Study Results: Delineating Areas Designated or Used for Class II Well Wastewater Injectate

TAGD Winter Business Meeting

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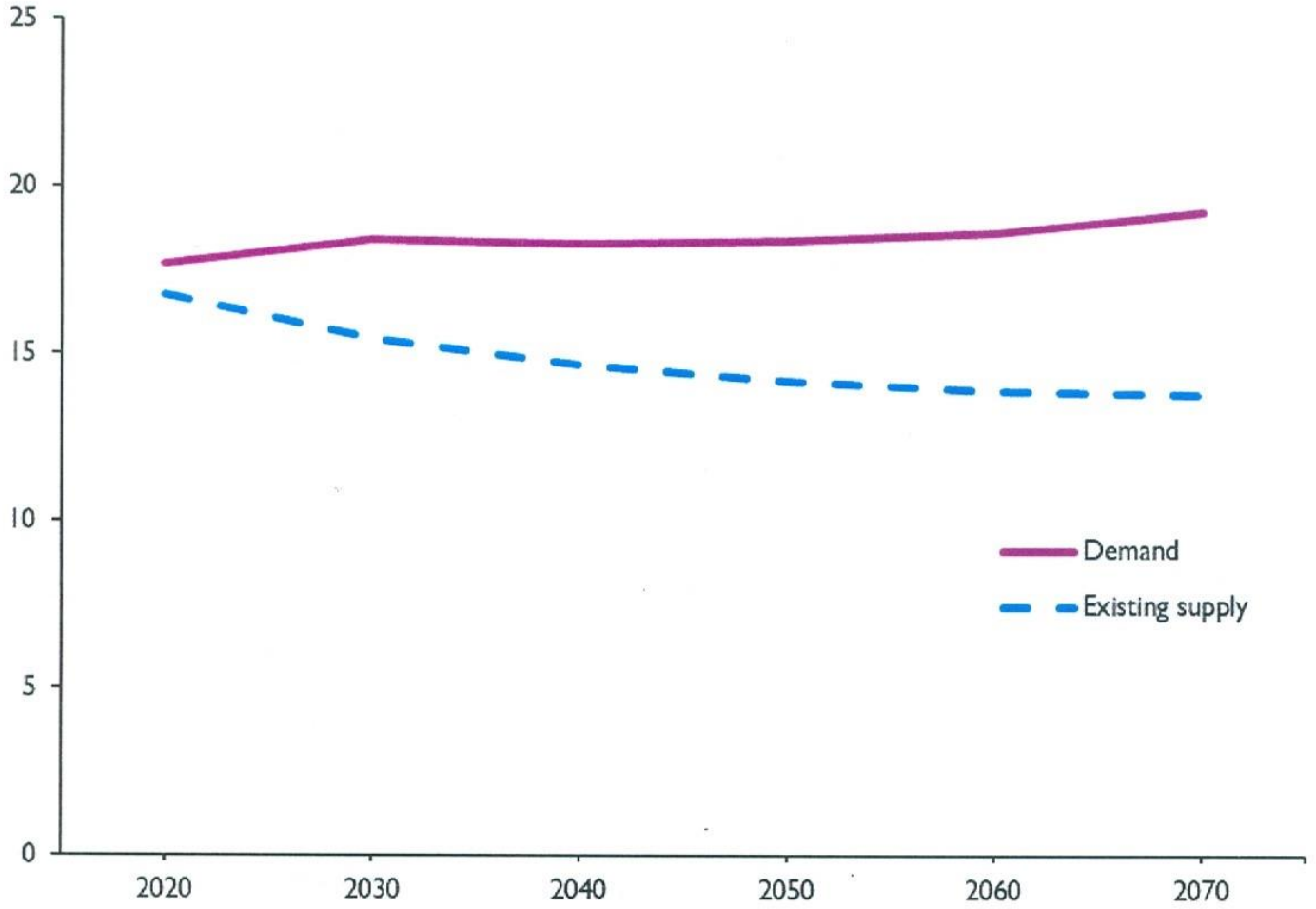
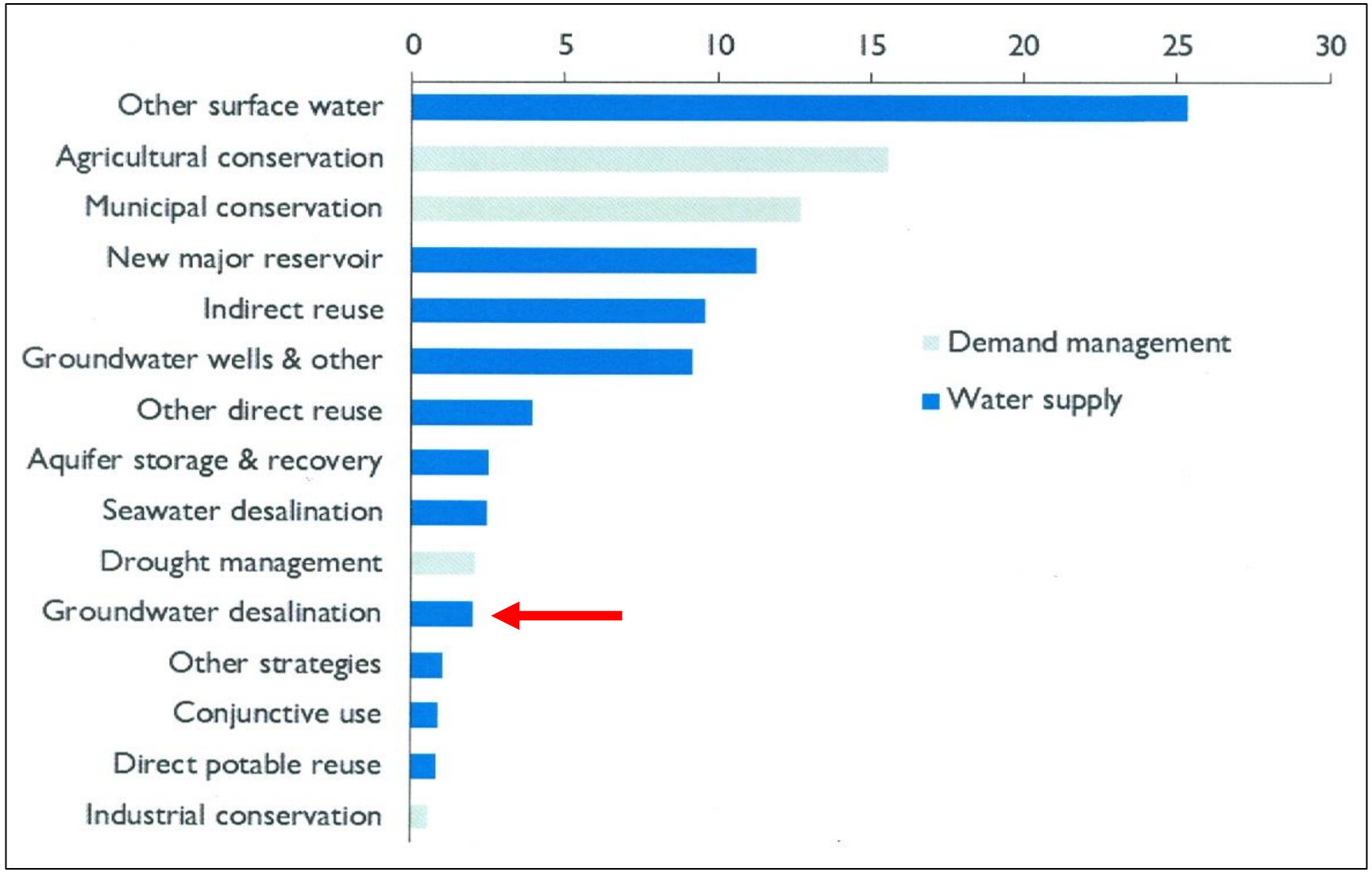
Background: Texas needs Water



Background: Texas needs Water



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HB 30: Requirements

- TWDB-BRACS Identifies and designates Brackish Groundwater Production Zones (BGPZs)
  - *BRACS = Brackish Resources Aquifer Characterization System*

- Determine the amount of brackish groundwater production from BGPZs over:
  - *a 30-year period,*
  - *a 50-year period; and*
  - *without causing significant impact to water availability or water quality*

- Make recommendations regarding reasonable monitoring
  - *to observe the effects of brackish groundwater production within the BGPZs*

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Statutory Requirements for BGPZ Designation

Must have brackish water	In areas of the state with moderate to high availability and productivity
Must have hydrogeologic barriers	Sufficient to prevent significant impacts to freshwater availability or quality
Cannot be within these boundaries	Edwards Aquifer within the Edwards Aquifer Authority, Barton Springs-Edwards Aquifer Conservation District, Harris-Galveston Subsidence District, Fort Bend Subsidence District, and Dockum Aquifer
Cannot be already in use	Brackish water already serving as a significant source of water supply for municipal, domestic or agricultural
Cannot be used for wastewater injection	Permitted under Title 2 of Texas Water Code, Chapter 27 [Class II Underground Injection Control (UIC) Wells used for saltwater disposal (SWD)]

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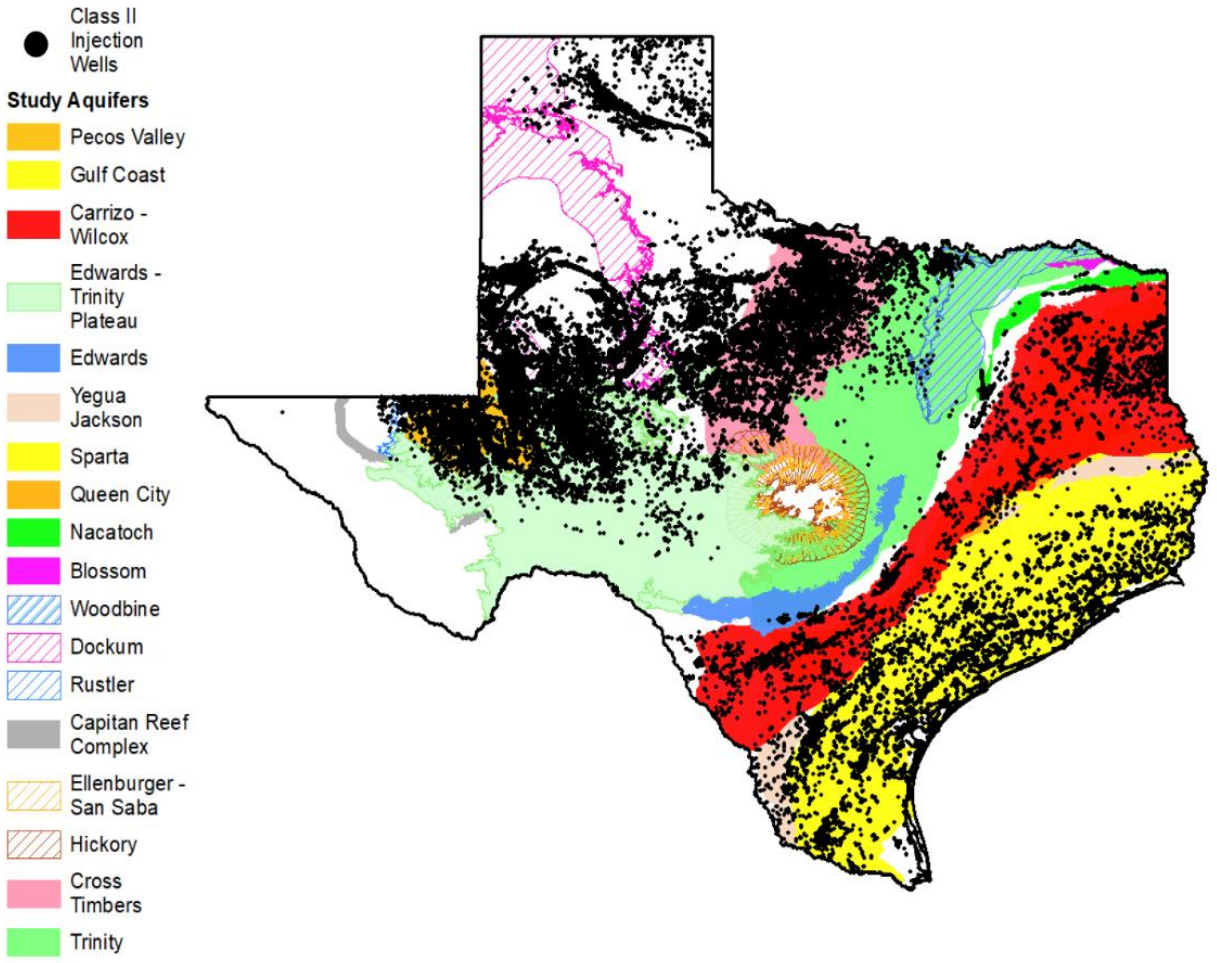
Statutory Requirements & Criteria for BGPZ



Class II wells are potentially injecting wastewater into the brackish portions of Texas Aquifers

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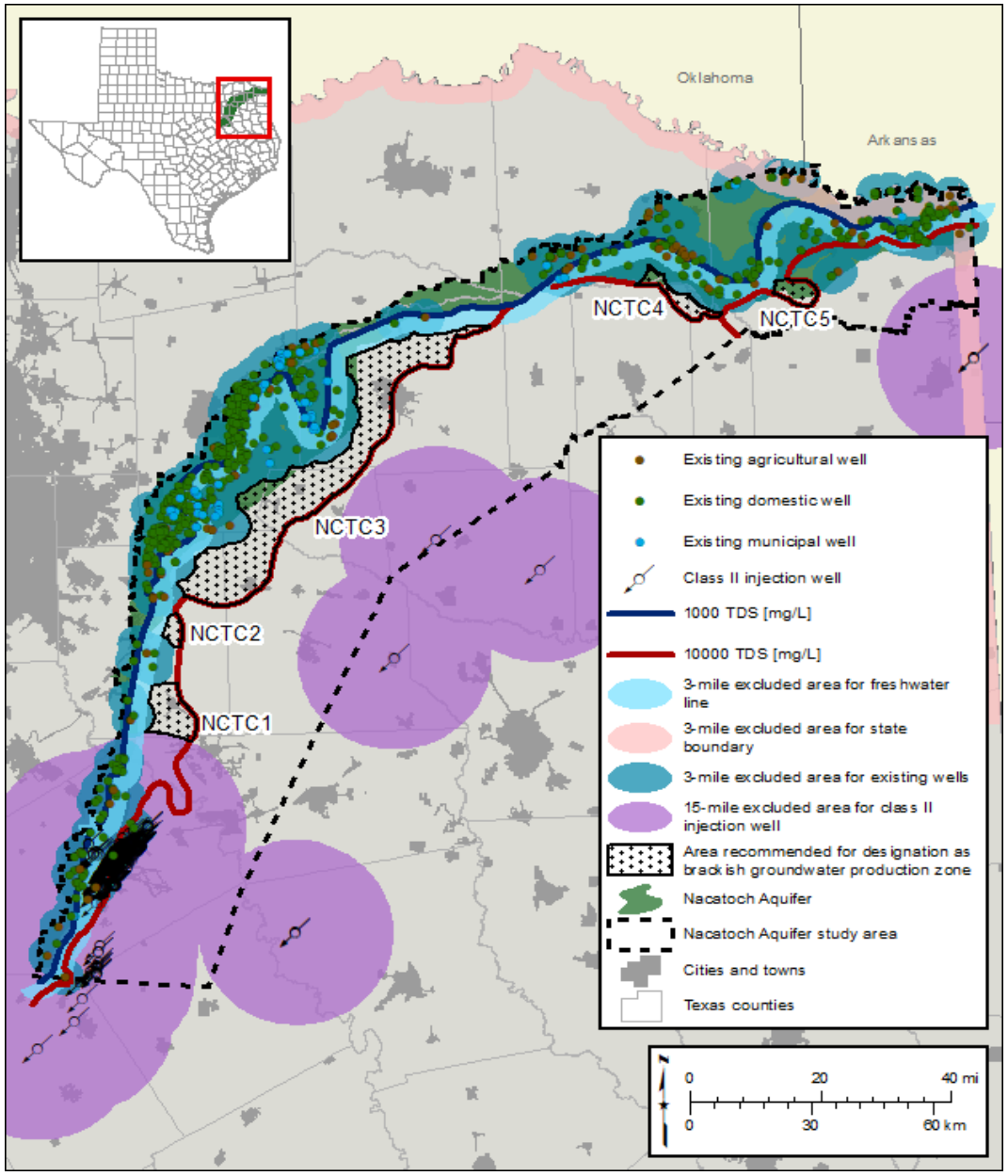
Aquifer BGPZ Example



- Previous BRACS studies applied 15-mile buffer to all class II wells injecting into aquifer study areas.

- Stakeholders pushed back on the 15-mile buffer designation
  - *too conservative*
  - *scientifically defensible?*

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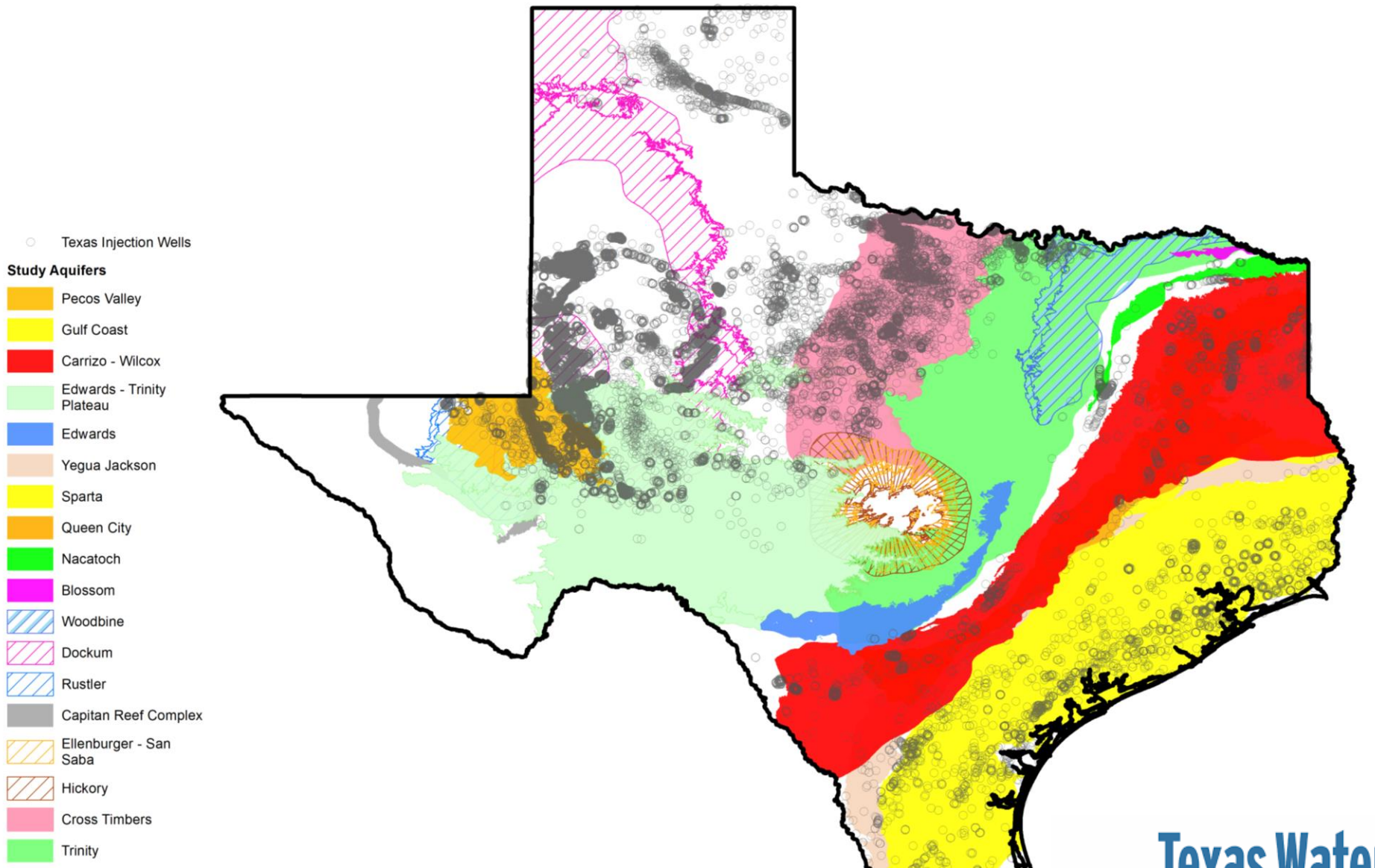
Aquifer Assessment



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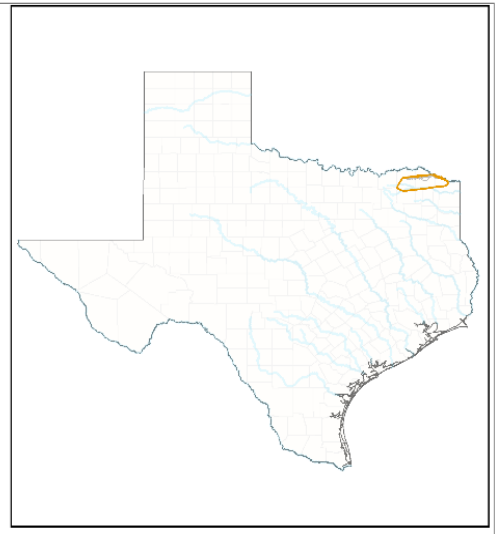
Aquifer Assessment Maps

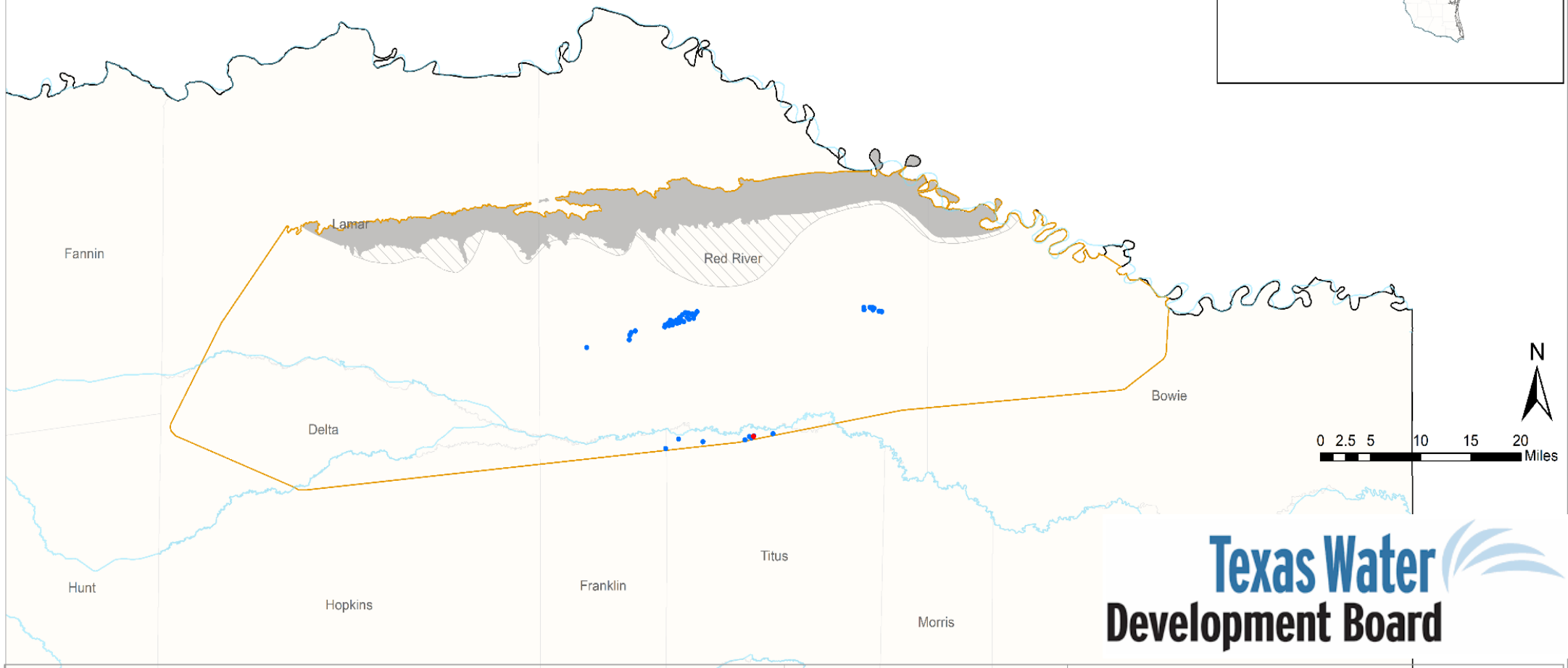
- Wells Potentially Injecting Into Blossom
- Wells Injecting Above Blossom
- Wells Injecting Below Blossom
- Wells With Anomalous Data

- BRACS Study Area
- Major Rivers
- Counties

- Blossom (outcrop)
- Blossom (subcrop)

		Official Aquifer Boundary	BRACS Study Area
●	Wells Potentially Injecting Into Blossom	0	1
●	Wells Injecting Above Blossom	0	0
●	Wells Injecting Below Blossom	0	49
●	Wells With Anomalous Data	0	0
	Total	0	50





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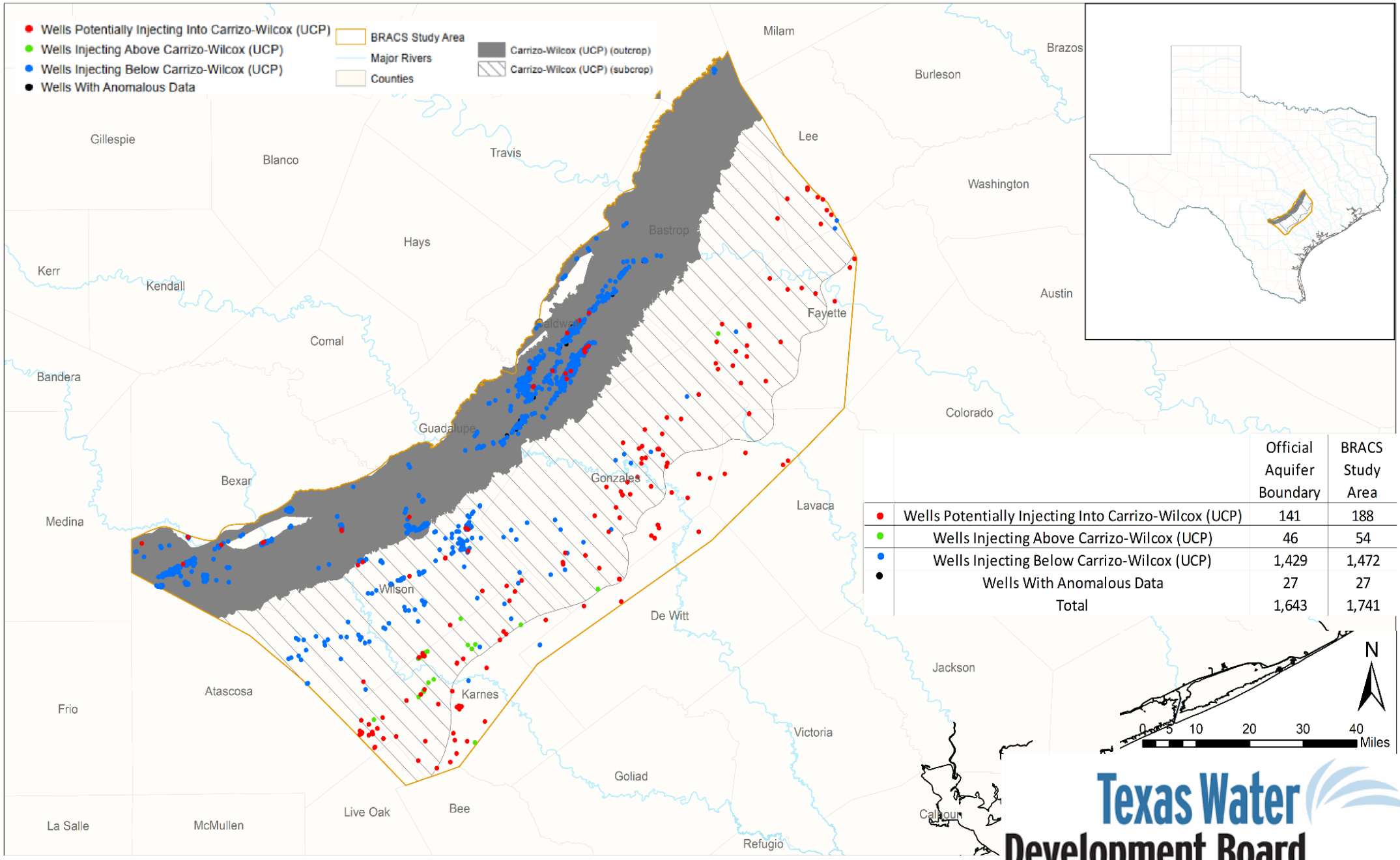
Aquifer Assessment Maps



	Official Aquifer Boundary	BRACS Study Area
Wells Potentially Injecting Into Carrizo-Wilcox (UCP)	141	188
Wells Injecting Above Carrizo-Wilcox (UCP)	46	54
Wells Injecting Below Carrizo-Wilcox (UCP)	1,429	1,472
Wells With Anomalous Data	27	27
Total	1,643	1,741

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Aquifer Assessment
Master Table – default aquifer parameters

S.No	Aquifer Name	Layers	Kx (ft/day)				Ky (ft/day)				Kz (ft/day)				Effective Porosity				Transmissivity (ft^2/day)			
			Min	Max	Mean	Median	Min	Max	Mean	Median	Min	Max	Mean	Median	Min	Max	Mean	Median	Min	Max	Mean	Median
1	Nacatoch	Layer 2 - Nacatoch	2.5	9.5	5	6	2.5	10	5	6	0.3	1	0.5	0.6	0.1	0.1	0.1	0.1	125	4,150	1,400	2,100
2	Trinity (northern section)	Layer 1 - Shallow outcrop Northern Trinity	0.03	100	15	2	0.03	100	15	2	1.0E-04	9.1	1	0.2	0.01	0.01	0.01	0.01	2.324	34,000	1,313	752
		Layer 4 - Paluxy Formation	0.01	9.1	1.5	1.2	0.01	9.1	1.5	1.2	0.006	9.1	1.1	1.2	0.01	0.01	0.01	0.01	0.03	802	82	18
		Layer 5 - Glen Rose Formation	0.2	9.1	1.3	1.3	0.2	9.1	1.3	1.3	0.2	9.1	1	1	0.01	0.01	0.01	0.01	388	194	142	27
		Layer 6 - Hensell Member	0.02	9	3	3	0.02	9	3	3	0.2	9	0.9	0.9	0.01	0.01	0.01	0.01	1	206	168	46
		Layer 7 - Pearsall/Cow Creek/Hammett members	0.01	9	1	1.4	0.01	9	1	1.4	0.009	9	0.6	0.6	0.01	0.01	0.01	0.01	0.3	610	99	14
		Layer 8 - Hosston Member	0.6	9.1	3.2	3.2	0.6	9.1	3.2	3.2	4.0E-06	9.1	0.5	0.5	0.01	0.01	0.01	0.01	18	4,276	509	194
3	Blossom	_	2.7	7.0	4.4	3.7	_	_	_	_	_	_	_	_	_	_	_	_	85.0	550.0	290.0	205.0
4	Carrizo-Wilcox (southern section)	Layer 3 -Carrizo	1.0E-04	13	1.0	0.5	1.0E-04	13	1.0	0.5	1.0E-04	13	1.0	0.5	0.01	0.01	0.01	0.01	0.03	8,536	920	270
		Layer 4 - Upper Wilcox	1	1	1	1	1	1	1	1	1	1	1	1	_	_	_	_	11	1,085	303	210
		Layer 5- Middle Wilcox	0.1	83	10	3	0.1	83	10	3	0.1	83	10	3	0.01	0.01	0.01	0.01	77	59,088	6,285	1,902
		Layer 6- Lower Wilcox	0.3	3	1.8	3	0.3	3	1.8	3	0.3	3	1.8	3	0.01	0.01	0.01	0.01	6	3,615	786	116

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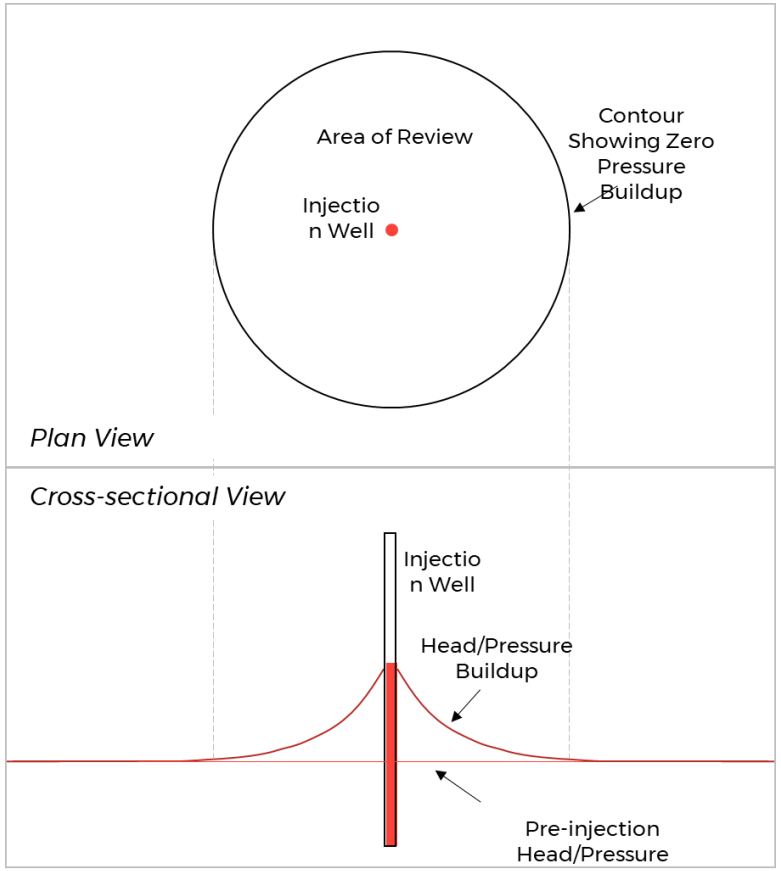
Potential Mapping Techniques

1. Analytical solutions (Preferred method):
   - *Stable*
   - *Easy-to-use*
   - *Simplifying assumptions but exact solutions*
   - *EPA (1994), Bear & Jacobs (1965)*
   - *Applicable on a regional scale*

2. Numerical solutions :
   - *Accommodate complex systems*
   - *Intensive data requirements*
   - *potentially unstable, require advanced users*
   - *Modflow 6*
   - *Applicable on a small/local scale*

Current EPA procedure is to calculate
"Zone of Endangering Influence"



Proposed Methods: Two-tiered – Analytical Solutions

- Tier 1 Analysis (no flow direction)
  - *EPA (1994)*
  - *Bear and Jacobs (1965)*
  - *Compute maximum migration extent*

$$r(t) = \left(\frac{Qt}{\pi\phi b}\right)^{1/2}$$

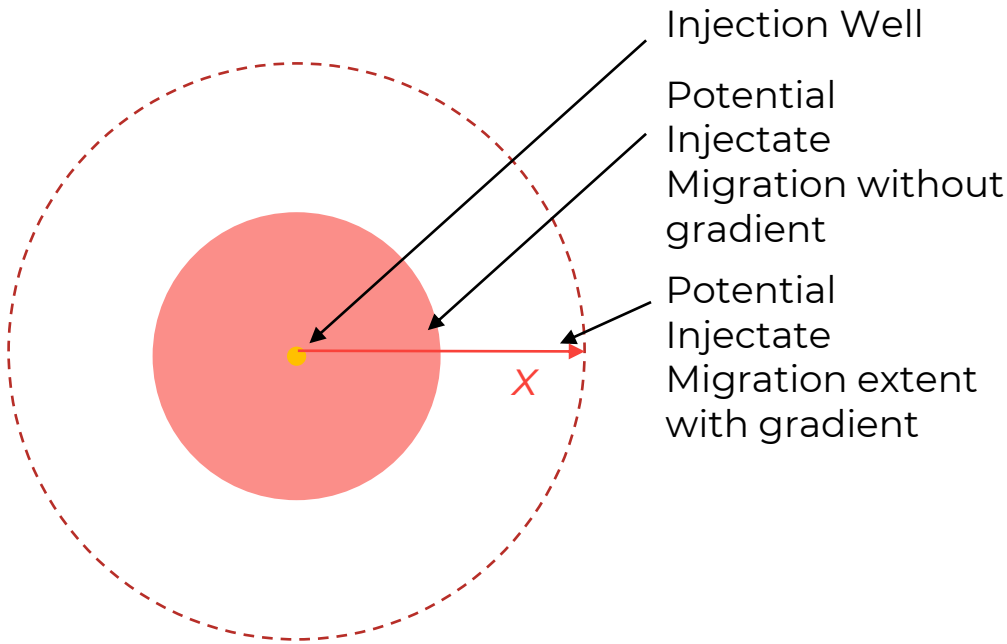
- Tier 2 Analysis (flow direction available)
  - *Both gradient and direction of flow*
  - *Bear and Jacobs (1965)*

$$t_D = x_D - ln\{1 + x_D\}$$

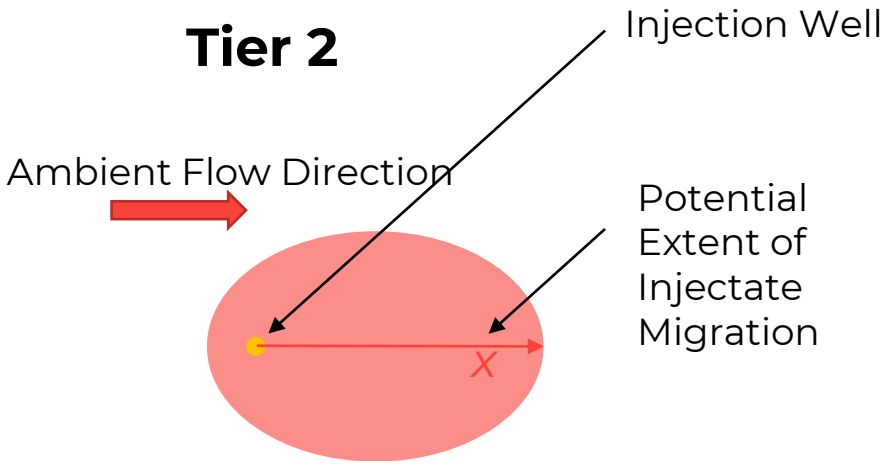
$$t_D = \frac{2\pi q^2 b}{\phi Q} t$$

$$x_D = \frac{2\pi q b}{Q} \bar{x}$$

Tier 1



Tier 2



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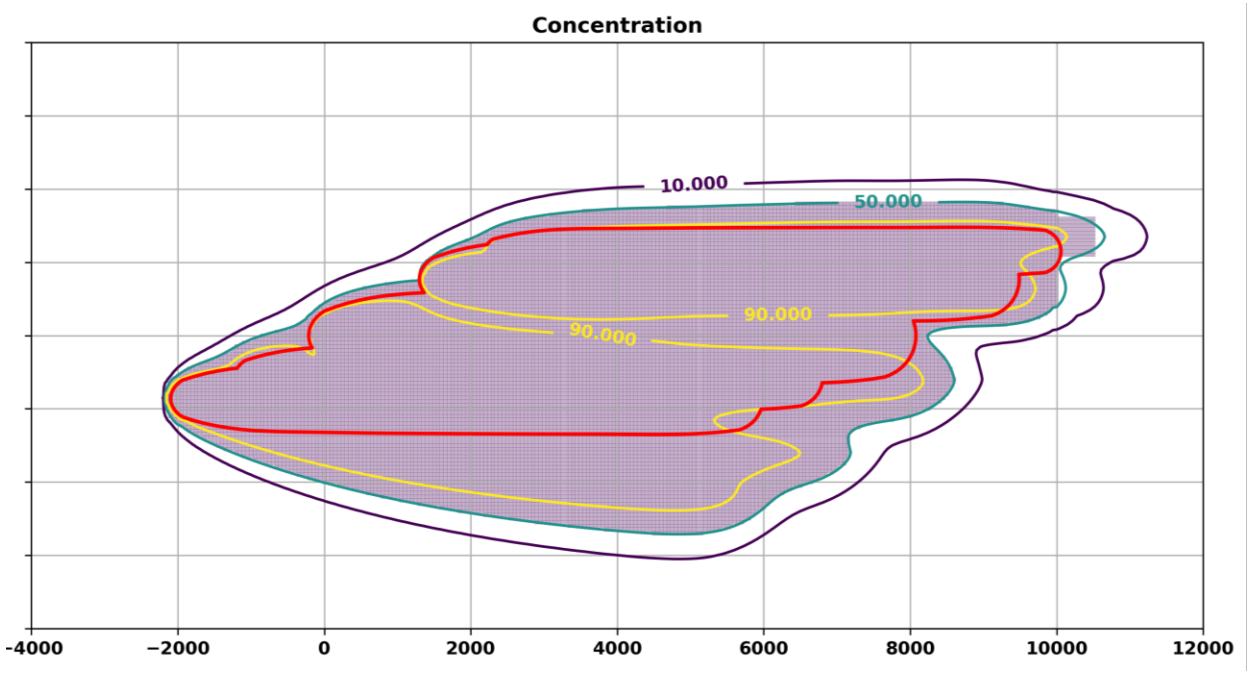
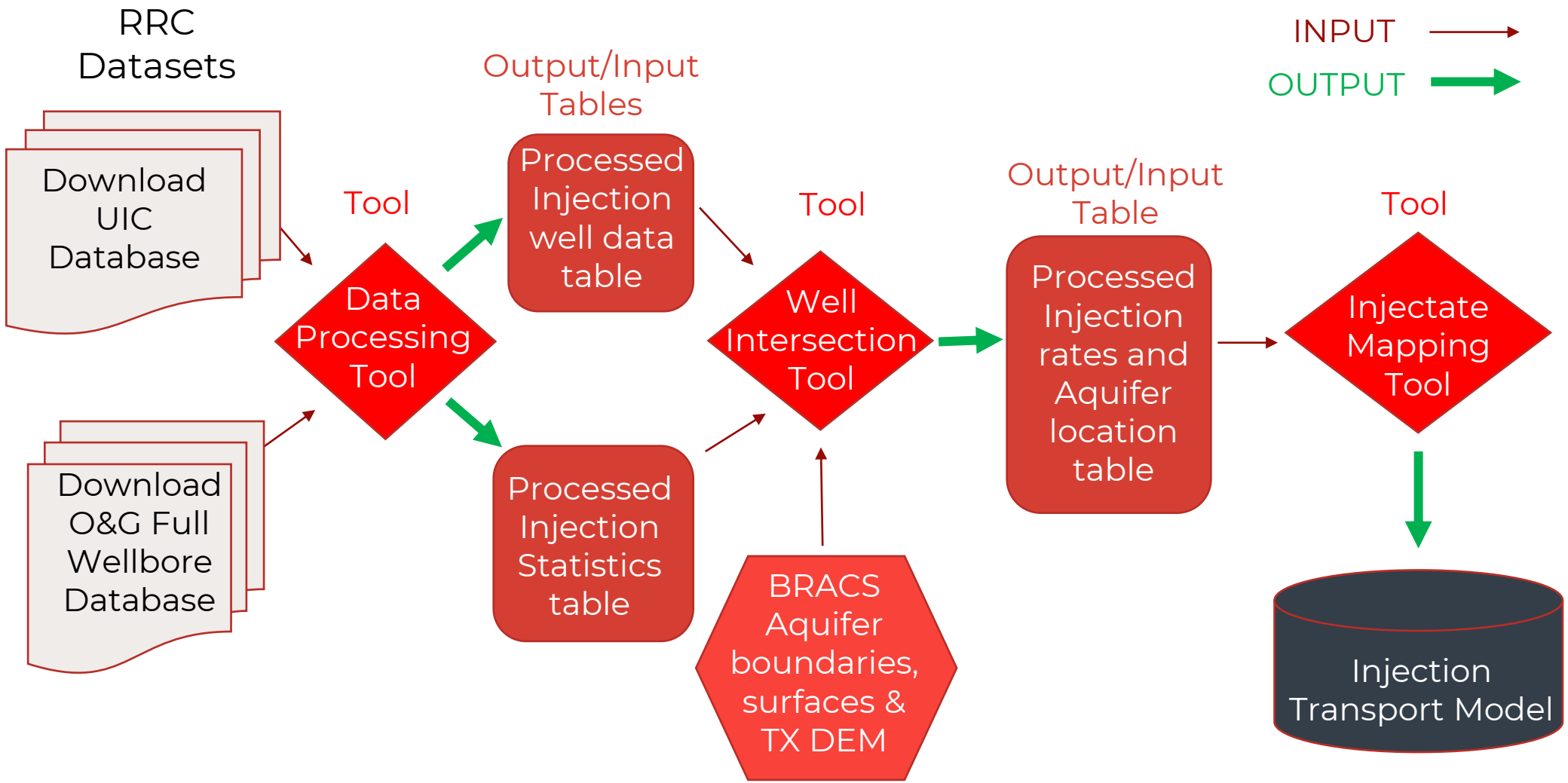
Limitation of Analytical Solutions

- Analytical solutions solve on a well-well basis
- Underestimates injectate migration when compared to numerical solution



Final Workflow



BRACS Aquifer Studies

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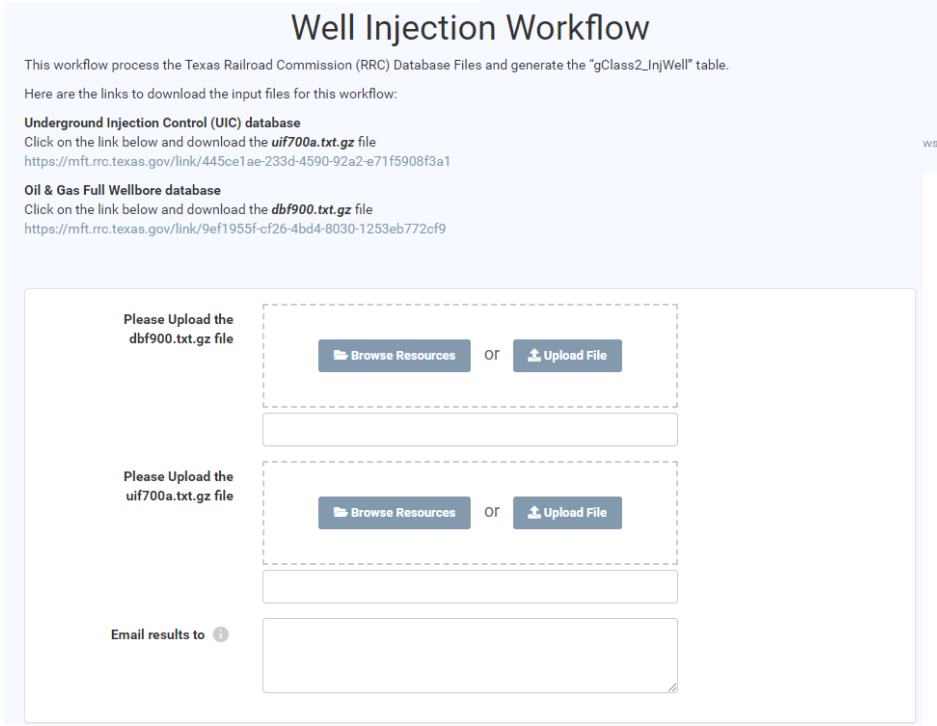
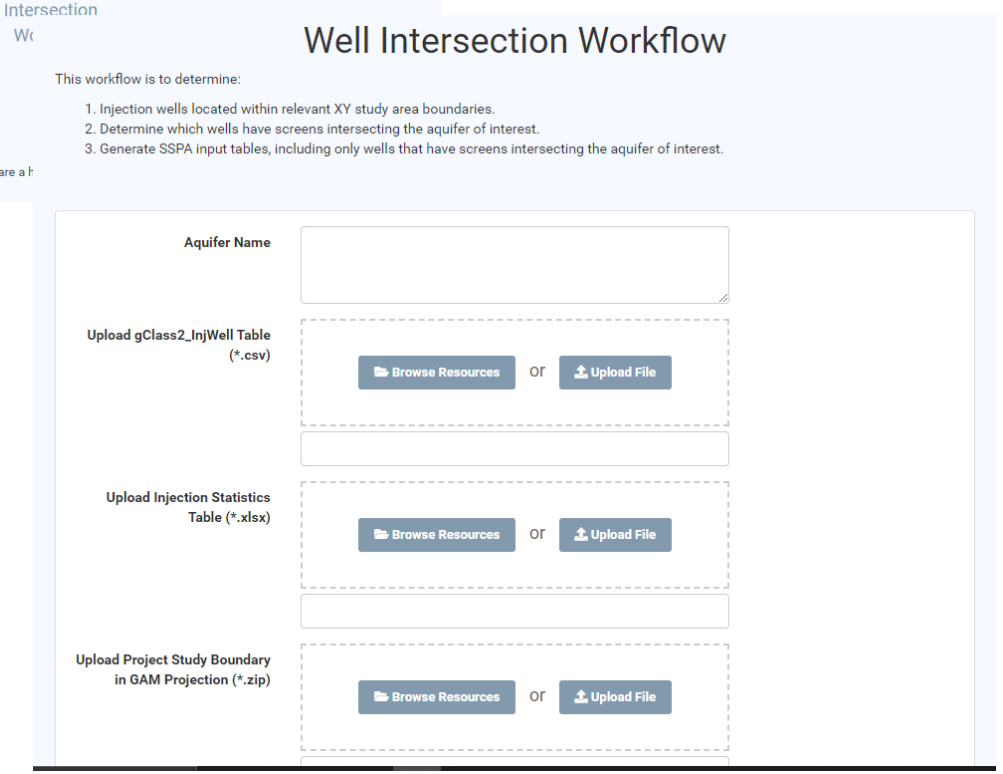
FME Tools





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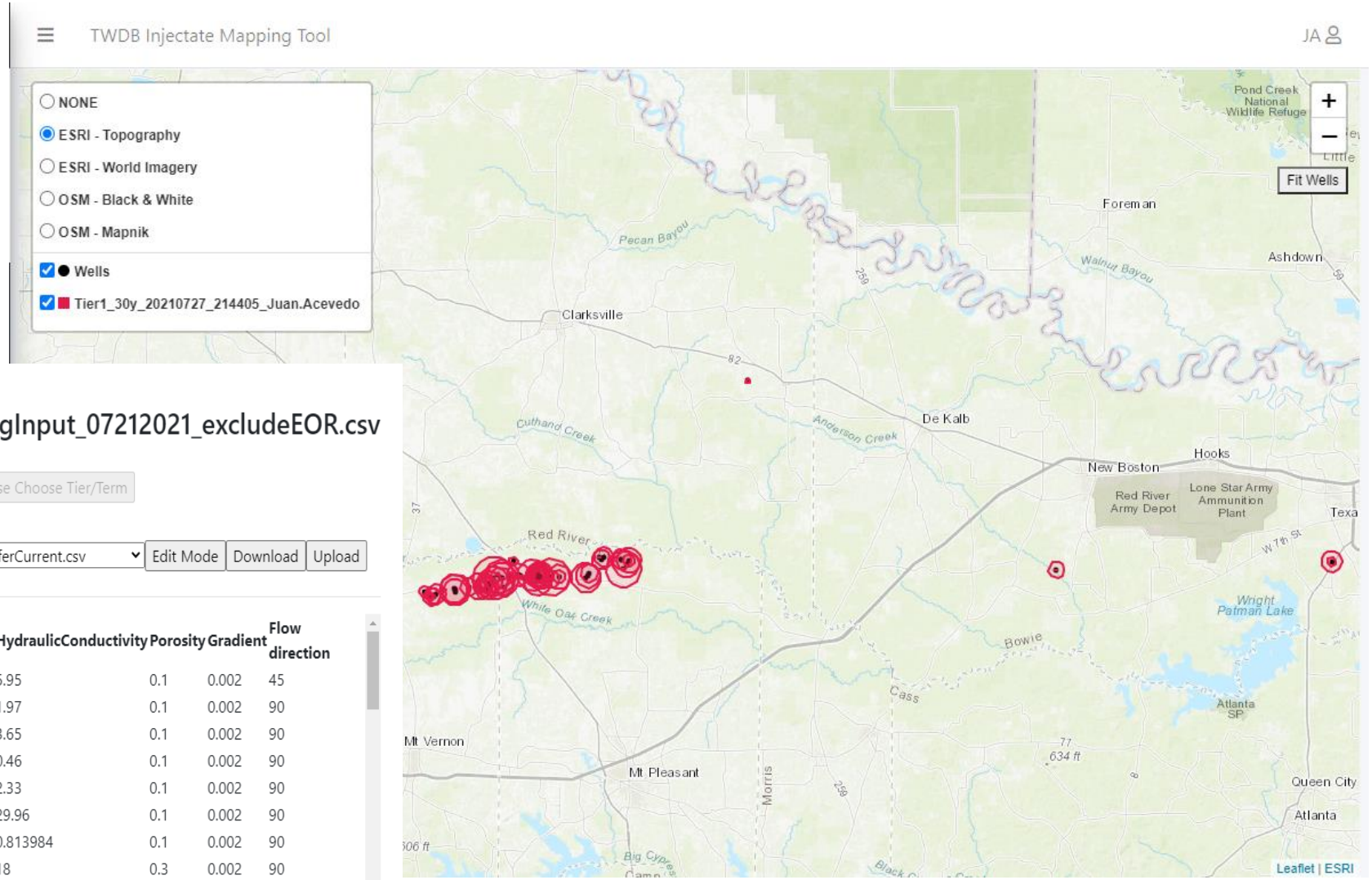
Injectate Mapping Tool



Run Options

NorthernTrinity_InjectateMappingInput_07212021_excludeEOR.csv

Analysis	Time Horizon
☐ Tier 1	☐ 30 years
☐ Tier 2	☐ 50 years

Please Choose Tier/Term

Default Aquifer Parameters

AquiferCurrent.csv | Edit Mode | Download | Upload

Aquifer	HydraulicConductivity	Porosity	Gradient	Flow direction
Nacatoch	5.95	0.1	0.002	45
Trinity (northern section)	1.97	0.1	0.002	90
Blossom	3.65	0.1	0.002	90
Carrizo (southern section)	0.46	0.1	0.002	90
Wilcox (southern section)	2.33	0.1	0.002	90
Gulf Coast (north of the LRGV)	29.96	0.1	0.002	90
Rustler	0.813984	0.1	0.002	90
Gulf Coast (LRGV)	18	0.3	0.002	90

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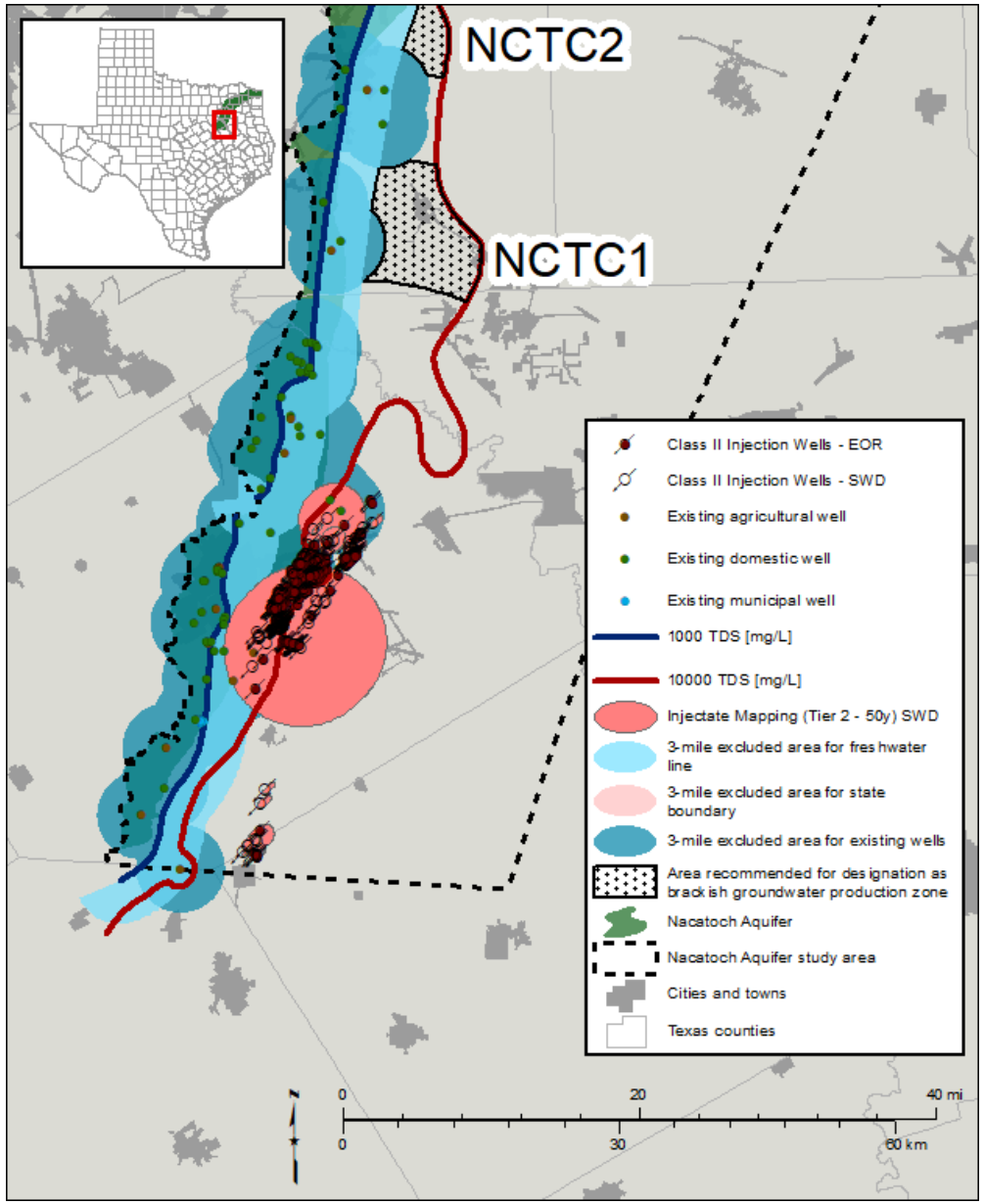
Tool Testing: Nacatoch Aquifer



- Original designation (2019)
  - *525 Class II wells*
    - 84 SWD wells
    - 441 EOR wells
- Updated Method (2021 Study)
  - *435 Class II wells*
    - 60 SWD wells
    - 375 EOR wells
  - *Largest injectate radius*
    - 6 miles

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Next Steps

BRACS team to apply tools and analyze outputs of injectate mapping tool and complete QA/QC

1. *Apply tools and procedures for Class II injection wells to aquifers ready for zone evaluation.*
2. *Provide list of Class II injection wells injecting to formation of interest to RRC for review and feedback.*
3. *Conduct the whole aquifer zone evaluation for all other statute requirements*
4. *Select buffer distances for Class II injection wells*
   - Injection mapping tool provides model for injectate migration but **not buffer distance**.
   - BRACS is developing guidance and will seek stakeholder feedback. Please contact us to be added to the stakeholder list.

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Thank you!

- Contact us with comments/questions or to be added to the stakeholder list
  - *Juan P. Acevedo, Juan.Acevedo@twdb.texas.gov*
- Or visit the study website:

  www.twdb.texas.gov/innovativewater/bracs/projects/Injection/index.asp

Caverns of Sonora, TX