



# Regulation of Disposal Wells In Seismically Active Areas of Texas

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March 30, 2023



Review of the RRC's approach to regulating disposal wells in seismically active areas of Texas that will include the following topics:

- Overview of Current Seismicity in Texas
- Authority for Regulation
- Seismic Permitting Guidelines
- Seismic Response Plan & Actions
- Seismic Investigation Regions

# More Acronyms!



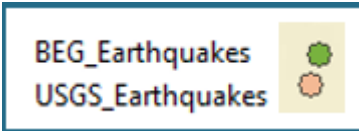
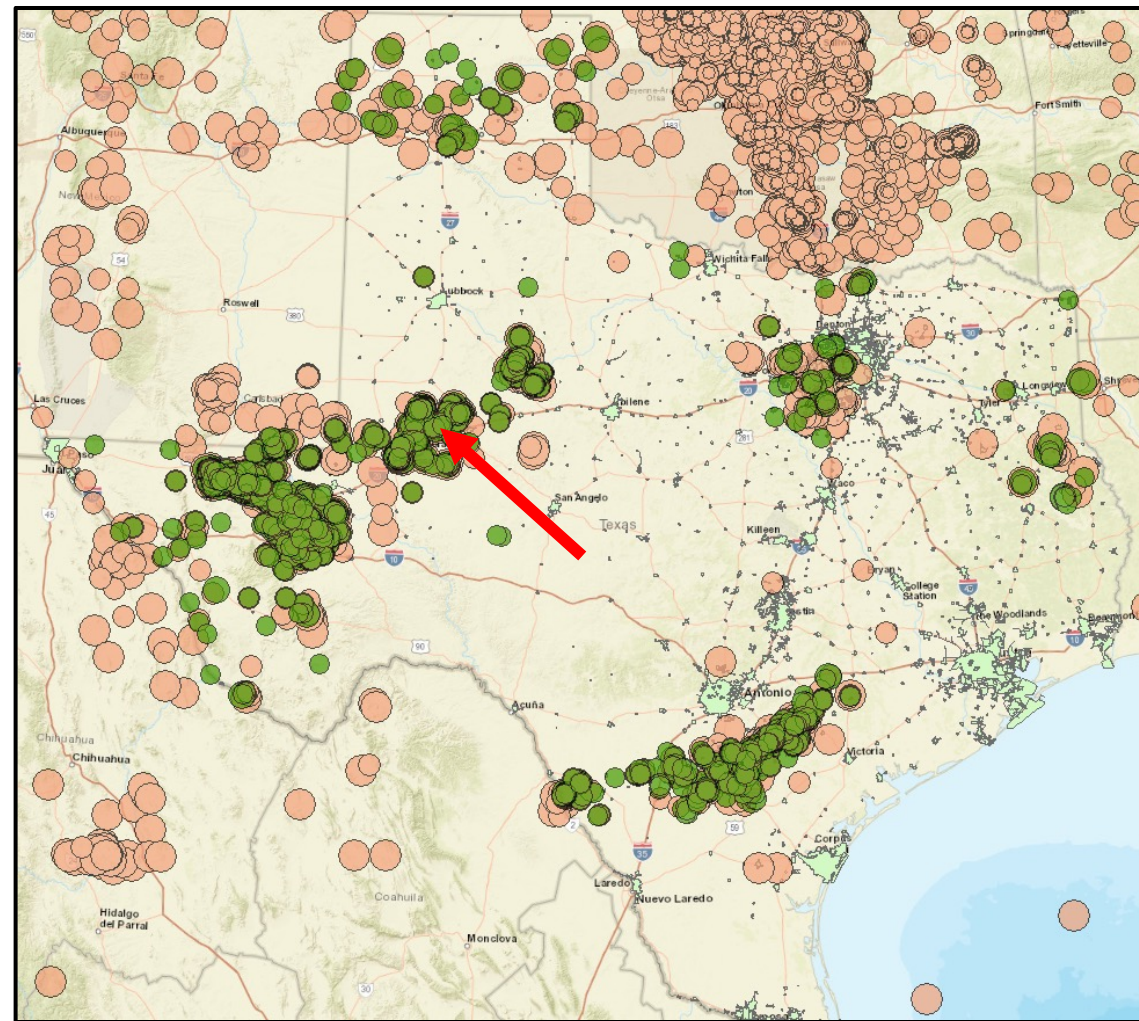
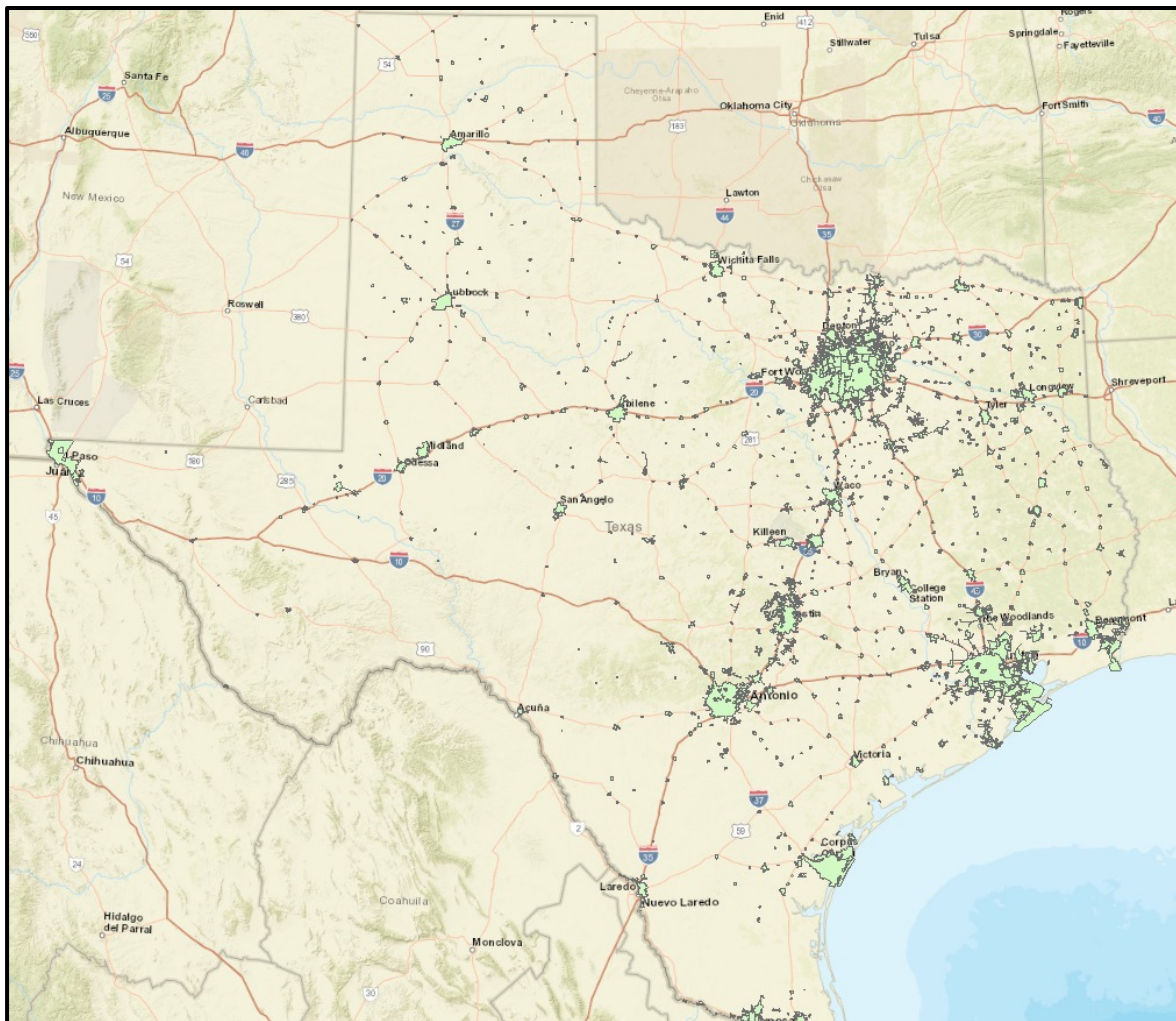
- **Common Terms**

- **UIC – Underground Injection Control**
- **SES – Seismic Event of Significance**
- **SIR – Seismic Investigation Region**
  - Geographic area established around seismic events of significance,  $M > 3.0/3.5+$
- **SRA – Seismic Response Area**
  - Region where seismicity has escalated to require RRC and/or Operator-led action to reduce seismicity
- **OLRP – Operator Led Response Plan**
  - Document governing the terms & conditions under which injection activity continues within designated boundary; established with goal of reducing seismicity
- **BUQW – Base of the Usable Quality Water**
  - $\leq 3,000$  ppm total dissolved solids (TDS)
- **USDW – Underground Source of Drinking Water**
  - $\leq 10,000$  ppm total dissolved solids (TDS)
- **BEG - Bureau of Economic Geology**
- **USGS – United States Geological Survey**



# Overview of Current Seismicity in Texas

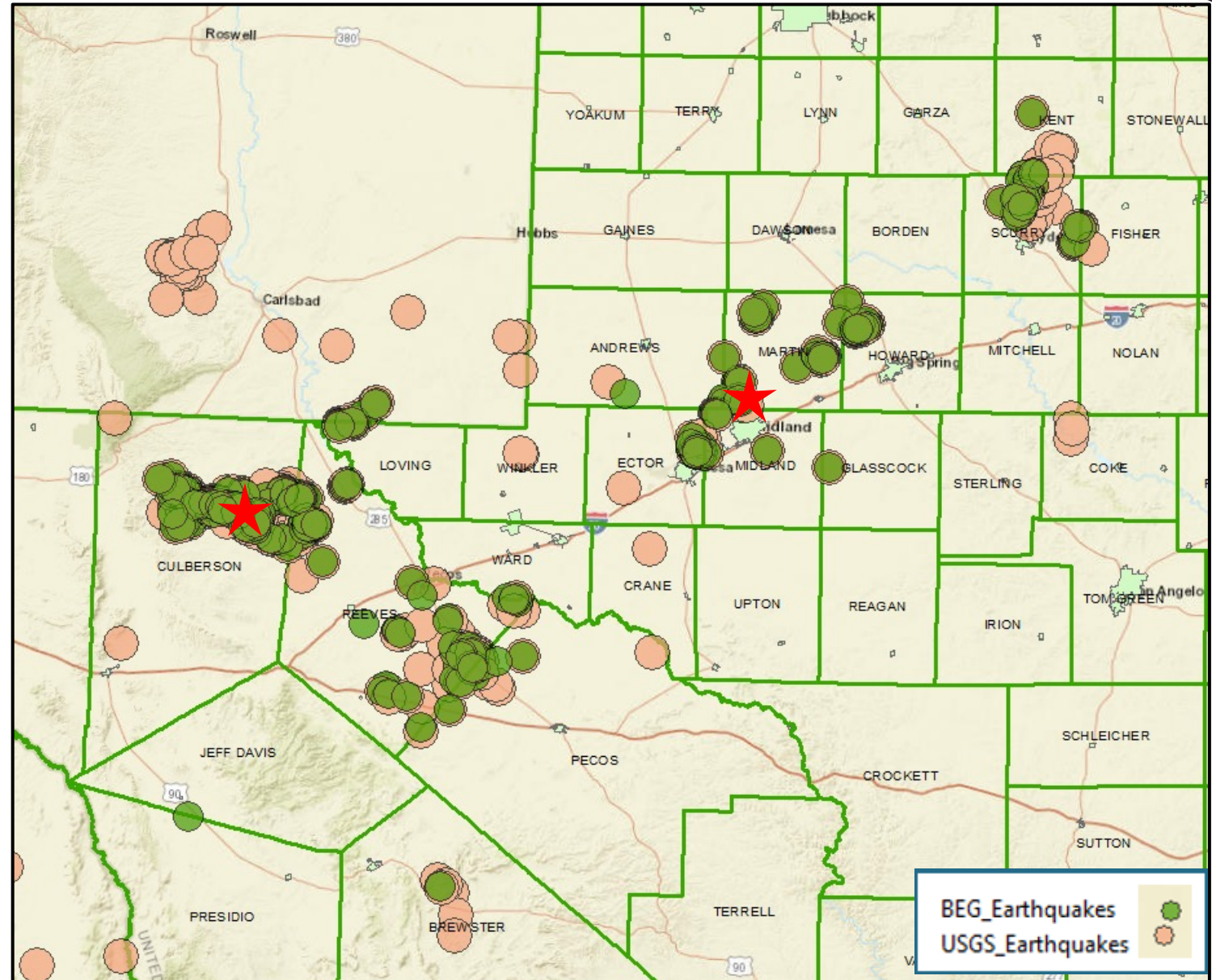
# Seismicity of Texas



# Seismicity of the Permian Basin



- Approx. 7,000 earthquakes in Permian
- 11/16/2022: M5.4 ~30 miles NW Pecos
- 12/16/2022: M5.2 ~13 miles N Midland
- 8/16/1931: M5.8 ~ SW Valentine, TX
- 3/28/1964: M9.2 Prince William Sound, Alaska



# Seismicity shaping our Response

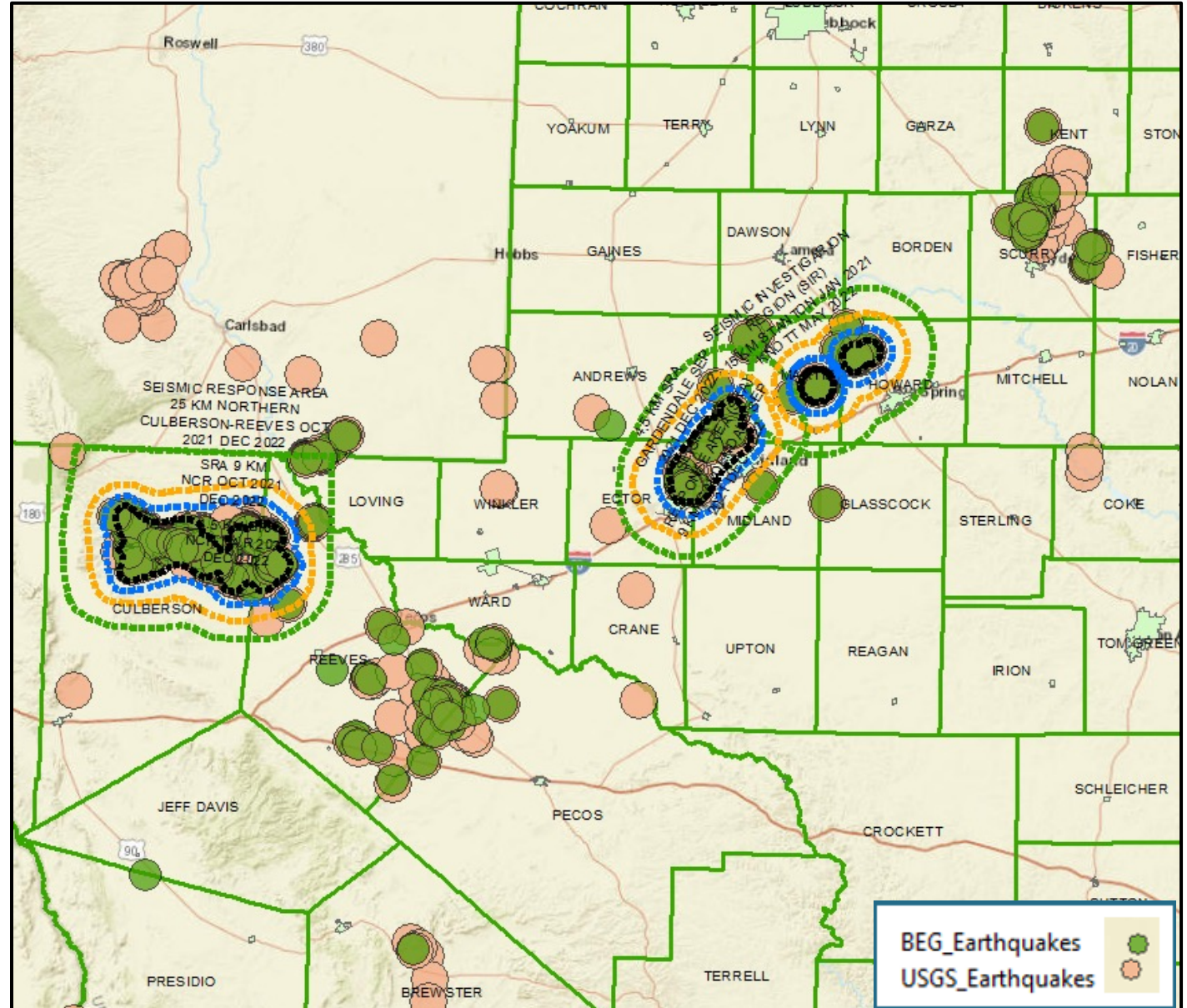


- Seismic Response Areas

- Northern Culberson Reeves
- Gardendale
- Stanton

- Seismic Investigation Region

- Knott





# Authority for Regulation



# How we got here



- Safe Drinking Water Act (SDWA) – 1974
  - To protect human health and drinking water
  - Underground Injection Control (UIC)
    - Prohibits contamination of USDWs
- Enforcement Primacy
  - RRC: April 23, 1982
- Injection well rules codified in 16 Texas Administrative Code §§3.9 & 3.46

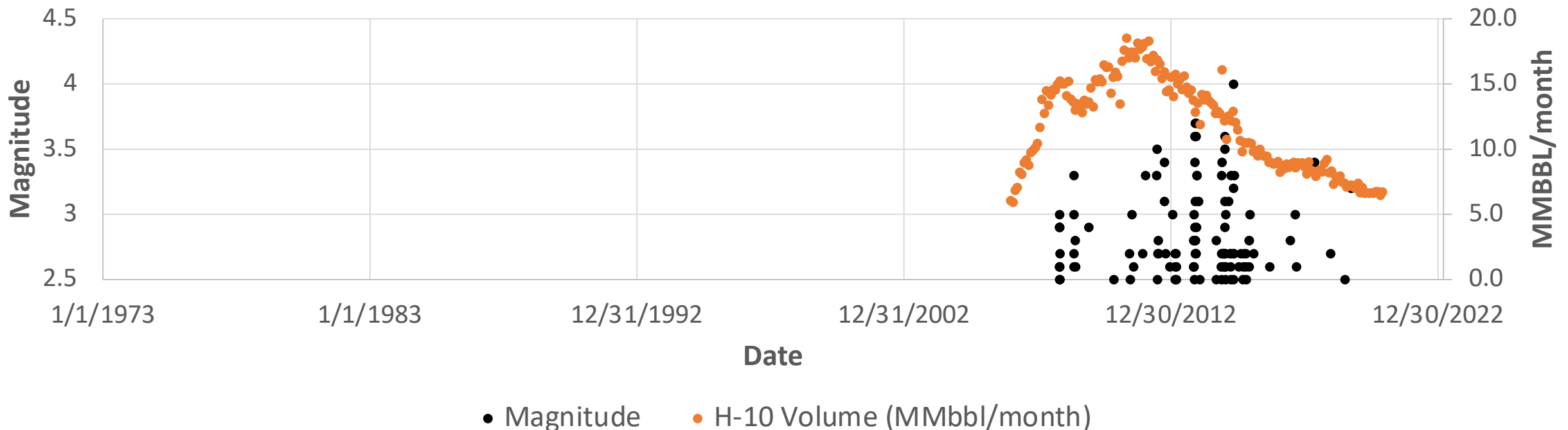


# Early Seismicity in Texas



- 2008: Fort Worth Basin Seismicity Begins
- 2014: RRC Amends Rules 9 and 46
- Adds State Seismologist to Staff

Dallas, Denton, Ellis, Johnson, Parker, Tarrant & Wise County Injection 2007-2020  
USGS Earthquakes in the Fort Worth Basin, 1973-2021



# 2014 Amendments to Rules 9 and 46



- Amendments to Rules 9 & 46 in 2014
  - **RRC may modify, suspend or terminate a permit if disposal is likely to be contributing to seismic activity**
  - Requires seismic information with disposal well applications



# 2014 Amendments to Rules 9 and 46 cont.



- Natural Resources Code §85.042 Rules and Orders
  - (b) When necessary, the commission shall make and enforce rules either general in their nature or applicable to particular fields for the prevention of actual waste of oil or operations in the field dangerous to life or property.



# How much?



UIC Class	Wells Permitted	% of Total
IIR – Secondary Recovery / EOR	37,851	72%
IID - Disposal	13,585	26%
IIH – Liquid Hydrocarbon Storage	515	1%
III – Brine Mining	214	<1%
<b>Total*</b>	<b>52,587</b>	

\* 421 wells in the Total are for Gas Storage



**5,309 in Permian**

**X 20,000**



# Seismic Permitting Guidelines

# Seismic Permitting Guidelines (2 of 2)



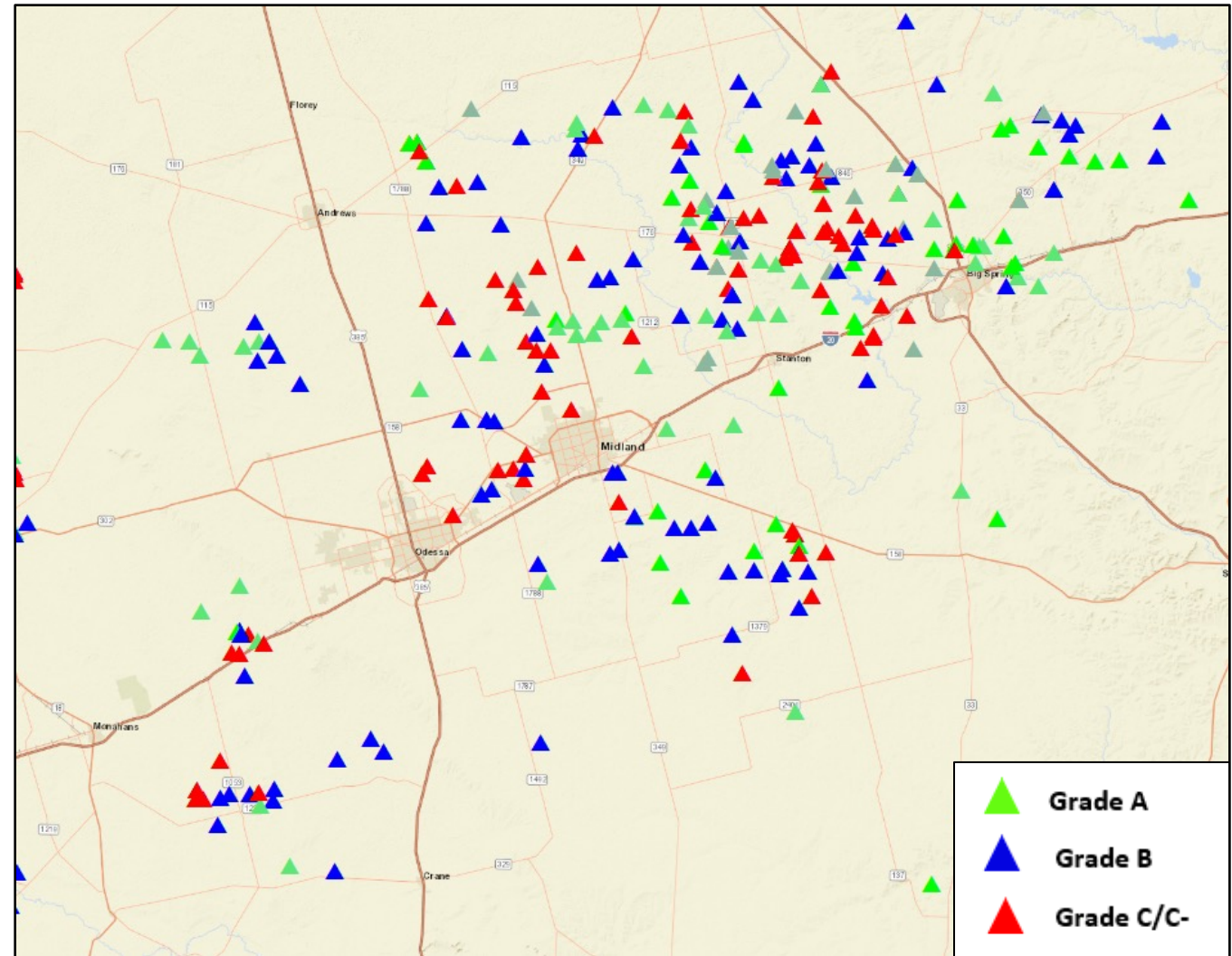
- Grading factors
- Seismic grade determines permit conditions
- Possible incentive

Seismicity Review Factors				
Maximum Seismic Event Magnitude within 9.08 km	< 2.5	2.5 – 2.9	3.0 – 3.49	>= 3.5
Number of Seismic Events >= 3.0 M within 9.08 km	0		1 – 2	> 2
Number of Seismic Events >= 2.0 M within 9.08 km	1 – 3	4 – 9	10 – 19	>= 20
Horizontal Distance to Nearest Seismic Event >= 2.0M (km)	> 4.5	4.5 – 1	< 1	
Years Since Last Seismic Events >= 2.0 M within 9.08 km	> 5	5 – 1	< 1	
Number of Mapped Faults within 9.08 km	0	1	> 1	
Horizontal Distance to Nearest Mapped Fault (km)	> 9.08	9.08 – 4.5	4.5 – 1	< 1
Seismicity & Faulting Data Confidence	High	Medium	Low	
Permitted Shallow Cumulative Injection Rate (kbbl / day) within 4.54 km	< 35	35 – 70	70 – 140	> 140
<b>Overall Score</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>C-</b>
<b>Permit Conditions</b>				
Non-monitoring MDIV (kbbl)	30	20	10	≤ 10 or Denial
Seismic Monitoring MDIV (kbbl)	40	30	20	N/A
Formation Frac Pressure Data	if MDIV >= 25,000	if MDIV >= 25,000	No	No
BHP	Initial	Initial	Initial	Initial

# Grading Mapped Out



- Consistency
- Trends over time
- Concern Areas





# Monitoring Incentive



- Disposal wells scored as “B” or “C” may be authorized to inject an additional 10,000



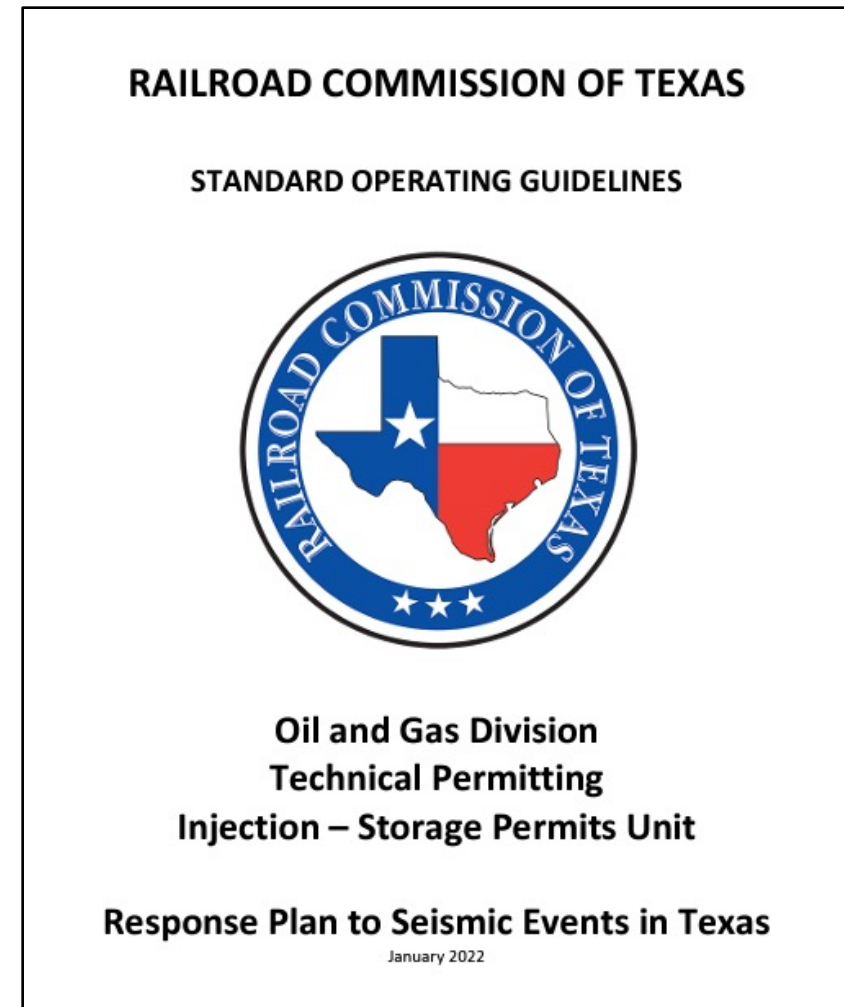


# Seismic Response Plan & Areas

# Seismic Response Plan



- Monitoring Seismic activity
- Designating investigation area
- Gathering additional information
- Analyzing available and new information
- Taking appropriate action



[https://www.rrc.texas.gov/media/buhgzt0o/2022-01-31\\_seismic\\_response\\_sog\\_final.pdf](https://www.rrc.texas.gov/media/buhgzt0o/2022-01-31_seismic_response_sog_final.pdf)



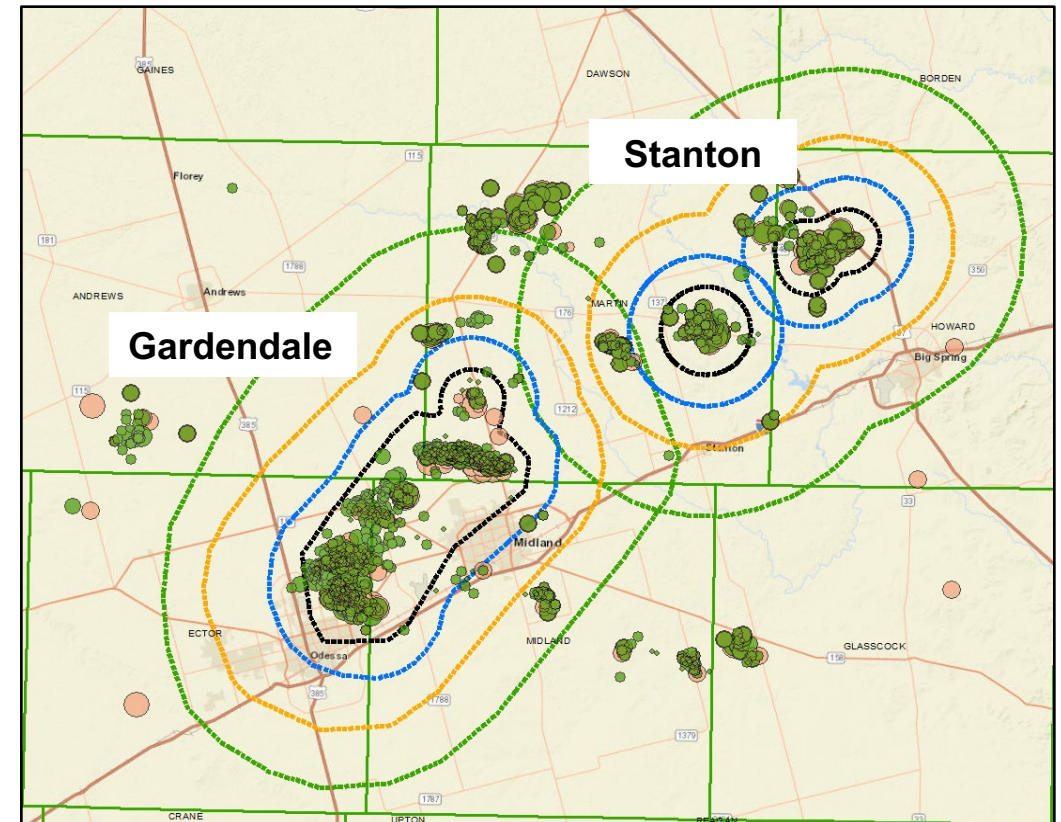
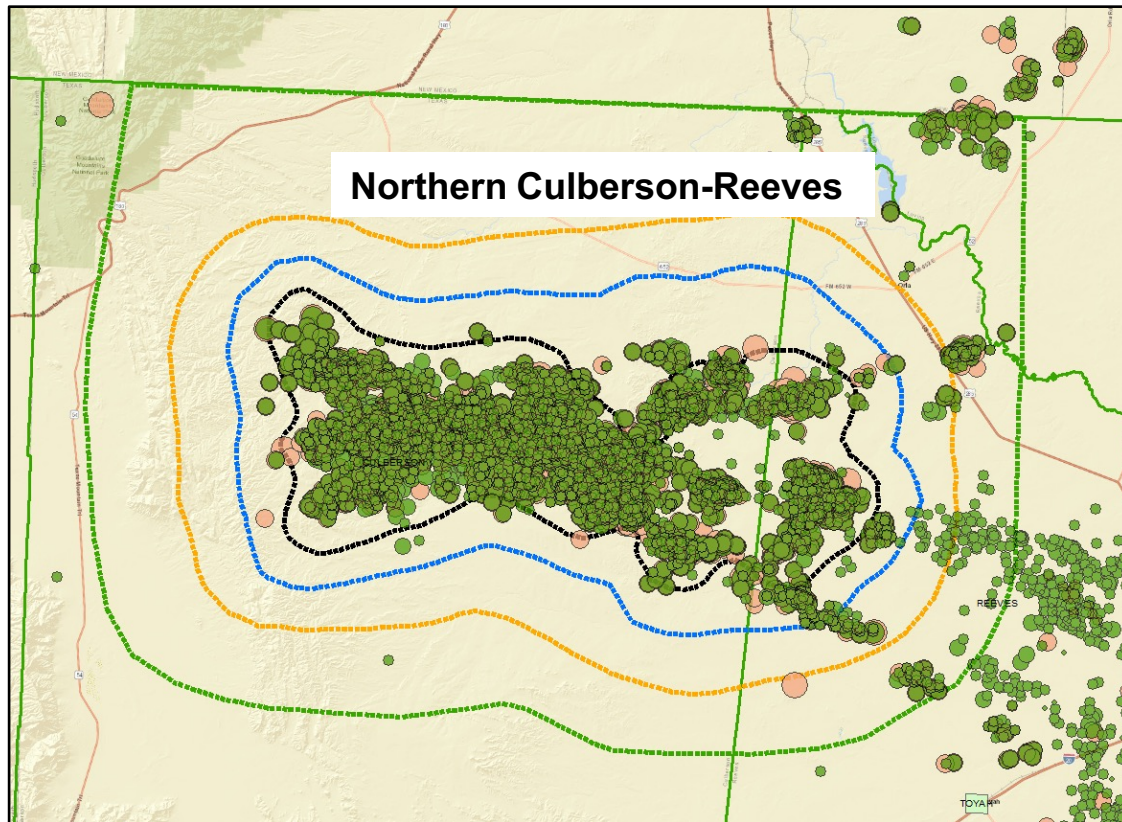
# Seismic Response Areas

What Action Has RRC Taken?

# Seismic Response Areas



- Gardendale – September 23, 2021
- Northern Culberson-Reeves – October 22, 2021
- Stanton – January 14, 2022



# Operator-Led Response Plan (OLRP)



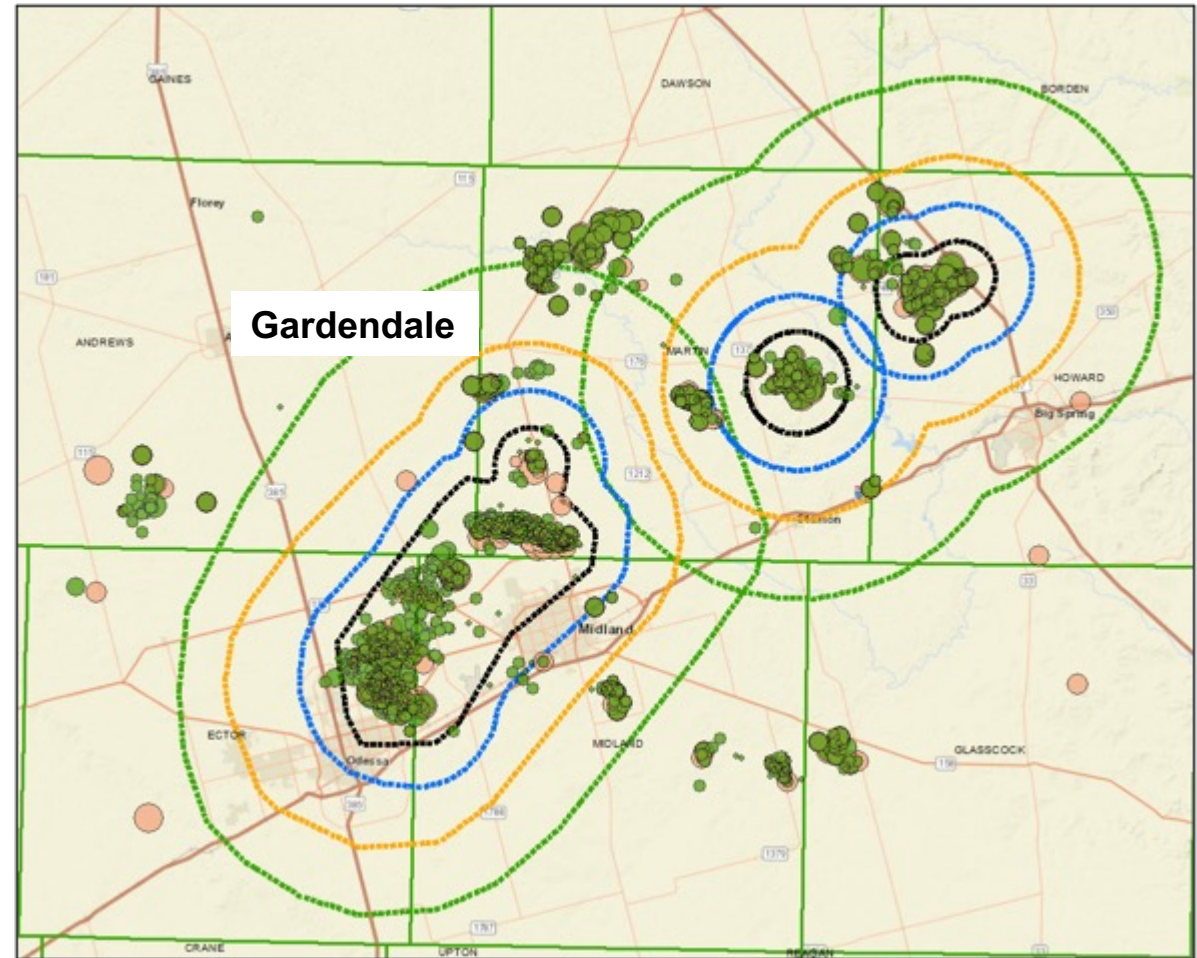
- RRC designates SRA
- Industry workgroup(s) form
- **RRC & Industry agree to plan**
- Industry implements plan
- RRC monitors compliance



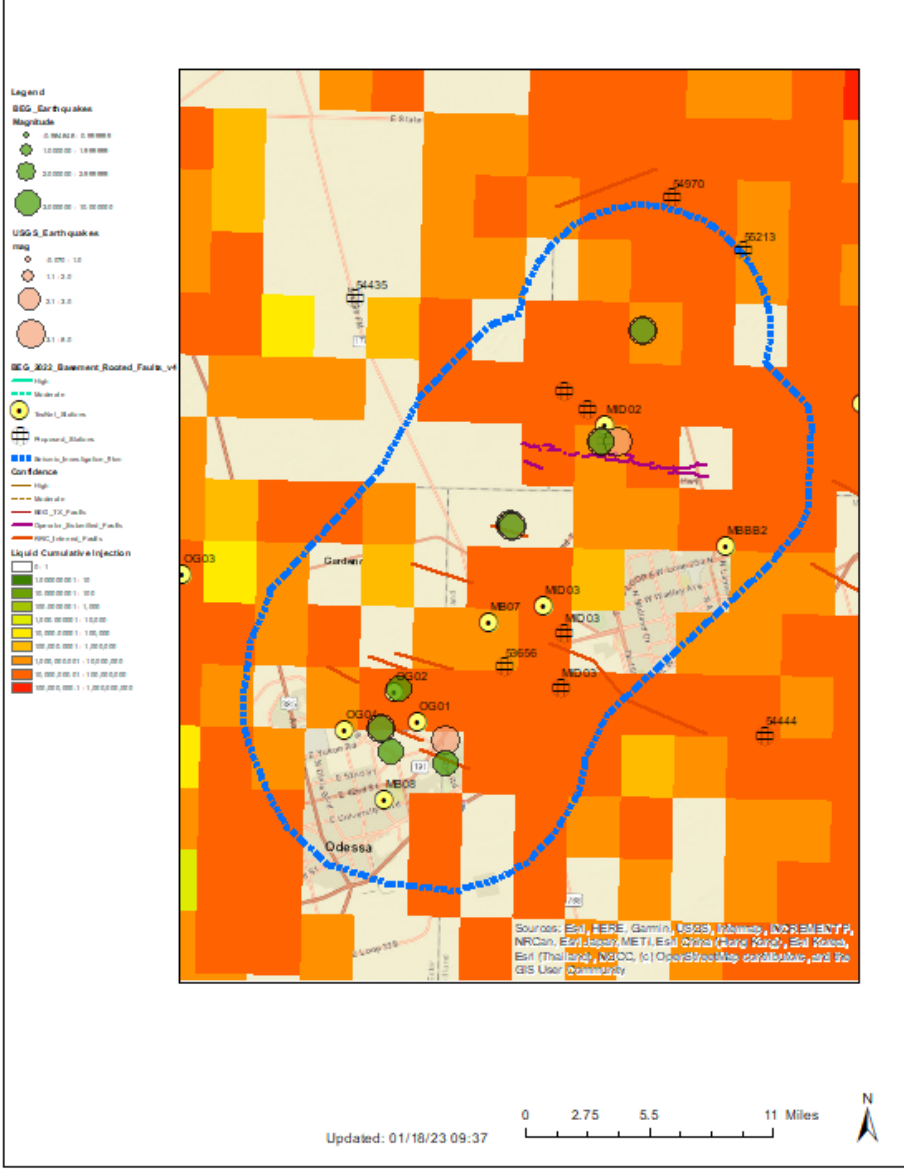
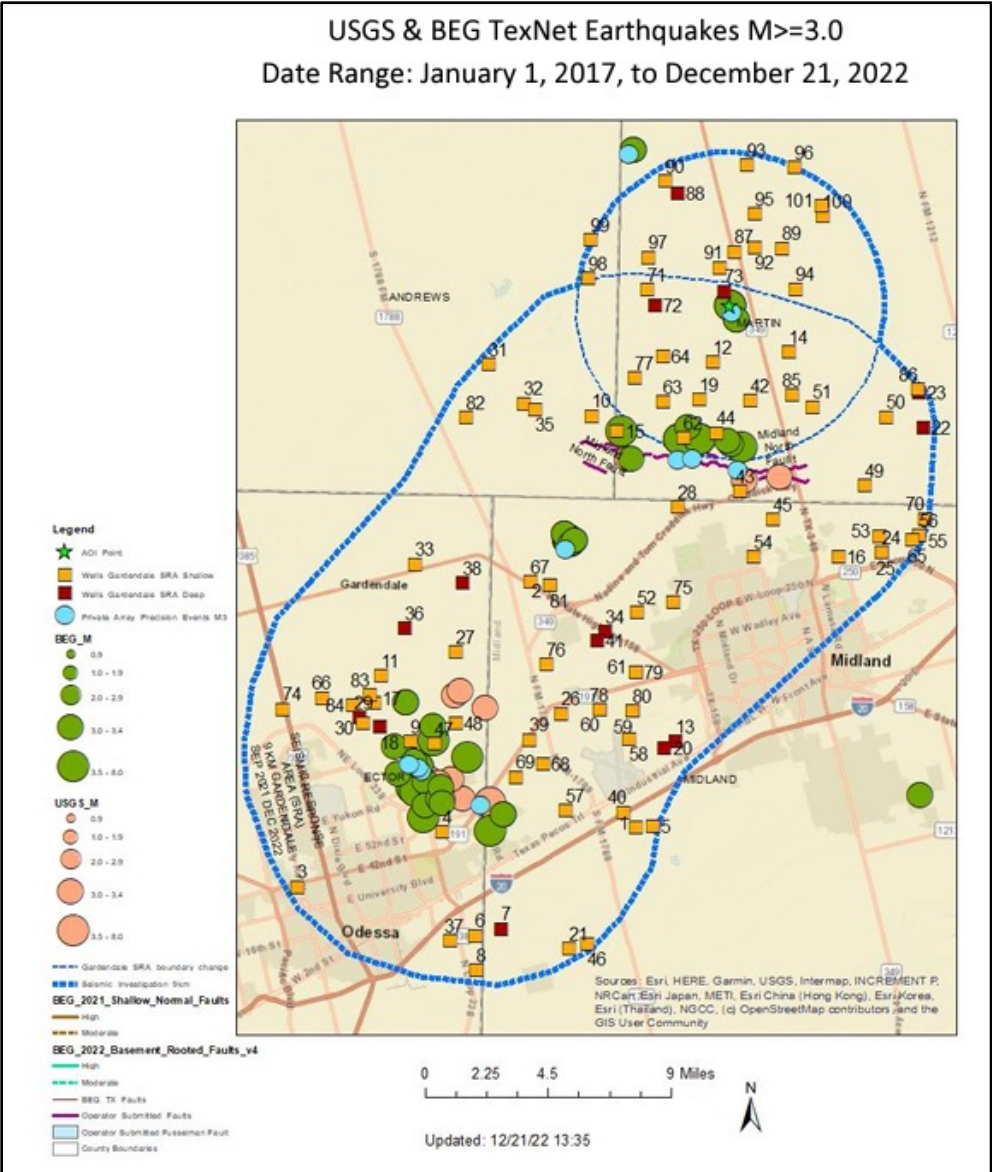
# Gardendale SRA



- Feb 2020 thru Sep 2021 – Multiple SES
- Sep 2021 – SRA Creation
  - Requests deep & shallow curtailment
- Dec 2021 – Suspends deep injection in SRA
- Dec 2022 – M5.2 event ~13 miles N Midland
  - Expands SRA boundary
    - I. New deep & shallow wells



# Gardendale SRA Cont.

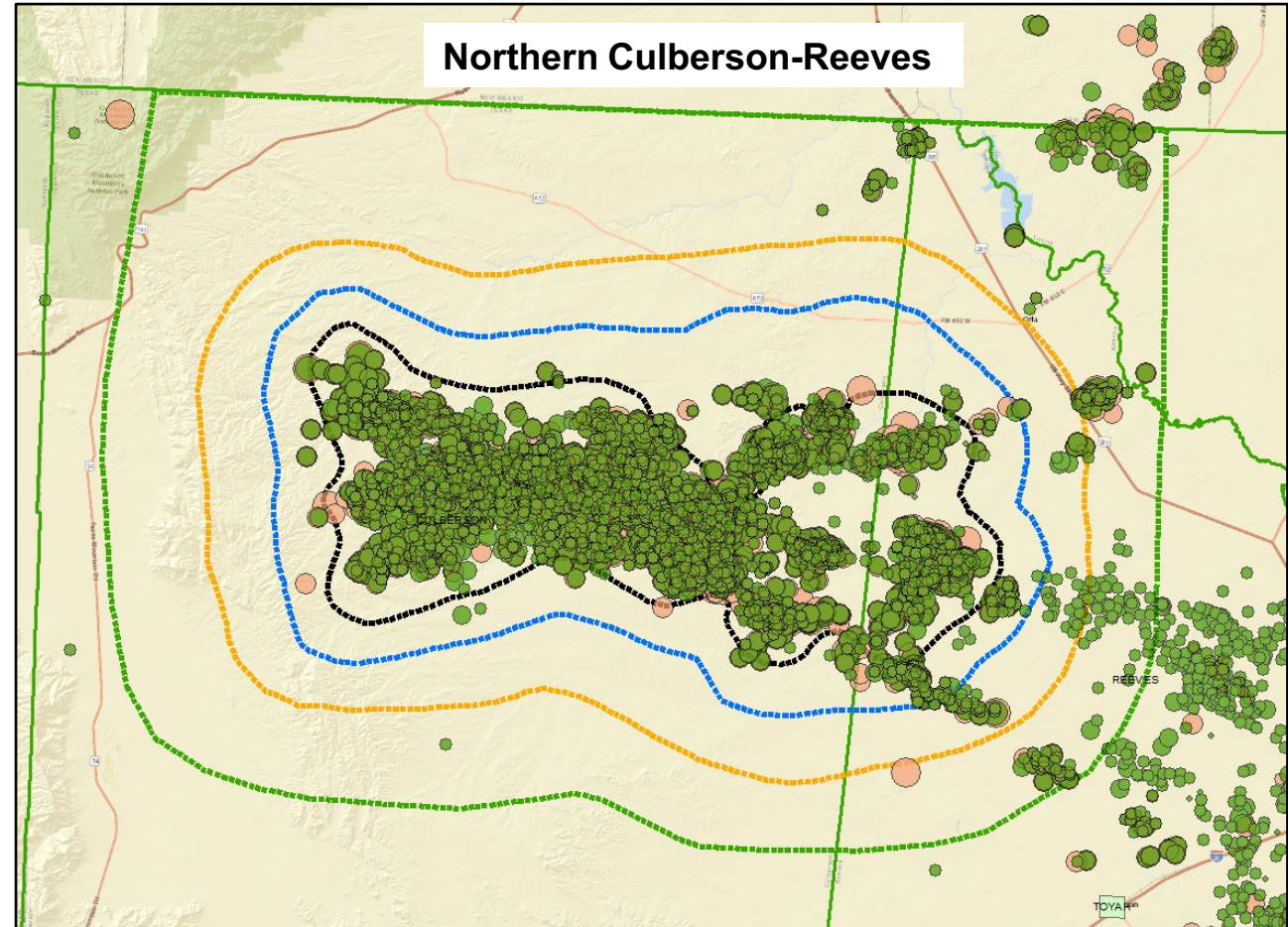




# Northern Culberson Reeves SRA



- Jan 2020 thru Sep 2021 – SES clusters
- Oct 2021- SRA creation
  - Requests deep & shallow curtailment
- Mar 2022 – OLRP initiated
- Nov 2022 – M5.4
  - Expanded SRA
    - New Deep and Shallow Wells
  - Further Curtailed Deep volume targets
  - Investigate nearby shallow disposal



# Northern Culberson Reeves SRA Cont.



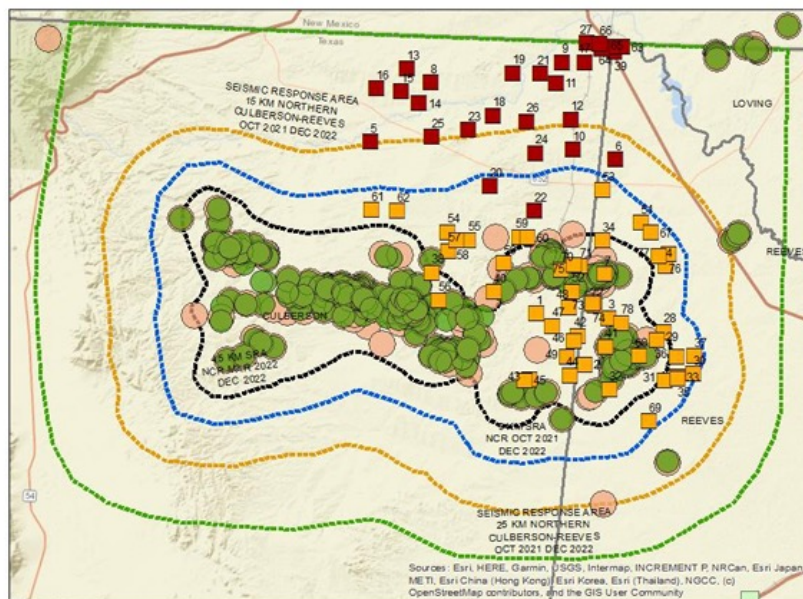
## Northern Culberson-Reeves (NCR) Seismic Response Area (SRA)

USGS & BEG TexNet Earthquakes M3.0+

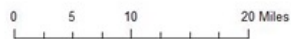
Date Range January 1, 2017, to December 9, 2022

### Legend

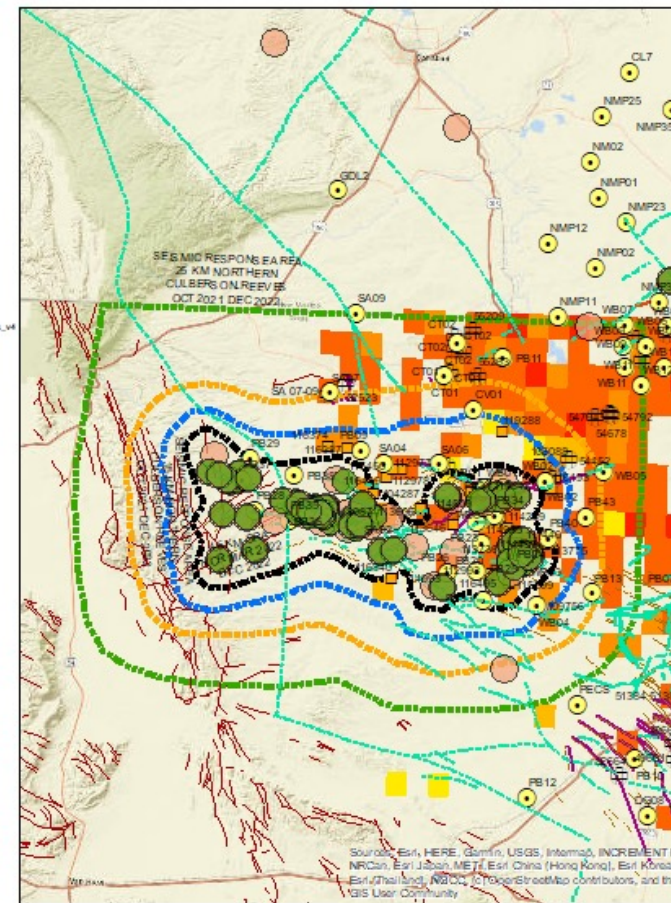
- BEG\_Earthquakes M3.0+
- USGS\_Earthquakes M3.0+
- NCR\_SRA Deep Wells
- NCR\_SRA Shallow Wells
- NCR\_SRA 4.5 km Boundary
- NCR\_SRA 9 km Boundary
- NCR\_SRA 15 km Boundary
- NCR\_SRA 25 km Boundary



Updated: 12/09/22 11:26



- Legend**
- BEG\_Earthquakes**
- Magnitude**
- 0.000000 - 0.999999
- 1.000000 - 1.999999
- 2.000000 - 2.999999
- 3.000000 - 3.999999
- USGS\_Earthquakes**
- mag**
- 0.00 - 1.0
- 1.1 - 2.0
- 2.1 - 3.0
- 3.1 - 4.0
- BEG\_2022\_Basement\_Routed\_Faults\_v4**
- High
- Moderate
- Low
- Basement\_Routed\_Faults**
- High
- Moderate
- Low
- Basement\_Routed\_Faults\_Confidence**
- High
- Moderate
- Low
- Liquid Cumulative Injection**
- 0 - 1
- 1.000000001 - 10
- 10.000000001 - 100
- 100.000000001 - 1,000
- 1,000.000000001 - 10,000
- 10,000.000000001 - 100,000
- 100,000.000000001 - 1,000,000
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- 10,000,000.000000001 - 100,000,000
- 100,000,000.000000001 - 1,000,000,000



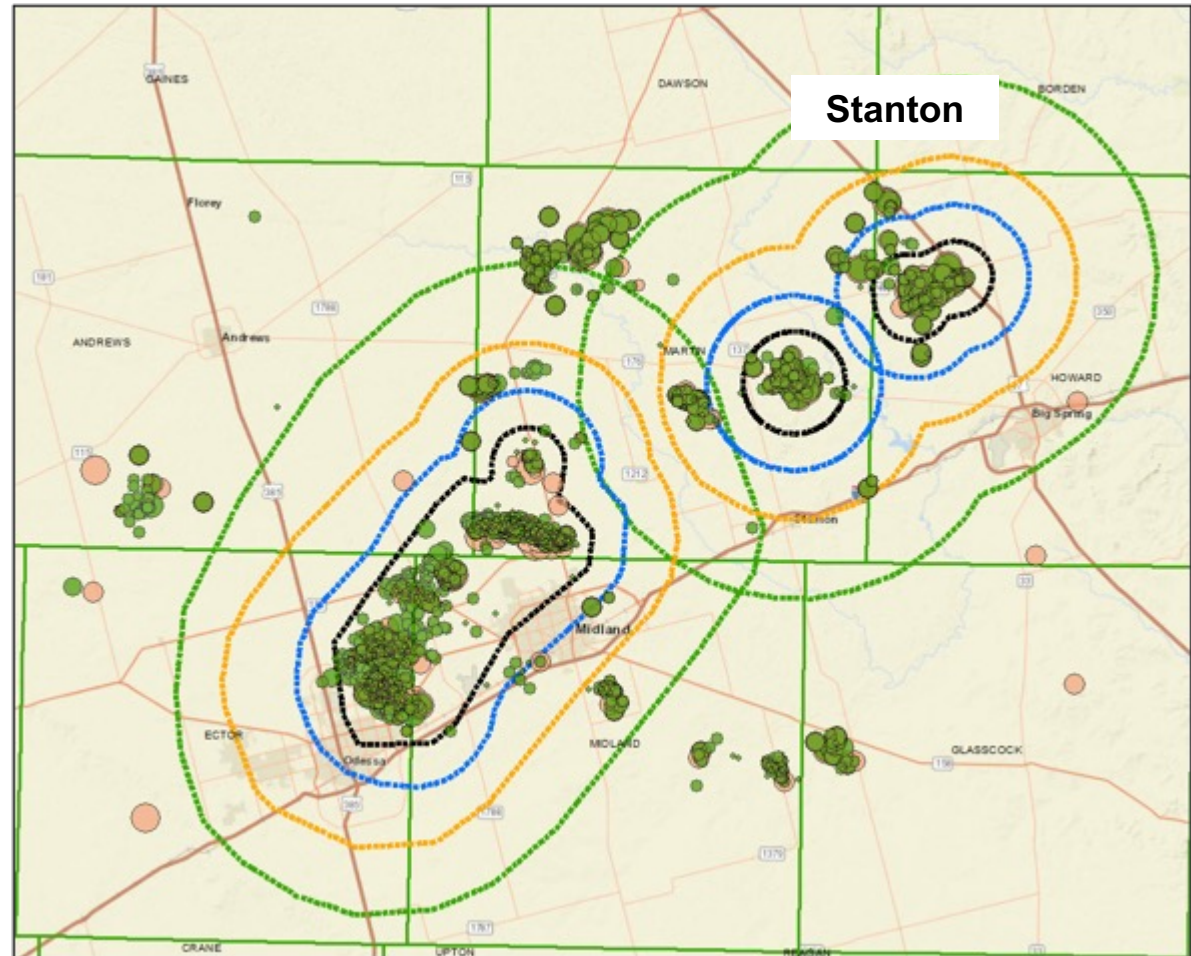
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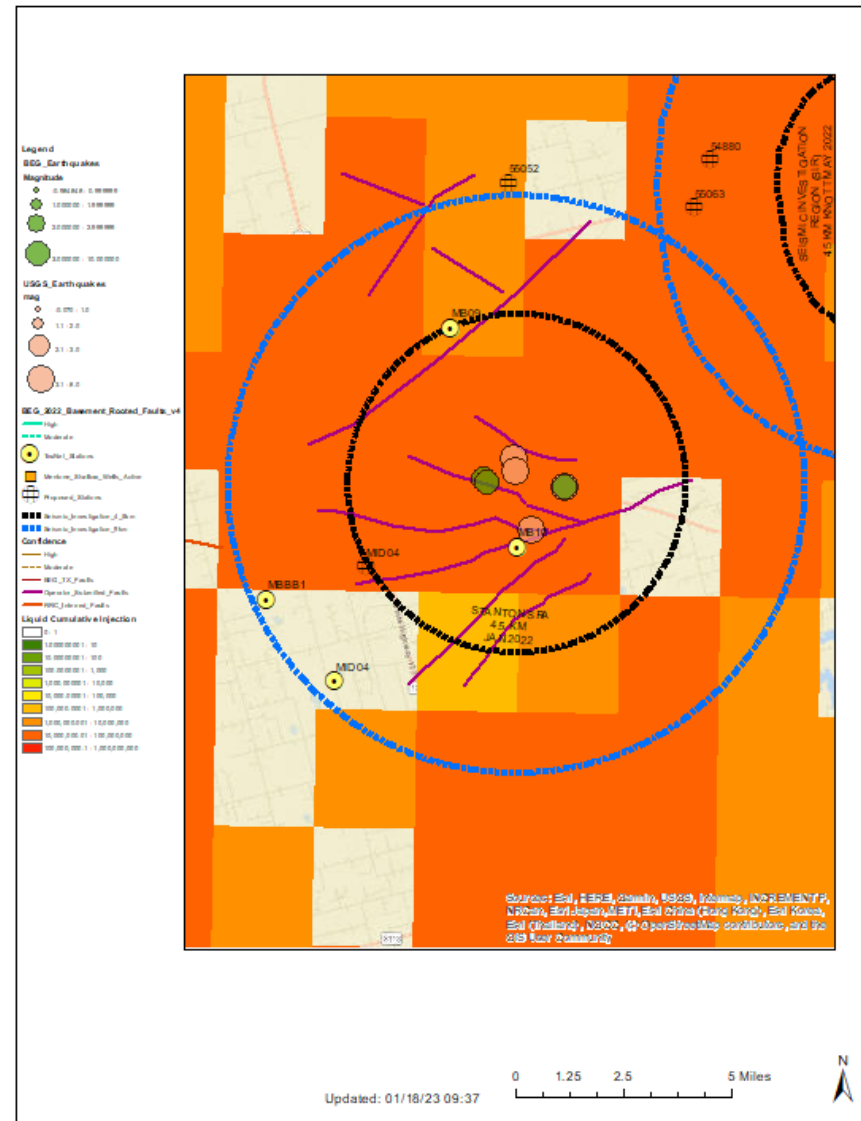
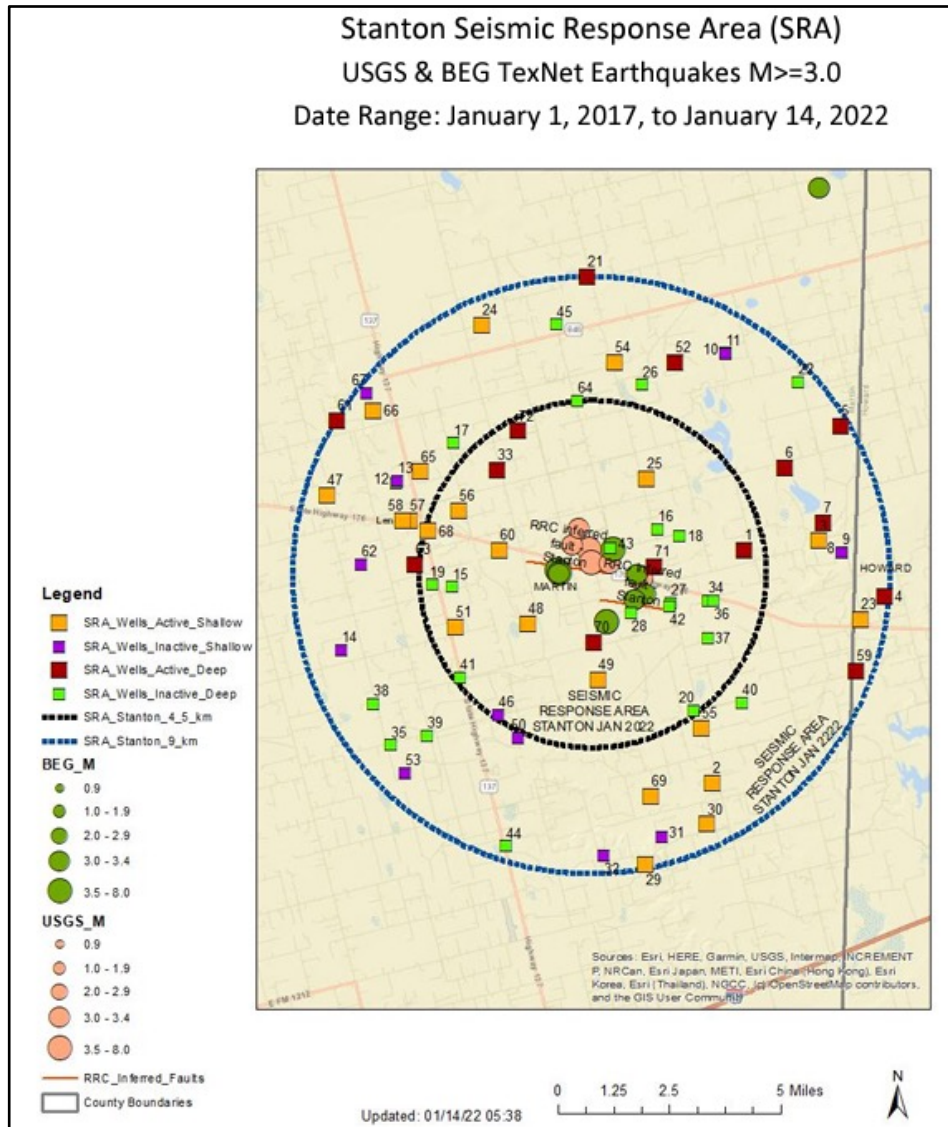
# Stanton SRA



- Dec 2020 – SES begin
- Dec 2021 – cluster SES leading to M4.6
- Jan 2022 – SRA creation
- May 2022 – OLRP initiated



# Stanton SRA Cont.





# Seismic Investigation Region

Where else are we investigating?

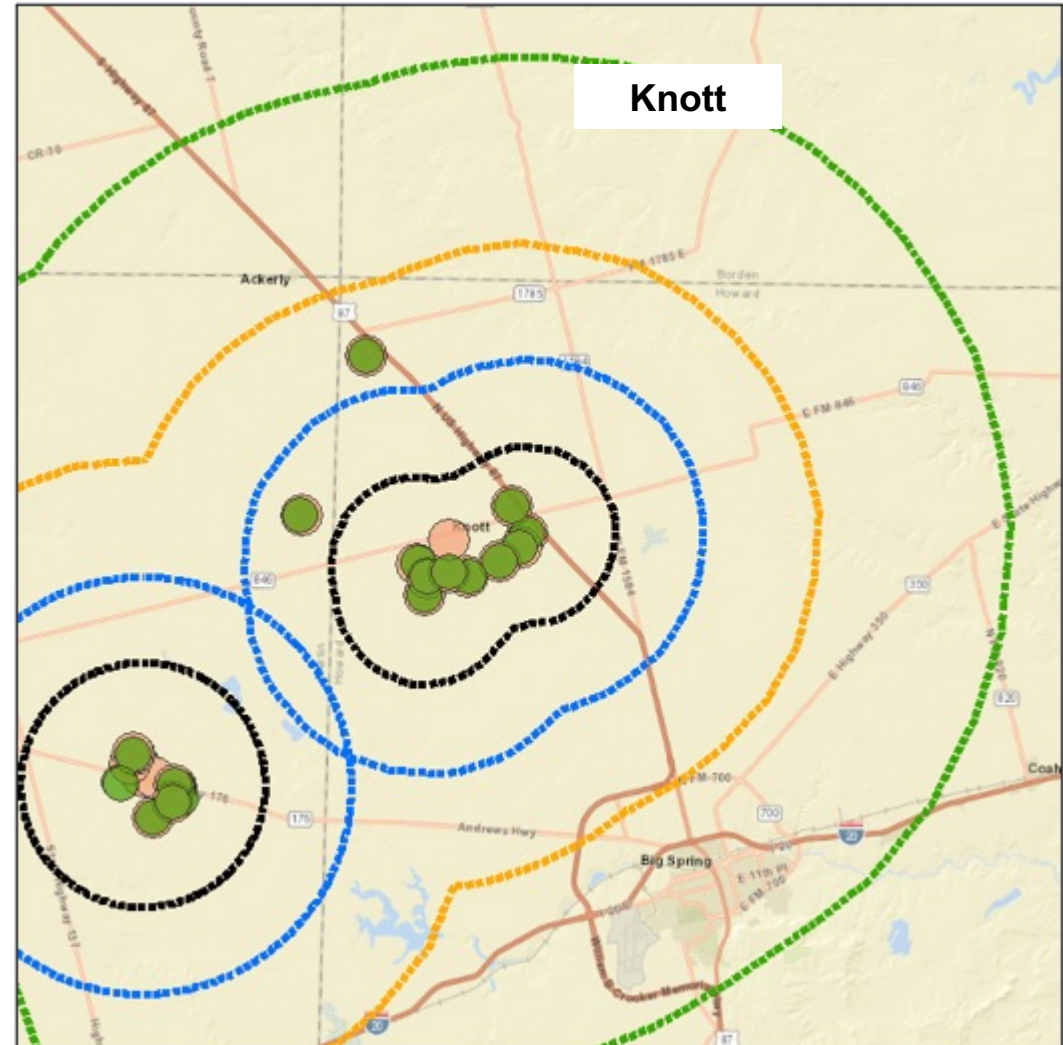
- RRC Seismologist will designate an SIR
- An SIR may be designated for a region that has experienced an SES
- Not all SES will result in SIR
- SIR Size
  - Generally, 9.08km radius from SES



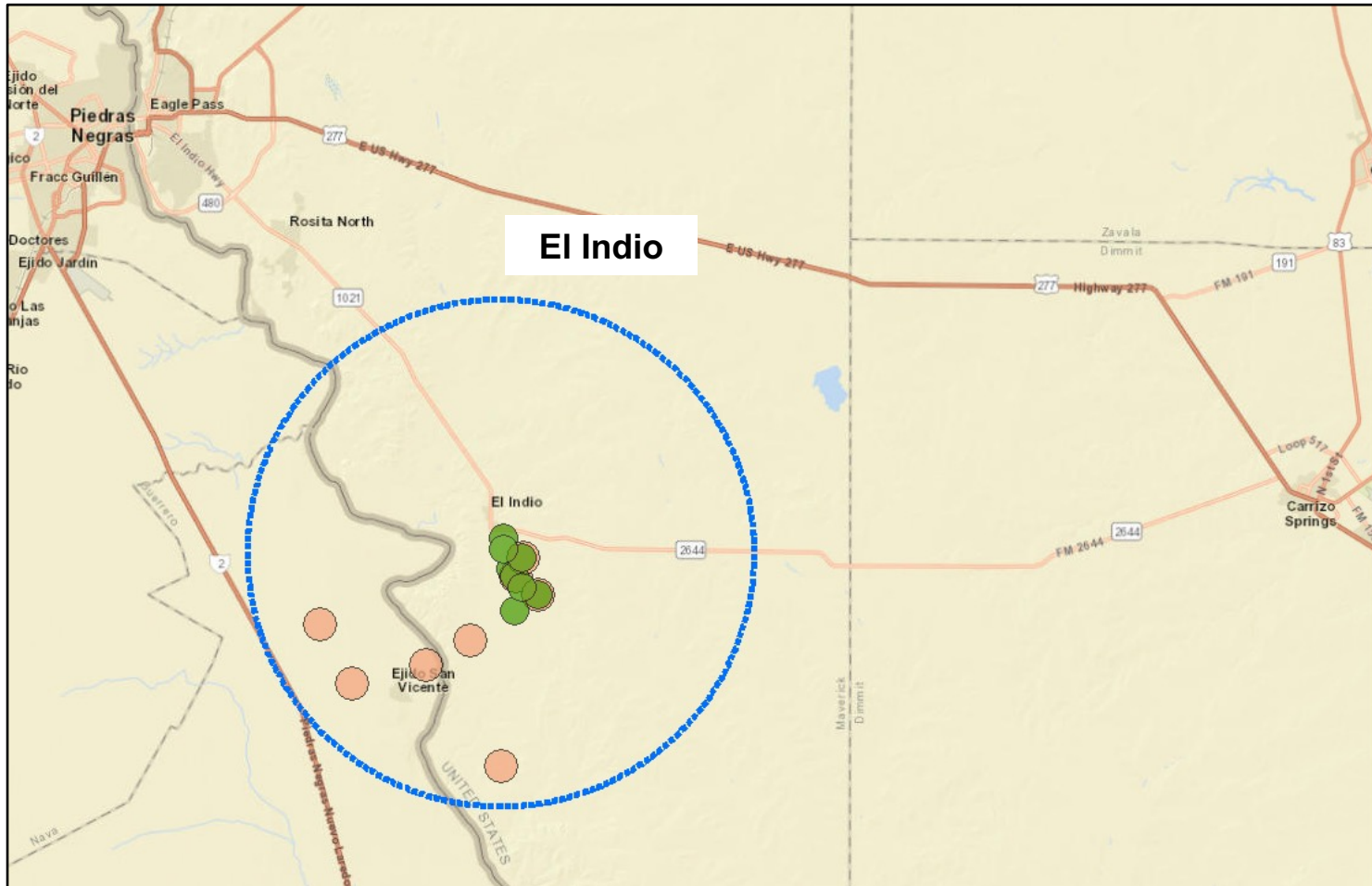
# SIR (2 of 3)



- Howard & Martin County
- Daily Volume/Pressure Reporting
- No Response taken yet
- Operator Group created



# SIR (3 of 3)



- Maverick County
- One disposal well in Georgetown Formation
- Daily Volume/Pressure Reporting





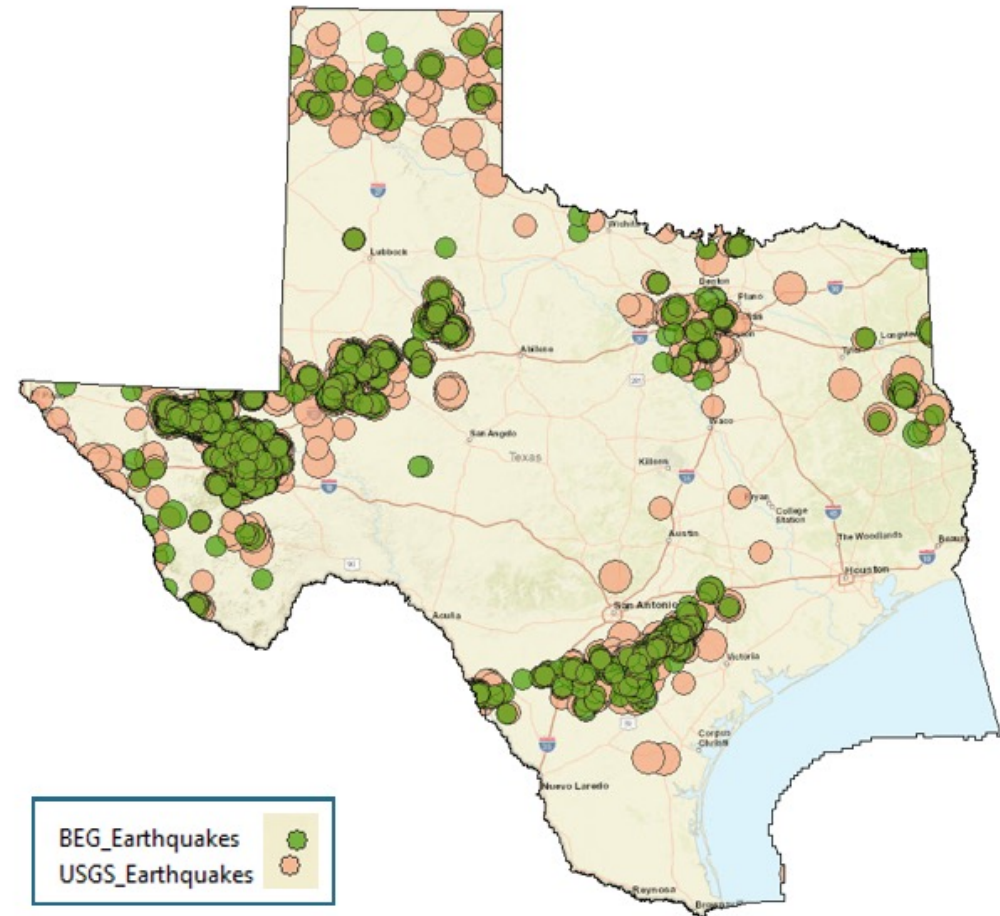
# Conclusion

What's the goal?

# One more time....



- Monitoring Seismic activity
- Designating investigation area
- Gathering additional information
- Analyzing available and new information
- Taking appropriate action



# Our Mission



## RRC Mission Statement

Our mission is to serve Texas by our stewardship of natural resources and the environment, our concern for personal and community safety, and our support of enhanced development and economic vitality for the benefit of Texans.

# Questions?



## **Rob Castillo**

Seismicity Team Lead

Injection-Storage Permits Unit

Oil & Gas Division

Railroad Commission of Texas

512-463-7152

# Sources of Texas Earthquake Information



- TexNet Earthquake Catalog
  - 2017 to present
  - <https://www.beg.utexas.edu/texnet-cisr/texnet/earthquake-catalog>
- USGS Earthquake Catalog
  - 1973 to present
  - <https://earthquake.usgs.gov/earthquakes/search/>
- TexNet Reporting Tool
  - <https://injection.texnet.beg.utexas.edu/>
- TexNet Seismic Monitoring Program and the Center for Integrated Seismic Research (CISR)
  - <https://www.beg.utexas.edu/texnet-cisr/>