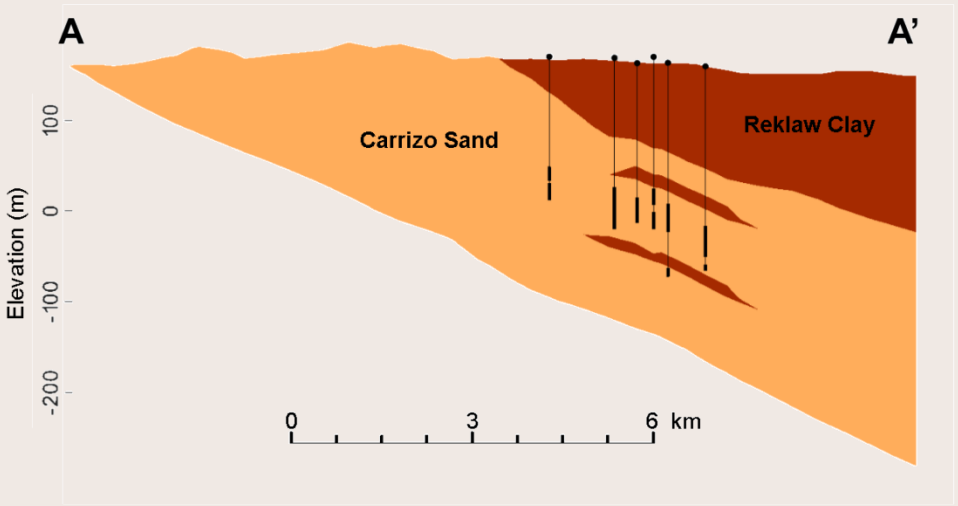
How do locations compare for ASR?

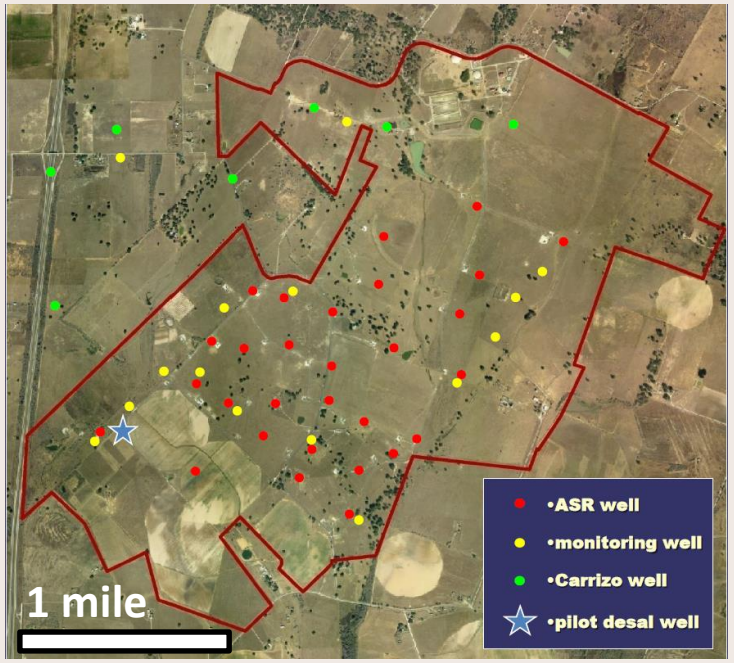


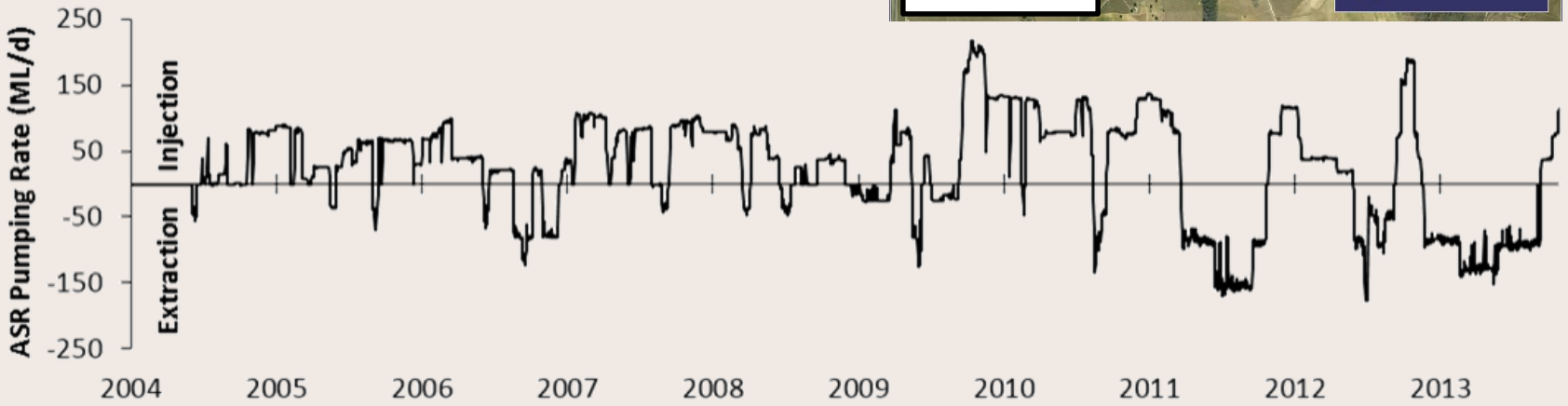


Smith et al. (2017). Assessing aquifer storage and recovery feasibility in the Gulf Coastal Plains of Texas, *Journal of Hydrology: Regional Studies*, doi:10.1016/j.ejrh.2017.10.007. (Open access)

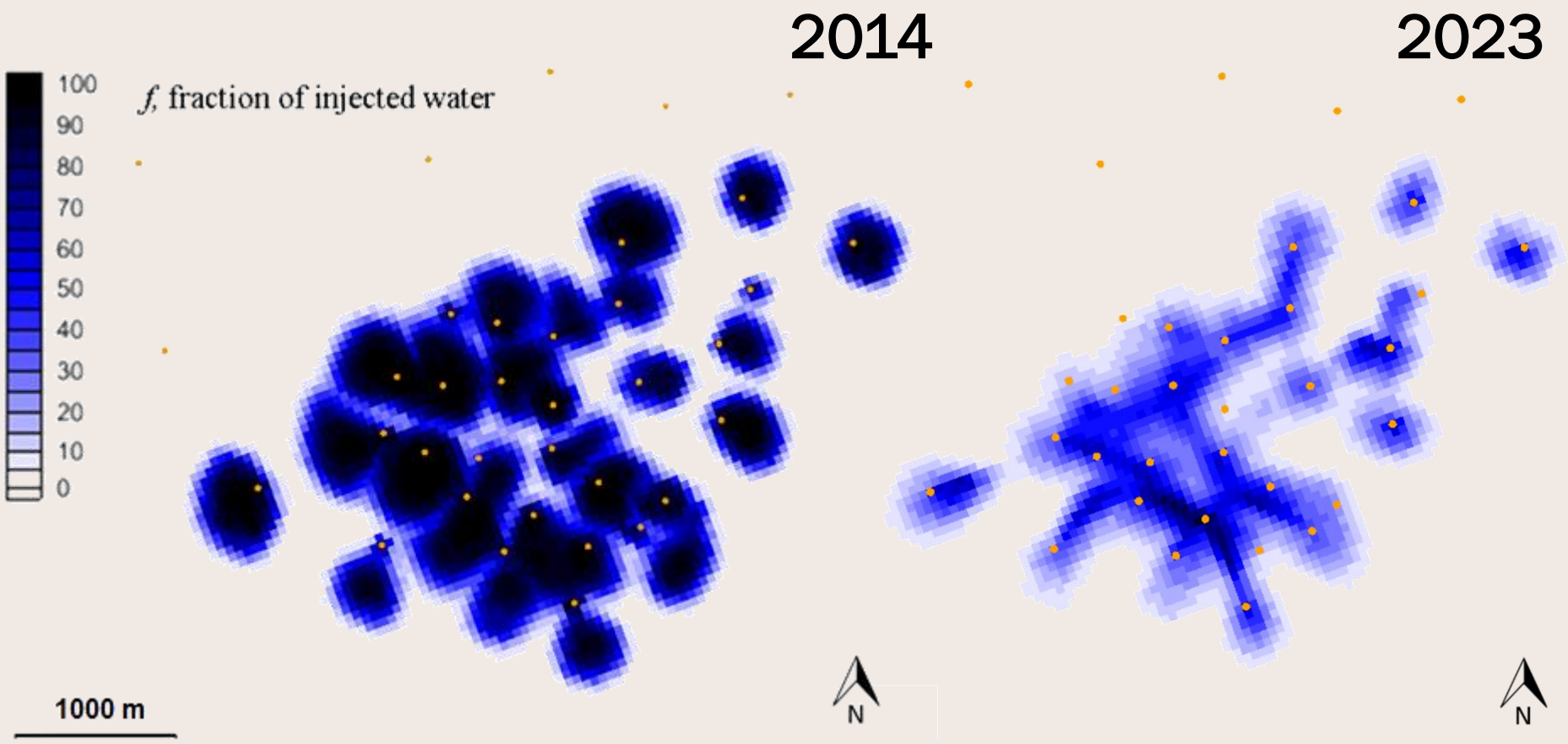
Can we recover quality water? SAWS Example







Can we recover quality water?



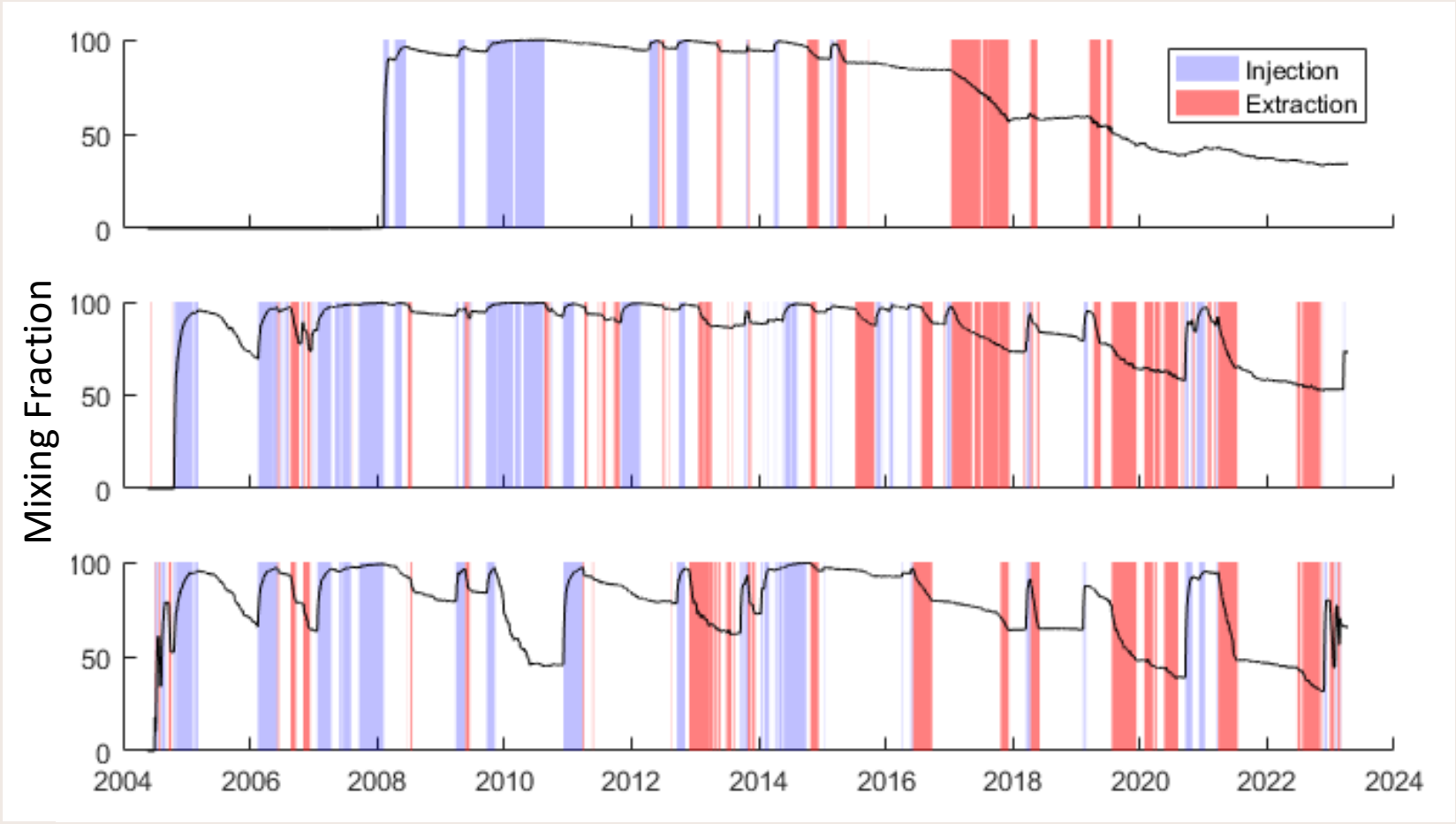
Smith et al. (in prep). Estimating the Performance of a Large, Multi-Well Aquifer Storage and Recovery System Using Transport Modeling, *for Submission to Ground Water.*

Can we recover quality water?

Center Well

Proximal Well

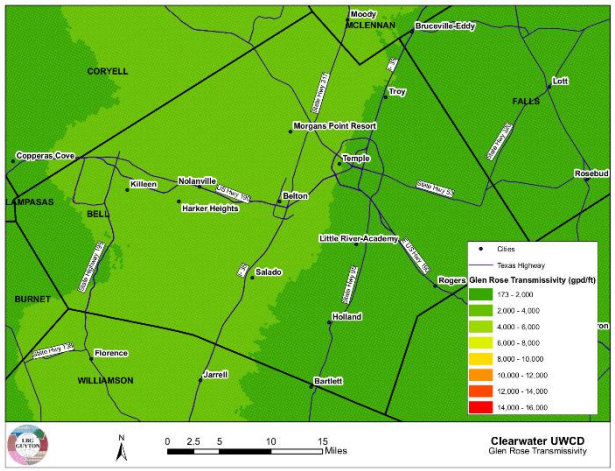
Distal Well



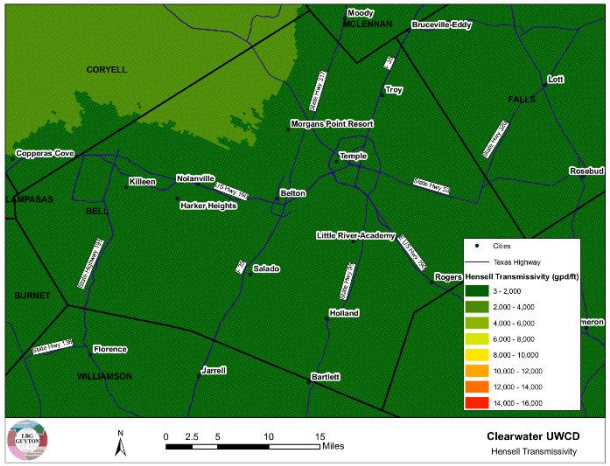
Smith et al. (in prep). Estimating the Performance of a Large, Multi-Well Aquifer Storage and Recovery System Using Transport Modeling, *for Submission to Ground Water.*

What about Bell County?

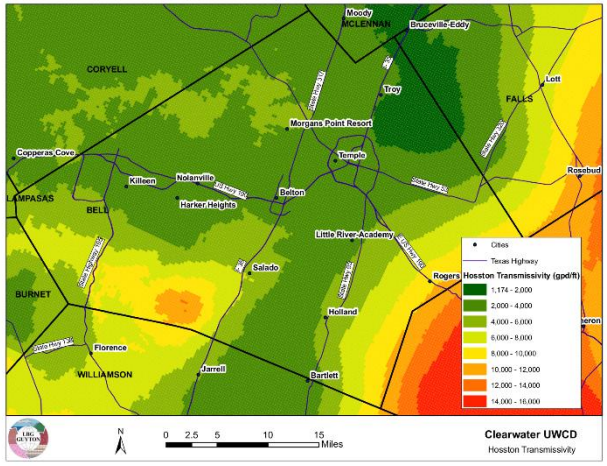
Upper Trinity (Glen Rose)



Middle Trinity (Hensell)



Lower Trinity (Hosston)

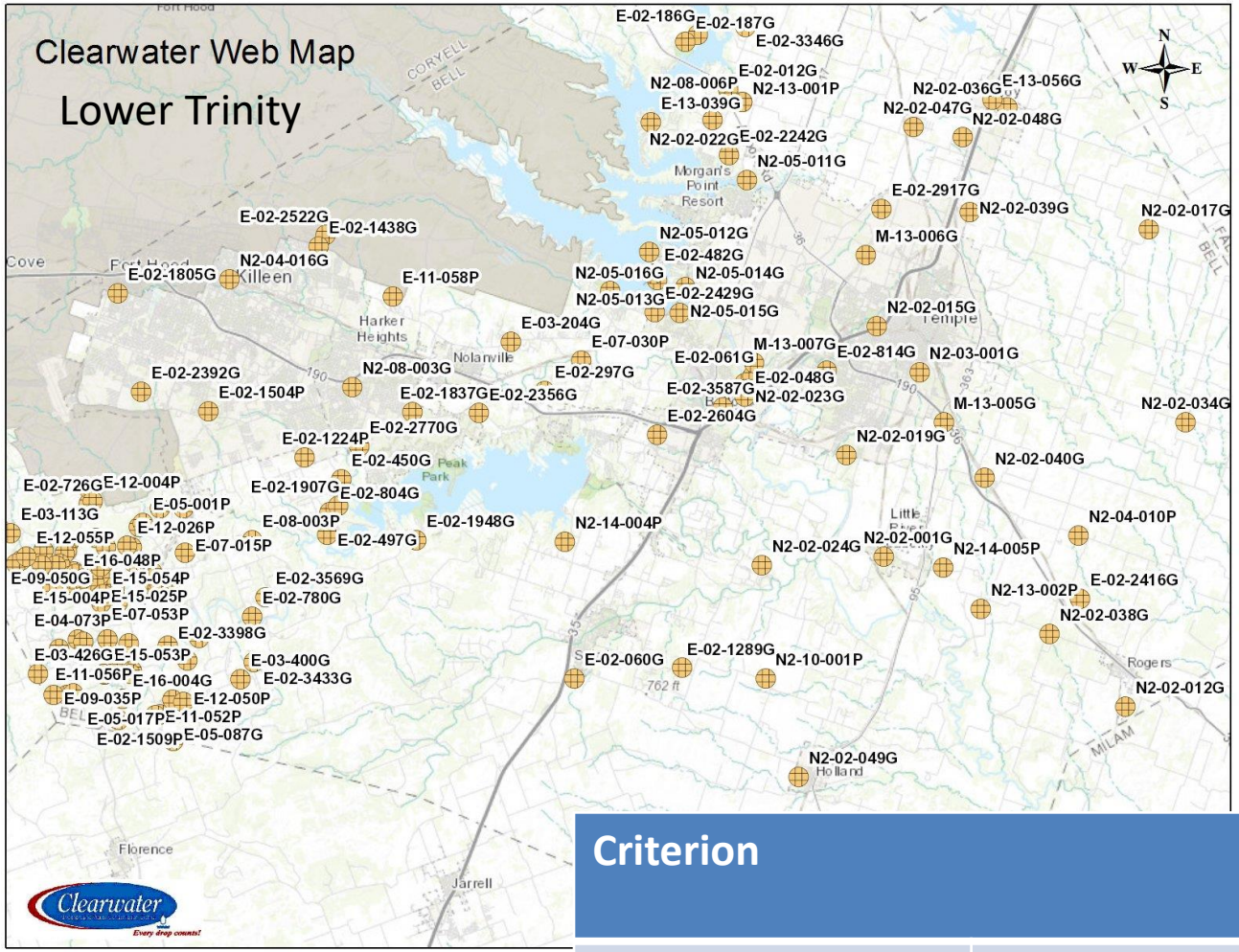


173 - 2,000
2,000 - 4,000
4,000 - 6,000
6,000 - 8,000
8,000 - 10,000
10,000 - 12,000
12,000 - 14,000
14,000 - 16,000

Criterion	More Desirable	Less Desirable
1: Transmissivity	50,000 - 80,000 gpd/ft	<8,000 or >40,000 gpd/ft

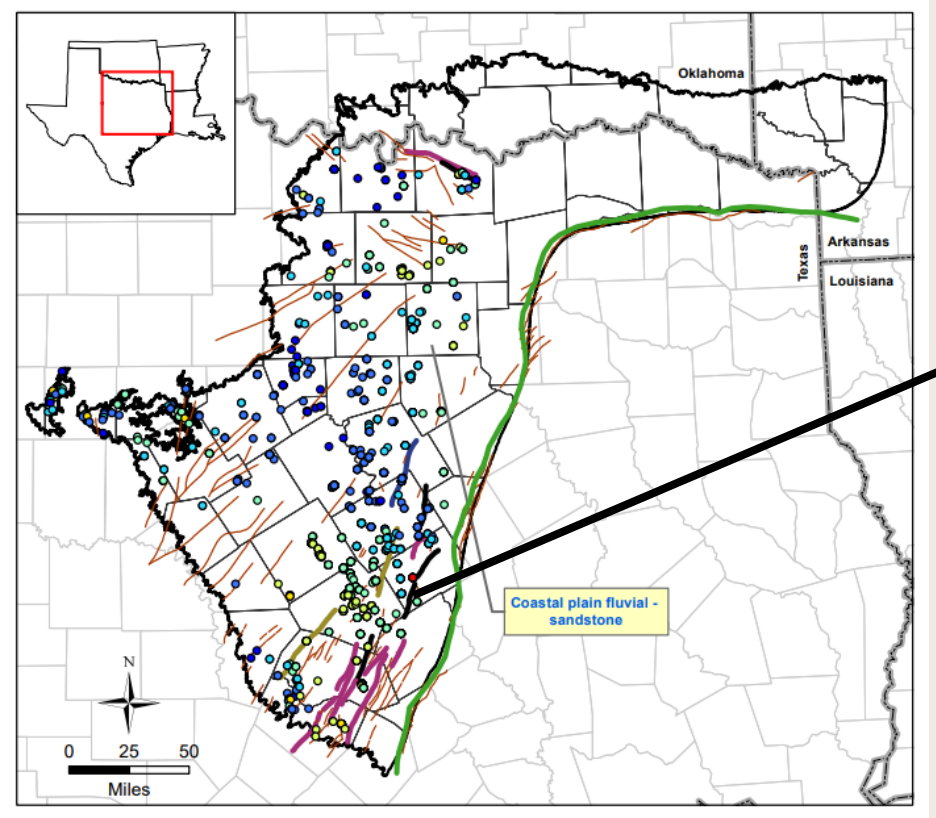
Maps from LBG Guyton

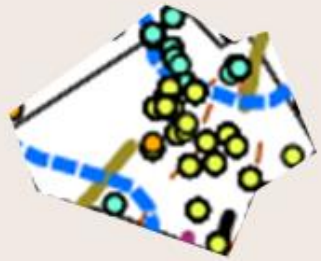
What about Bell County?



Criterion		More Desirable	Less Desirable
7: Interfering Uses	Well Proximity Source Prox.	>5 mi >1 mi	<0.25 mi <0.25 mi

What about Bell County?





Total Dissolved Solids (milligrams per liter)
Hosston Aquifer

< 250	1001 - 1500
251 - 500	1501 - 3000
501 - 1000	> 3000

Chloride Concentration (milligrams per liter)
Hosston Aquifer

< 20	251 - 500
21 - 50	501 - 1000
51 - 100	1001 - 2000
101 - 250	> 2000

Criterion		More Desirable	Less Desirable
4: Native Water Quality	Chloride TDS	<400 mg/L <700 mg/L	>6000 mg/L >10,000 mg/L

Maps from N. Trinity and Woodbine GAM Report, Intera (2014)

Questions?

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gretchen.r.miller@tamu.edu
979.862.2581