

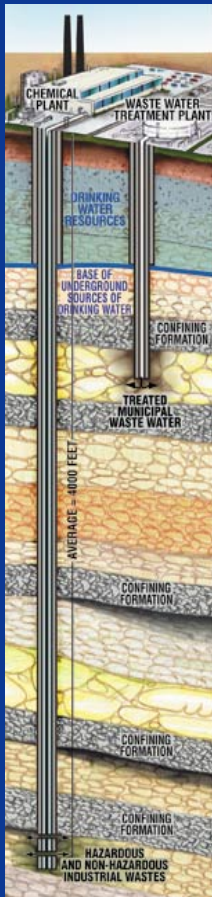


Texas Commission on Environmental Quality: Class I Injection Well Program Update

Ground Water Protection Council Forum
Orlando, Florida September 14, 2016

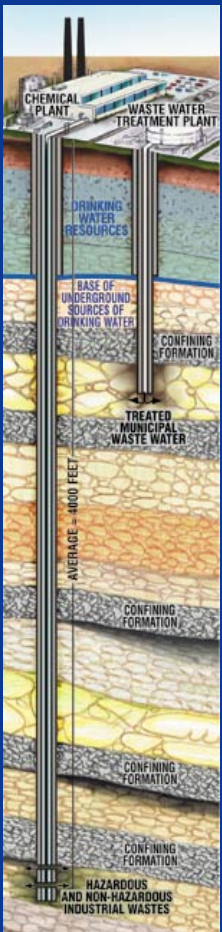
Lorrie Council, P.G., Manager, UIC Permits Section
David Murry, P.G. Senior Geologist, UIC Permits Section

Texas Commission on Environmental Quality
Office of Waste, Radioactive Materials Division



TCEQ: Class I Injection Well Program Update - Presentation Content

- Class I UIC General Program Information, Well Numbers and Locations, and Permitting Activities
- Recent Experience Plugging Older Class I Injection Wells
- Recent Experience Installing New Class I Injection Wells
- Considerations When Permitting Existing Class II Wells as Class I Wells in Texas
- Maintaining Positive Annular Pressure
- Maximum Allowable Surface Injection Pressure
- Cone of Influence and Area of Review
- Other Technical Considerations
- Questions and Contact Information

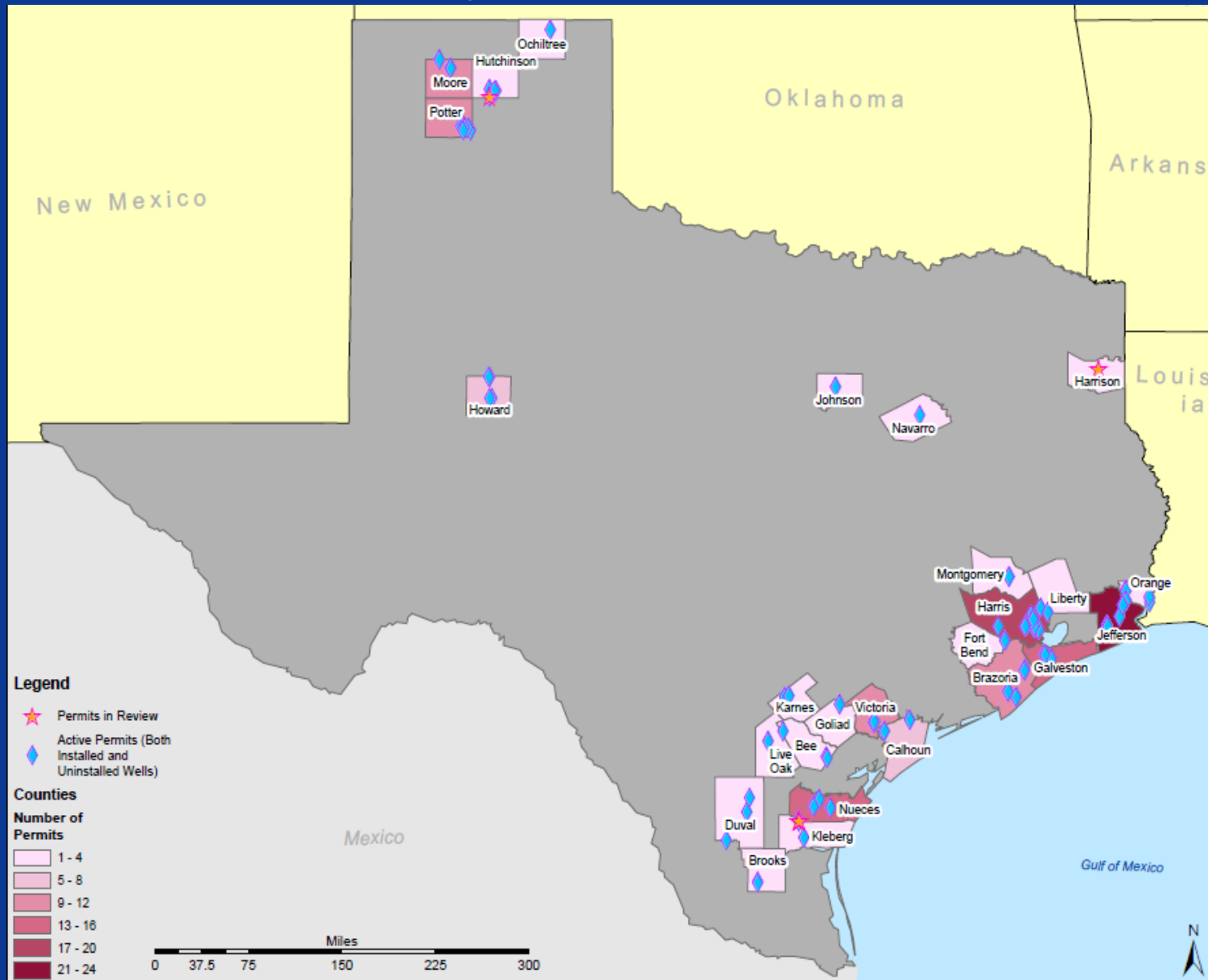




General Program Info: Texas Class I Well Inventory

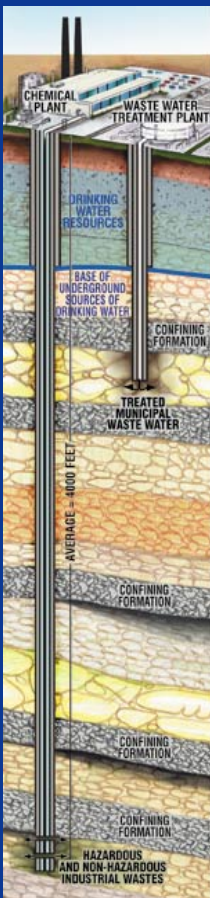
Well Class	Type of Injection Well	Number of Facilities	Permitted or Authorized Wells (Some Not Installed)	Installed & Active Permitted Wells	Wells Temporarily Abandoned	Other Wells (Plugged but Still Under Closure Review)
I	Hazardous Waste Disposal	24	75	53	4	3
I	Nonhazardous Waste Disposal	27	93	45	2	1
Total No. Facilities and Wells (as reported to EPA 2/26/16)		51	168	98	6	4

General Program Info: Active Class I Injection Well Permits in Texas



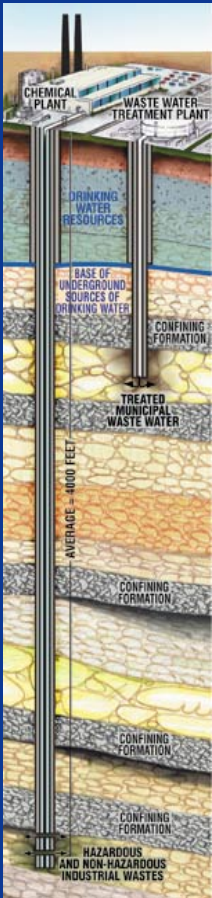
General Program Info: TCEQ UIC Class I Permit Applications Received and Permits Issued in 2015

Class I Applications		Class I Permits	
New Permit	3	New Permit	5
Permit Renewal	30	Permit Renewal	15
Permit Renewal/Major Amend	6	Permit Renewal/Major Amend	4
Permit Renewal/Minor Amend	3	Permit Renewal/Minor Amend	0
Major Amendment	0	Major Amendment	3
Minor Amendment	4	Minor Amendment	4
Minor Modification	15	Minor Modification	12
Endorsement	2	Endorsement	2
Transfer	6	Transfer	8
PIU Registration New/Renewal	1	PIU Registration New/Renewal	1
PIU Minor Amendment	0	PIU Minor Amendment	0



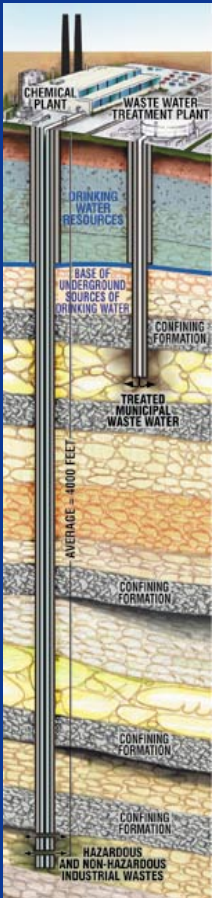
TCEQ Class I Well Permitting Highlights

- TCEQ received three new Class I permit applications for new facilities in 2015 and anticipates receiving applications for Class I wells for one or two new facilities. Several Class I renewal, amendment, and minor modification applications are in process as are transfers.
- Similar to occurrences in 2014, additional Class I applications were not able to initially be issued Railroad Commission “No-Harm” letters due to presence of newer petroleum reservoirs in Texas; this required Class I applicants to provide more detailed information to Railroad Commission for their evaluation.



Recent Experience Plugging Older Class I Injection Wells

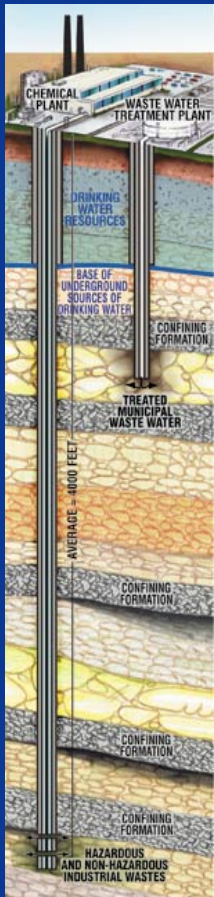
- Recently, Permittees have plugged or are in the process of plugging multiple Class I injection wells for various reasons:
 - April 2015 haz-waste well plugged; completed in over-pressure zone; Temporary Abandonment (TA) (operated 1981-2004)
 - August 2015 non-haz well plugged that had been in TA (operated 1977-2001)
 - August 2015 non-haz well (also permitted as a Class II well) plugged that had experienced MIT issues (operated as Class I 2006-2013)
 - Nov 2015 haz-waste well plugged; completed in over-pressured zone (operated 1988 – 2014)
 - November 2015 haz-waste well plugged; in TA (operated 1969-1991)
 - Currently in progress 3 haz-waste wells being plugged; in TA (operated 1987-2007; 1982-2006; 1995-2007)



Recent Experience Installing New Class I Injection Wells



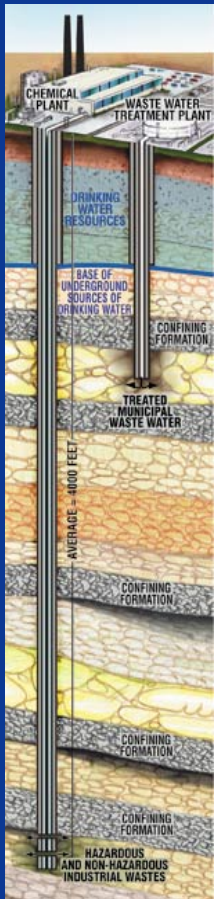
- New Class I injection wells installed in recent time:
 - March 2014 haz-waste well completion report approved
 - February 2016 non-haz well completion report approved; difficult drilling conditions requiring changes to well completion plan
 - Installed February 2016 non-haz well; completion report in review
 - Currently being installed haz-waste well; installation of well didn't go as planned; reworking well with new contractors
 - Currently being installed; non-haz well; difficult drilling conditions being encountered



Considerations When Permitting Existing Class II Wells as Class I Wells in Texas



- Statutory and rule-based differences in Oil & Gas Injection Well Operator Responsibilities & Liabilities and Solid Waste Disposal Responsibilities & Liabilities
- Must Have Landowner Consent to Disposal (not typically covered in an Oil & Gas lease)
- Solid Waste Disposal Authorization Must be Obtained for Class I Injection Well Permit (may be a separate permit)
- Disposal Fees Required on an Annual Basis During Operation
- Education Needed for Permit Applicants (Class II Operators) on Class I Regulatory Requirements & Permitting Process
- Increased Coordination with Railroad Commission of Texas





TCEQ Class I Wells: Maintaining Positive Annular Pressure

- TCEQ rules require that the “annulus pressure shall be at least 100 psi greater than the injection tubing pressure to prevent leaks” 30 TAC §331.63(e)
- Pressure differential is measured at the **surface**, but density and friction affect pressure drop in tubulars

$$\Delta P_{tubular} = \rho g D - \frac{f D}{2 d_i} \rho V^2$$

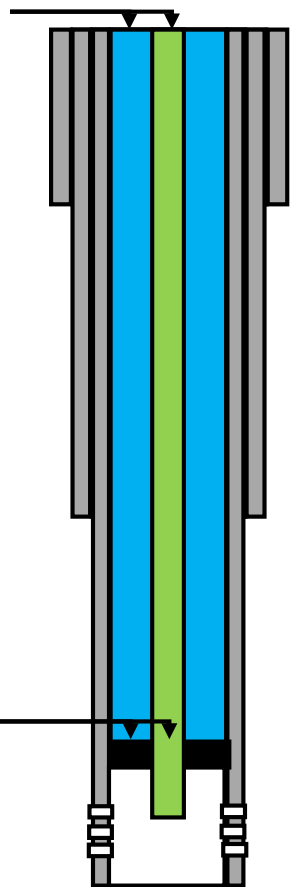
- We need to maintain positive annulus pressure from the surface down to the packer for leak prevention

$$P_{annulus} - P_{tubing} = 100 \text{ psi}$$

High specific gravity waste streams will gain hydrostatic pressure faster than annulus fluid

Low injection rates or large tubing diameters will cause less frictional pressure drop in tubing

$$P_{annulus} - P_{tubing} = ???$$

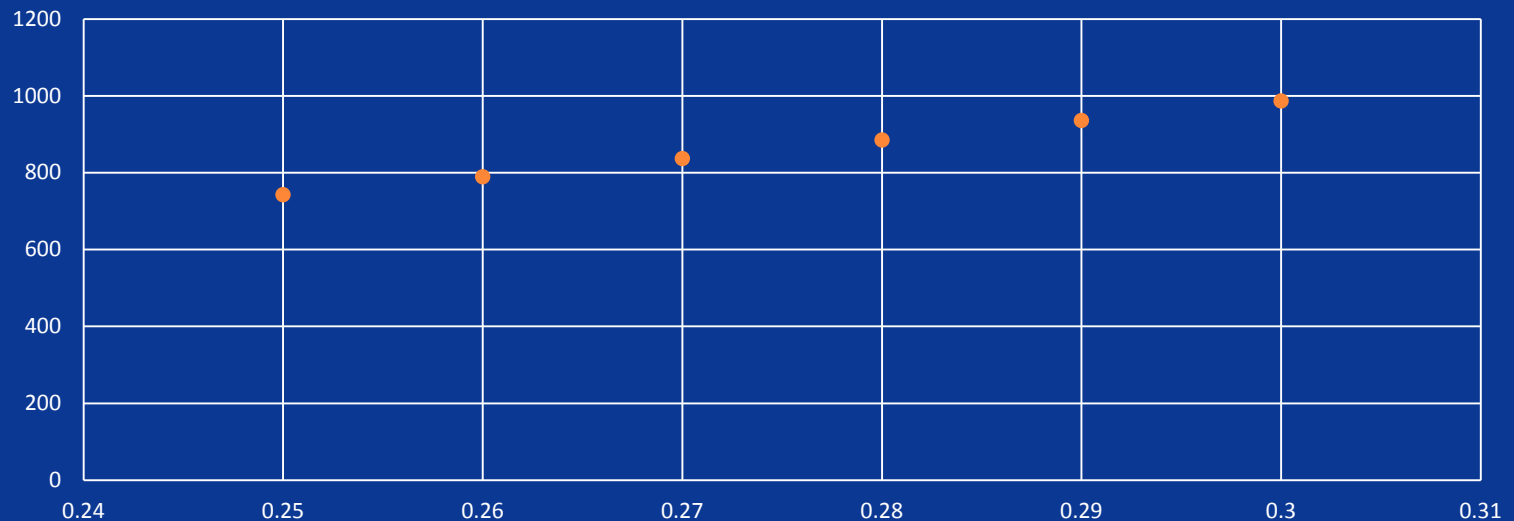




TCEQ Class I Wells: Maximum Allowable Surface Injection Pressure (MASIP)

- The MASIP is the max pressure at which the injection well can be operated to ensure injection doesn't initiate new fractures or propagate existing fractures in the confining zone or injection zone
- Calculation of the MASIP is most sensitive to Poisson's Ratio
- Values used for Poisson's Ratio must be supported:

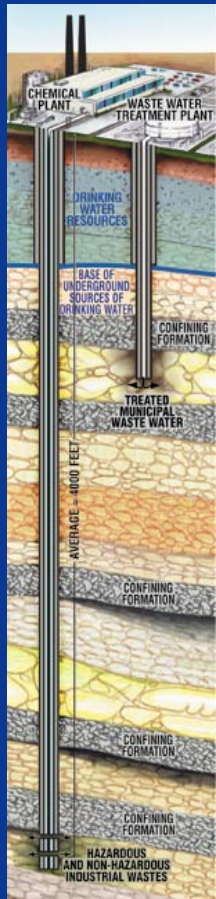
MASIP vs Poisson's Ratio





TCEQ Class I Wells: Area of Review (AOR) & Cone of Influence (COI)

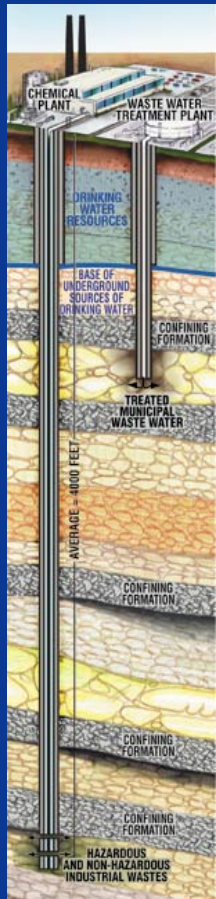
- The AOR for a Class I UIC well is the area surrounding the well for which a new or renewal permit application must provide detailed information on all artificial penetrations (APs), including all producing wells, injection wells, abandoned wells, and dry holes.
- AORs for Class I wells are described in Title 30 Texas Administrative Code (30 TAC) §331.42:
 - Class I hazardous and nonhazardous wells— [30 TAC §331.42\(a\)\(1\)](#)
 - Class I nonhazardous wells for disposal of drinking water treatment residuals and desalination concentrate— [30 TAC §331.42\(a\)\(2\)](#)
 - Class I salt cavern wells— [30 TAC §331.42\(a\)\(3\)](#)





TCEQ Class I Wells: AOR & COI

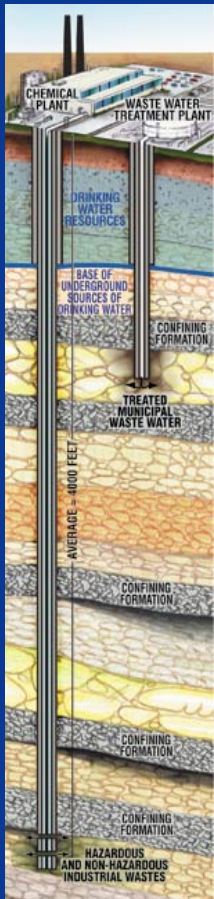
- For a Class I UIC well, the AOR is an area determined by 2.5-miles radius from the proposed or existing wellbore, or the area of the COI, whichever is greater.
- The COI is the potentiometric surface area around the injection well within which increased injection zone pressures caused by injection of wastes would be sufficient to drive fluids into a USDW. (30 TAC §331.2(31).
- The extent of the cone of influence is based on the projected life of the injection well. In Texas, a period of 30 years typically is used for life of a Class I UIC well.





TCEQ Class I Wells: AOR & COI

- Extent of COI may be based on method described in 30 TAC §331.42(b), which is used to determine the area of endangering influence (i.e., the area over which pressures in the injection zone may cause migration of the injected fluid or formation water into a USDW.
- For Class I UIC wells, TCEQ considers the COI to be the area surrounding the proposed or existing wellbore over which injection would result in a pressure increase within the injection zone sufficient to displace 9.0 pound per gallon (ppg) fluid in an open borehole.

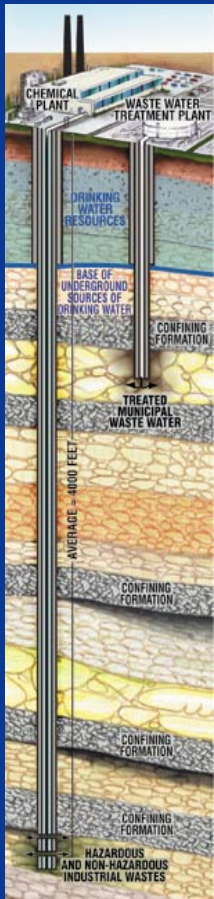




TCEQ Class I Wells: AOR & COI

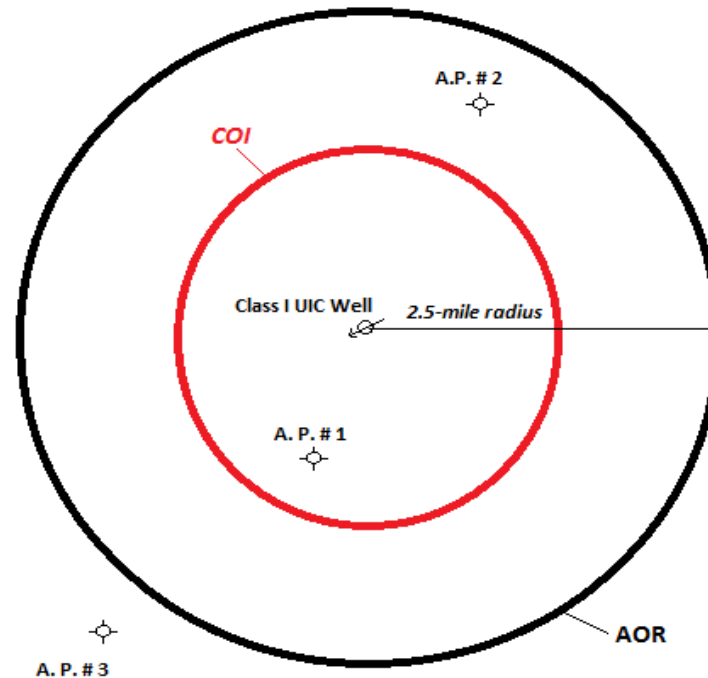
AOR Methods & Procedures

- AOR: Identify locations of all artificial penetrations (APs) within AOR
- Submit completion and plugging records on all APs, within the AOR, that penetrate the top of the confining zone and/or the injection zone
- Submit a well schematic for each AP within the COI, including:
 - Well status
 - Casing and line strings
 - Tubing
 - Open hole intervals
 - Top of cement behind pipe
 - Plugs
 - Mud weight
 - Perforations
 - Depth to USDW
 - Tops of confining zone, injection zone, and injection interval





TCEQ Class I Wells: AOR & COI Methods & Procedures



Information must be provided to demonstrate that A.P. #1 was constructed such that a pressure increase over the life of the injection well would not be sufficient to displace a 9.0 ppg fluid column in the A.P. wellbore.

Information must be provided on the construction of A.P. #2.

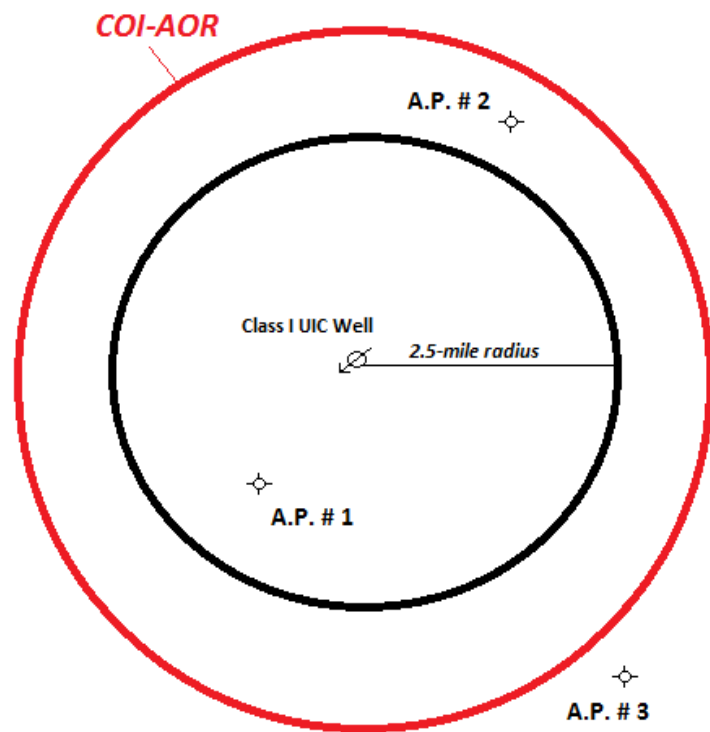
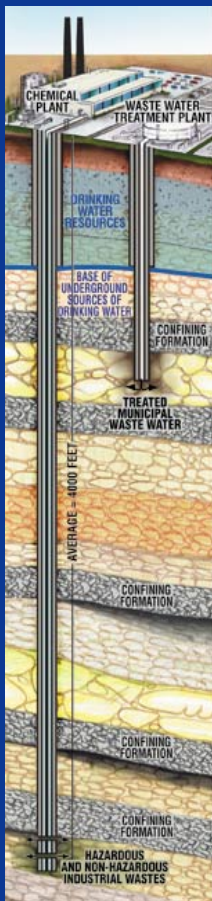
No information would be required for A.P. #3.

Area of Review Schematic
COI area < 2.5-mile radius area





TCEQ Class I Wells: AOR & COI Methods & Processes



Area of Review Schematic
COI area > 2.5-mile radius area

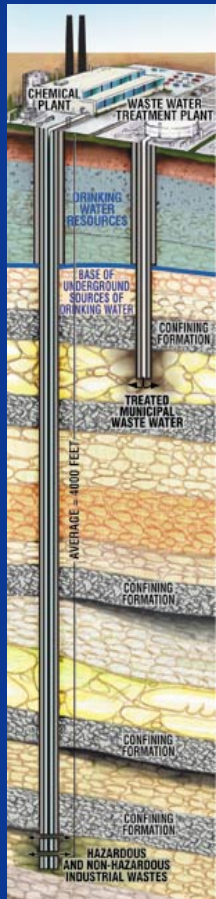
Information must be provided to demonstrate that A.P. # 1 and A.P. # 2 were constructed such that a pressure increase over the life of the injection well would not be sufficient to displace a 9.0 ppg fluid column in the A.P. wellbore.

No information would be required for A.P. # 3.



TCEQ Class I Wells: AOR & COI COI Determination

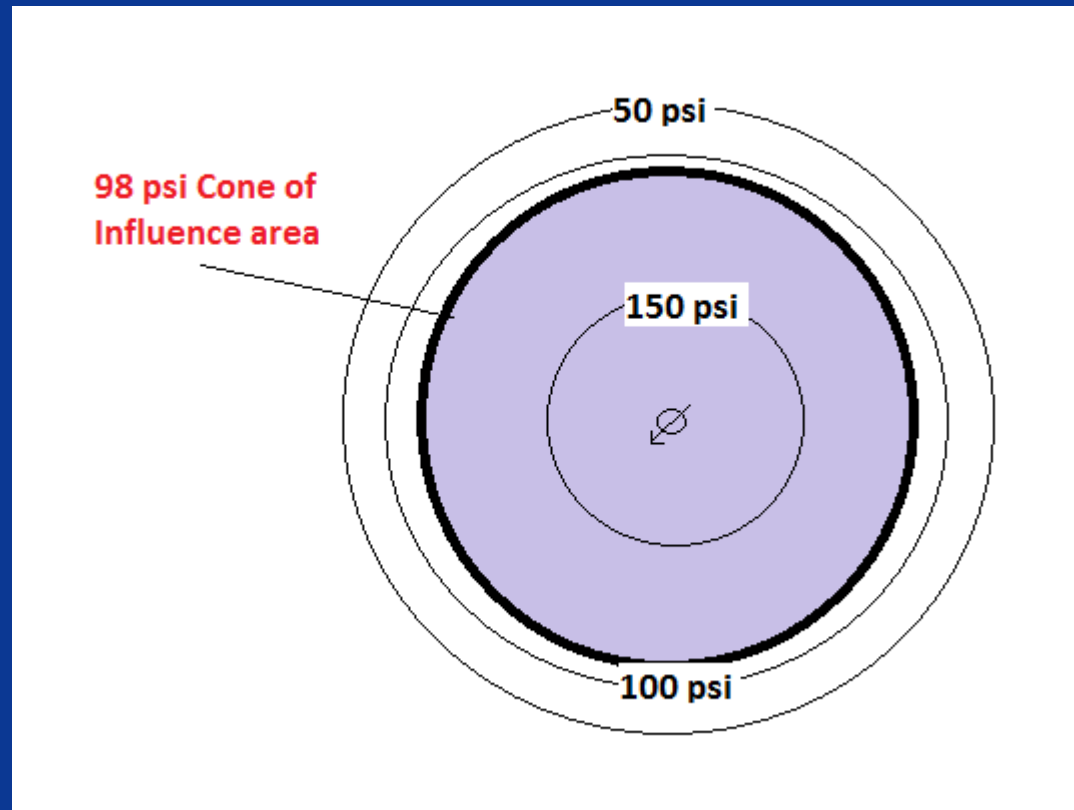
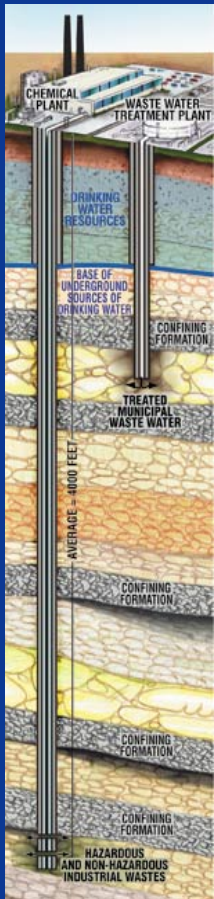
- Determine original formation pressure at the top of the injection reservoir;
- Determine pressure build-up based on injection at the maximum allowable injection rate over 30 years;
- Identify isobar at which pressure build-up plus the original formation pressure is sufficient to displace 9.0 ppg mud in a wellbore
- Example: Depth to top of injection zone: 5000 feet
Pressure gradient for 9.0 ppg mud: 0.4675 psi/ft
Initial Formation Pressure at top of injection zone: 2240 psi
 $5000 \text{ feet} \times 0.4675 \text{ psi/ft} = 2338 \text{ psi}$
 $2338 \text{ psi} - 2240 \text{ psi} = 98 \text{ psi}$
COI is area within the 463 psi isobar





TCEQ Class I Wells: AOR & COI COI Determination, Cont.

- Example: Resulting AOR





TCEQ Class I Wells: Other Recent Technical Considerations

Induced Seismicity Concerns:

- Currently reviewing locations of Class I UIC wells with regard to earthquake occurrences
 - Historical earthquake occurrences
 - Regional Geology
 - Structure
 - Stratigraphy
- To date, there is no evidence that the mechanical integrity of any Class I UIC wells in Texas have been compromised by a seismic event

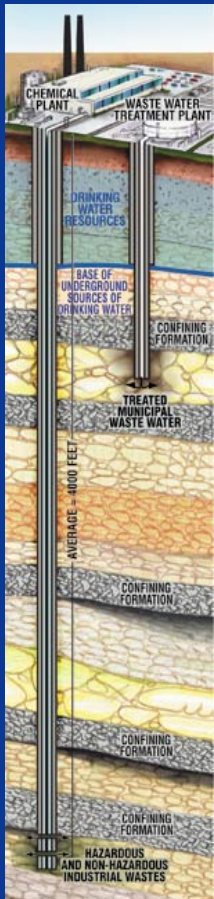




TCEQ Class I Wells: Other Recent Technical Considerations

Key References TCEQ Used In Evaluating Induced Seismicity:

- *Minimizing and Managing Potential Impacts of Injection-Induced Seismicity from Class II Disposal Wells: Practical Approaches.* Underground Injection Control National Technical Workgroup, USEPA, February 6, 2015.
- *Induced or Triggered Earthquakes in Texas: Assessment of Current Knowledge and Suggestions for Future Research.* Clifford Frohlich, Institute for Geophysics, University of Texas at Austin



UIC Program Contact Information



Lorrie Council, PG, Manager, UIC Permits Section
Phone: 512-239-6461, Fax: 512-239-6464
Email: lorrie.council@tceq.texas.gov

David Murry, PG, Sr. Geologist, UIC Permits Section
Phone: 512-239-6080, Fax: 512-239-6464
Email: david.murry@tceq.texas.gov

Texas Commission on Environmental Quality
Radioactive Materials Division, Office of Waste
Main RMD/UIC Phone: 512-239-6466

http://www.tceq.texas.gov/permitting/waste_permits/uic_permits/uic.html

