

# SALT WATER DISPOSAL TERMS AND DATA

## GENERAL DEFINITIONS AND INFORMATION

### **What is “parts per million” or ppm?**

In terms of water, 1 part per million or 1 ppm is equal to 1 milligram of something per liter of water.<sup>1</sup> It would be approximately 1 teaspoon of something in a cube of water measuring 21 feet on all sides.

### **What is salinity?**

Salinity is the saltiness or dissolved salt content of a body of water.<sup>2</sup>

Typical Salinity Levels in Water<sup>3</sup> (ppm is parts per million)

- drinking water - 100 ppm
- restriction on drinking water - 500 ppm
- limit drinking water - 1000 ppm
- limit agriculture irrigation - 2000 ppm
- brackish water - 500 - 30,000 ppm
- sea water - 30,000 - 50,000 ppm
- brine > 50,000 ppm
- flowback and produced water from natural gas drilling fracking – 80,000 – 180,000 ppm

### **What is flowback and/or produced water?**

Flowback is water that returns to the surface during the completion phase of the well (after hydraulic fracturing). It is a mixture of the water used in the hydraulic fracturing process, chemicals and water returning from the geological formation being drilled. Typically, the volume of flowback water is greater during the first week after completion and through the first month. It also has a lower salinity of up to 80,000 ppm when compared to produced water. The salinity of seawater by comparison is 30,000 – 50,000 parts per million (ppm).

Produced water is naturally occurring wastewater from the geological formation being drilled. The salinity of produced water may range from 80,000 to 180,000 ppm.

### **What is the breakdown, in gallons, of produced water and frack water from a typical gas well?**

Estimates for volumes of flowback water are variable. They reportedly range from 15-40% of the water used in the fracturing process. Water requirements for fracturing a gas well are estimated

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<sup>1</sup> [http://groups.molbiosci.northwestern.edu/holmgren/Glossary/Definitions/Def-P/parts\\_per\\_million.html](http://groups.molbiosci.northwestern.edu/holmgren/Glossary/Definitions/Def-P/parts_per_million.html)

<sup>2</sup> <http://en.wikipedia.org/wiki/Salinity>, accessed Dec 22, 2011

<sup>3</sup> [http://www.engineeringtoolbox.com/water-salinity-d\\_1251.html](http://www.engineeringtoolbox.com/water-salinity-d_1251.html), accessed Dec 22, 2011

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from 3.5 to 5 million gallons. Highest and lowest estimates would be 525,000 to 2,000,000 gallons that would return during approximately the first month after the fracturing.

Produced water is waste water that comes out of the formation. Its volume is also variable depending on location. Estimates are 100-1,300 gallons/day/well and declining over time.

## **How many gallons of water in a barrel?**

42 U.S. gallons = 1 barrel

## **At what depth do drillers hit the Barnett Shale formation in Tarrant County?**

Depth to top of Barnett is 6,500 to 8,500 feet depending on location.<sup>4</sup>

## **What is the thickness of the Barnett Shale formation in Tarrant County?**

Thickness of the Barnett varies from 100 – 600 feet.<sup>5</sup> Areas around Muenster to the north may be as thick as 900 feet.

## **At what depth does the Ellenberger formation begin in Tarrant County?**

Ellenberger depth begins at approximately 7,500 feet

## **What is the thickness of the Ellenberger formation in Tarrant County?**

Thickness unknown as this is the layer before consolidated granite is reached. In some areas this begins at 10,000 feet so upwards of 2500 thick.

## **At what depth is drilling waste water deposited?**

Ellenberger begins approximately 7500 feet. The Texas Railroad Commission permits high volume wells (e.g. daily disposal rates of 5,000 barrels or greater) into the Ellenberger by policy. Other low volume wells could be permitted into shallower formations.

## **SALT WATER DISPOSAL (SWD)**

### **Is there a current recommended ordinance to regulate SWD wells in Fort Worth?**

Yes. City staff brought forward a recommendation to the City Council on December 6, 2011. The City Council subsequently directed staff to hold a series of public meetings to receive public input on salt water disposal as well as water use. A copy of the previously recommended language is attached at the end of this document.

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<sup>4</sup> Hayden, J. and Purcell, D. 2005, *The Barnett Shale. Visitors Guide to the Hottest Gas Play in the U.S.* October 2005.

<sup>5</sup> Hayden, J. and Purcell, D. 2005, *The Barnett Shale. Visitors Guide to the Hottest Gas Play in the U.S.* October 2005.

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**Is public notice of intended SWD wells required, or have they been exempted from notice?**

Notice is required by the City's gas drilling ordinance for residences within 1000 feet of the well (site) and Neighborhood Associations with ½ mile.

**How many and where are SWD wells currently located in Tarrant County?**

See attached map.

**What is the typical cost, or cost range, of creating an SWD well in this area?**

Cost is significant and vary from \$2.5 million and upward depending on rate and type of facility.

**For how many years can a disposal well typically receive and hold SWD fluids?**

Life of a SWD well is undeterminable. Life will last as long as well bore maintains integrity.

**What is the typical current distance between Tarrant County gas wells and disposal wells?**

There is no typical distance. SWD wells can share the same pad with a gas well.

**What is the current total cost per gallon of depositing drilling water into an SWD well?**

40 to 65 cents per barrel not including travel cost.

**How much solid waste might be typically generated from a gallon of produced water?**

TDS of produced water varies from 80,000 to 180,000 ppm.

1 ppm = 8.345 lbs/million gallons of water.     $80,000 \times 8.345/1,000,000 = 0.67 \text{ lbs/gal}$   
 $180,000 \times 8.345/1,000,000 = 1.5 \text{ lbs/gal}$

Suspended solids such as sand are not included.

**How and where is solid waste disposed?**

Solid waste would be disposed of at a facility approved by the Texas Railroad Commission and the tceq such as Itasca, Texas.

## **TRANSPORTATION OF WASTE (TRUCKING/SALT WATER PIPELINES)**

**How many gallons of water does a typical waste water truck haul?**

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The capacity for a typical waste water truck is 190 barrels or 8,000 gallons. Weight limits on roadway may determine actual volumes being hauled.

**What is the typical hauling distance from a drill site to a recycling facility?**

There is not a typical distance. Operators would desire a facility close to their operations to minimize truck mileage and associated cost.

**Please confirm that the constructors of disposal pipelines do or do not possess eminent domain rights. Does this apply to street crossings?**

Operators obtaining easement or right-of-way for salt water pipelines do not have eminent domain authority in Texas.

**Is there a City master plan for pipeline routes? If so, where can it be read?**

There is no master plan for either gas or salt water pipelines. Proposed pipelines are reviewed by city staff to determine impacts on public facilities and for the purpose of preparing license agreements etc... Gas pipelines that are planned to go through residential developed areas are also reviewed by a staff committee in an open meeting and require a notice to owners along the proposed route

## WATER USE/RECYCLING

**What is commercial water rate that the City of Fort Worth charges a gas operator under contract?**

\$6/1000 gallons

**What is the current total cost per gallon of recycling drilling water?**

Cost varies based on the technology used. Can be less than \$1.00/bbl upwards to \$5-6/bbl

**Can on-site water recycling equipment (e.g., NOMAD) operate within urban drilling sites?**

Yes. However, centralized treatment facilities would require larger areas of land to place equipment. Mobile units would also require adequate space either on the well pad site or adjacent. The feasibility of using these types of options decreases as the density of development increases.

**How many drilling water pits and/or ponds are located in Tarrant County and where are they?**

Unknown drill pits in county, 0 within the city. Freshwater ponds/pits are allowed by the City's gas drilling ordinance but do not contain added chemicals or drilling by products.

## EARTHQUAKES

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## How are the fault lines that may lead to an increased potential for earthquakes checked/monitored?

The Commission adheres to the code of Federal Regulation (146.22) part (a) (Title 40-- Protection of the Environment Chapter 1- EPA part 146-- UIC Program: Criteria and Standards) addressing construction requirements states, "All new wells shall be sited in such a fashion that they inject into a formation separated from any USDW (Underground Source of Drinking Water(s) -- water typically between 3,000 and 10,000 TDS - total dissolved solids) by a confining zone that is free of known open faults or fractures within the Area of Review (AOR)".

The AOR is a set radius around the applicant well (usually 1/4 mile) that is examined as part of the application review process for conduits that could potentially allow injected fluids to migrate out of the permitted injection interval.

If the Commission were to become aware of a breach in fluid confinement a permit suspension would take place until a proper resolution is achieved.<sup>6</sup>

## How does CFW staff consider and apply knowledge of existing geological fault lines (Ouchita/Balcones) to drilling and pipeline permits?

City staff does not review or consider geologic fault lines for drilling or pipeline permits. Jurisdiction falls under the Texas Railroad Commission.

## What's in Hydraulic Fracturing Fluid?

Water and sand make up 98 to 99.5 percent of the fluid used in hydraulic fracturing. In addition, chemical additives are used. The exact formulation varies depending on the well.<sup>7</sup>

## What Chemicals are used in the hydraulic fracturing process?

As previously noted, chemicals perform many functions in a hydraulic fracturing job. Although there are dozens to hundreds of chemicals which could be used as additives, there are a limited number which are routinely used in hydraulic fracturing. The following is a list of the chemicals used most often. This chart is sorted alphabetically by the Product Function to make it easier for you to compare to the fracturing records .

<u>Chemical Name</u>	<u>CAS</u>	<u>Chemical Purpose</u>	<u>Product Function</u>
Hydrochloric Acid	007647-01-0	Helps dissolve minerals and initiate cracks in the rock	Acid

<sup>6</sup> Email response, Gil Bujano, Deputy Director, Texas Railroad Commission, Oil and Gas Division's Technical Permitting Section, 1/4/2012.

<sup>7</sup> <http://fracfocus.org/chemical-use/what-chemicals-are-used>, accessed 1-11-12

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Glutaraldehyde	000111-30-8	Eliminates bacteria in the water that produces corrosive by-products	Biocide
Quaternary Ammonium Chloride	012125-02-9	Eliminates bacteria in the water that produces corrosive by-products	Biocide
Quaternary Ammonium Chloride	061789-71-1	Eliminates bacteria in the water that produces corrosive by-products	Biocide
Tetrakis Hydroxymethyl-Phosphonium Sulfate	055566-30-8	Eliminates bacteria in the water that produces corrosive by-products	Biocide
Ammonium Persulfate	007727-54-0	Allows a delayed break down of the gel	Breaker
Sodium Chloride	007647-14-5	Product Stabilizer	Breaker
Magnesium Peroxide	014452-57-4	Allows a delayed break down the gel	Breaker
Magnesium Oxide	001309-48-4	Allows a delayed break down the gel	Breaker
Calcium Chloride	010043-52-4	Product Stabilizer	Breaker
Choline Chloride	000067-48-1	Prevents clays from swelling or shifting	Clay Stabilizer
Tetramethyl ammonium chloride	000075-57-0	Prevents clays from swelling or shifting	Clay Stabilizer
Sodium Chloride	007647-14-5	Prevents clays from swelling or shifting	Clay Stabilizer
Isopropanol	000067-63-0	Product stabilizer and / or winterizing agent	Corrosion Inhibitor
Methanol	000067-56-1	Product stabilizer and / or winterizing agent	Corrosion Inhibitor
Formic Acid	000064-18-6	Prevents the corrosion of the pipe	Corrosion Inhibitor
Acetaldehyde	000075-07-0	Prevents the corrosion of the pipe	Corrosion Inhibitor
Petroleum Distillate	064741-85-1	Carrier fluid for borate or zirconate crosslinker	Crosslinker
Hydrotreated Light Petroleum Distillate	064742-47-8	Carrier fluid for borate or zirconate crosslinker	Crosslinker
Potassium Metaborate	013709-94-9	Maintains fluid viscosity as temperature increases	Crosslinker
Triethanolamine Zirconate	101033-44-7	Maintains fluid viscosity as temperature increases	Crosslinker
Sodium Tetraborate	001303-96-4	Maintains fluid viscosity as temperature increases	Crosslinker
Boric Acid	001333-73-9	Maintains fluid viscosity as temperature increases	Crosslinker
Zirconium Complex	113184-20-6	Maintains fluid viscosity as temperature increases	Crosslinker
Borate Salts	N/A	Maintains fluid viscosity as temperature increases	Crosslinker
Ethylene Glycol	000107-21-1	Product stabilizer and / or winterizing agent.	Crosslinker
Methanol	000067-56-1	Product stabilizer and / or winterizing agent.	Crosslinker
Polyacrylamide	009003-05-8	"Slicks" the water to minimize friction	Friction Reducer
Petroleum Distillate	064741-85-1	Carrier fluid for polyacrylamide friction reducer	Friction Reducer
Hydrotreated Light Petroleum Distillate	064742-47-8	Carrier fluid for polyacrylamide friction reducer	Friction Reducer
Methanol	000067-56-1	Product stabilizer and / or winterizing agent.	Friction Reducer

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Ethylene Glycol	000107-21-1	Product stabilizer and / or winterizing agent.	Friction Reducer
Guar Gum	009000-30-0	Thickens the water in order to suspend the sand	Gelling Agent
Petroleum Distillate	064741-85-1	Carrier fluid for guar gum in liquid gels	Gelling Agent
Hydrotreated Light Petroleum Distillate	064742-47-8	Carrier fluid for guar gum in liquid gels	Gelling Agent
Methanol	000067-56-1	Product stabilizer and / or winterizing agent.	Gelling Agent
Polysaccharide Blend	068130-15-4	Thickens the water in order to suspend the sand	Gelling Agent
Ethylene Glycol	000107-21-1	Product stabilizer and / or winterizing agent.	Gelling Agent
Citric Acid	000077-92-9	Prevents precipitation of metal oxides	Iron Control
Acetic Acid	000064-19-7	Prevents precipitation of metal oxides	Iron Control
Thioglycolic Acid	000068-11-1	Prevents precipitation of metal oxides	Iron Control
Sodium Erythorbate	006381-77-7	Prevents precipitation of metal oxides	Iron Control
Lauryl Sulfate	000151-21-3	Used to prevent the formation of emulsions in the fracture fluid	Non-Emulsifier
Isopropanol	000067-63-0	Product stabilizer and / or winterizing agent.	Non-Emulsifier
Ethylene Glycol	000107-21-1	Product stabilizer and / or winterizing agent.	Non-Emulsifier
Sodium Hydroxide	001310-73-2	Adjusts the pH of fluid to maintains the effectiveness of other components, such as crosslinkers	pH Adjusting Agent
Potassium Hydroxide	001310-58-3	Adjusts the pH of fluid to maintains the effectiveness of other components, such as crosslinkers	pH Adjusting Agent
Acetic Acid	000064-19-7	Adjusts the pH of fluid to maintains the effectiveness of other components, such as crosslinkers	pH Adjusting Agent
Sodium Carbonate	000497-19-8	Adjusts the pH of fluid to maintains the effectiveness of other components, such as crosslinkers	pH Adjusting Agent
Potassium Carbonate	000584-08-7	Adjusts the pH of fluid to maintains the effectiveness of other components, such as crosslinkers	pH Adjusting Agent
Copolymer of Acrylamide and Sodium Acrylate	025987-30-8	Prevents scale deposits in the pipe	Scale Inhibitor
Sodium Polycarboxylate	N/A	Prevents scale deposits in the pipe	Scale Inhibitor
Phosphonic Acid Salt	N/A	Prevents scale deposits in the pipe	Scale Inhibitor
Lauryl Sulfate	000151-21-3	Used to increase the viscosity of the fracture fluid	Surfactant
Ethanol	000064-17-5	Product stabilizer and / or winterizing agent.	Surfactant
Naphthalene	000091-20-3	Carrier fluid for the active surfactant ingredients	Surfactant

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Methanol	000067-56-1	Product stabilizer and / or winterizing agent.	Surfactant
Isopropyl Alcohol	000067-63-0	Product stabilizer and / or winterizing agent.	Surfactant
2-Butoxyethanol	000111-76-2	Product stabilizer	Surfactant

One of the problems associated with identifying chemicals is that some chemicals have multiple names. For example Ethylene Glycol (Antifreeze) is also known by the names Ethylene alcohol; Glycol; Glycol alcohol; Lutrol 9; Macrogol 400 BPC; Monoethylene glycol; Ramp; Tescol; 1,2-Dihydroxyethane; 2-Hydroxyethanol; HOCH<sub>2</sub>CH<sub>2</sub>OH; Dihydroxyethane; Ethanediol; Ethylene glycol; Glygen; Athylenglykol; Ethane-1,2-diol; Fridex; M.e.g.; 1,2-Ethandiol; Ucar 17; Dowtherm SR 1; Norkool; Zerex; Aliphatic diol; Ilexan E; Ethane-1,2-diol 1,2-Ethanedio.

This multiplicity of names can make a search for chemicals somewhat difficult and frustrating. However, if you search for a chemical by the CAS number it will return the correct chemical even if the name on the fracturing record does not match. For example if the fracturing record listed the chemical Hydrogen chloride and you searched for it by name using a chemical search site you may not get a result. But if you search for CAS # 007647-01-0 it might return Hydrochloric acid which is another name of Hydrogen chloride. Therefore, by using the CAS number you can avoid the issue of multiple names for the same chemical.

Multiple names for the same chemical can also leave you with the impression that there are more chemicals than actually exist. If you search the [National Institute of Standards and Technology \(NIST\) ‡](#) website the alternate names of chemicals are listed. This may help you identify the precise chemical you are looking for. The NIST site also contains the CAS numbers for chemicals. NIST is only one of many websites you can use to locate additional information about chemicals. You can also search the following websites using the chemical name or CAS number:

[OSHA/EPA Occupational Chemical Database ‡](#)

[The Chemical Database ‡](#)

[EPA Chemical Fact Sheets ‡](#)

‡ - When you click links marked with the ‡ symbol, you will leave the FracFocus website and go to websites that are not controlled by or affiliated with this site. <sup>8</sup>

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<sup>8</sup> <http://fracfocus.org/chemical-use/what-chemicals-are-used>, accessed 1-11-12

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## USEFUL LINKS FOR SWD's

**Railroad Commission frequently asked questions about salt water injection wells.**

<http://www.rrc.state.tx.us/about/faqs/saltwaterwells.php>

**Texas Water Code pertaining to regulation of salt water injection wells.**

<http://www.statutes.legis.state.tx.us/DocViewer.aspx?K2DocKey=odbc%3a%2f%2fTCAS%2fASUPUBLIC.dbo.vwTCAS%2fWA%2fS%2fWA.27%40TCAS2&QueryText=injection%3cOR%3ewells&HighlightType=1>

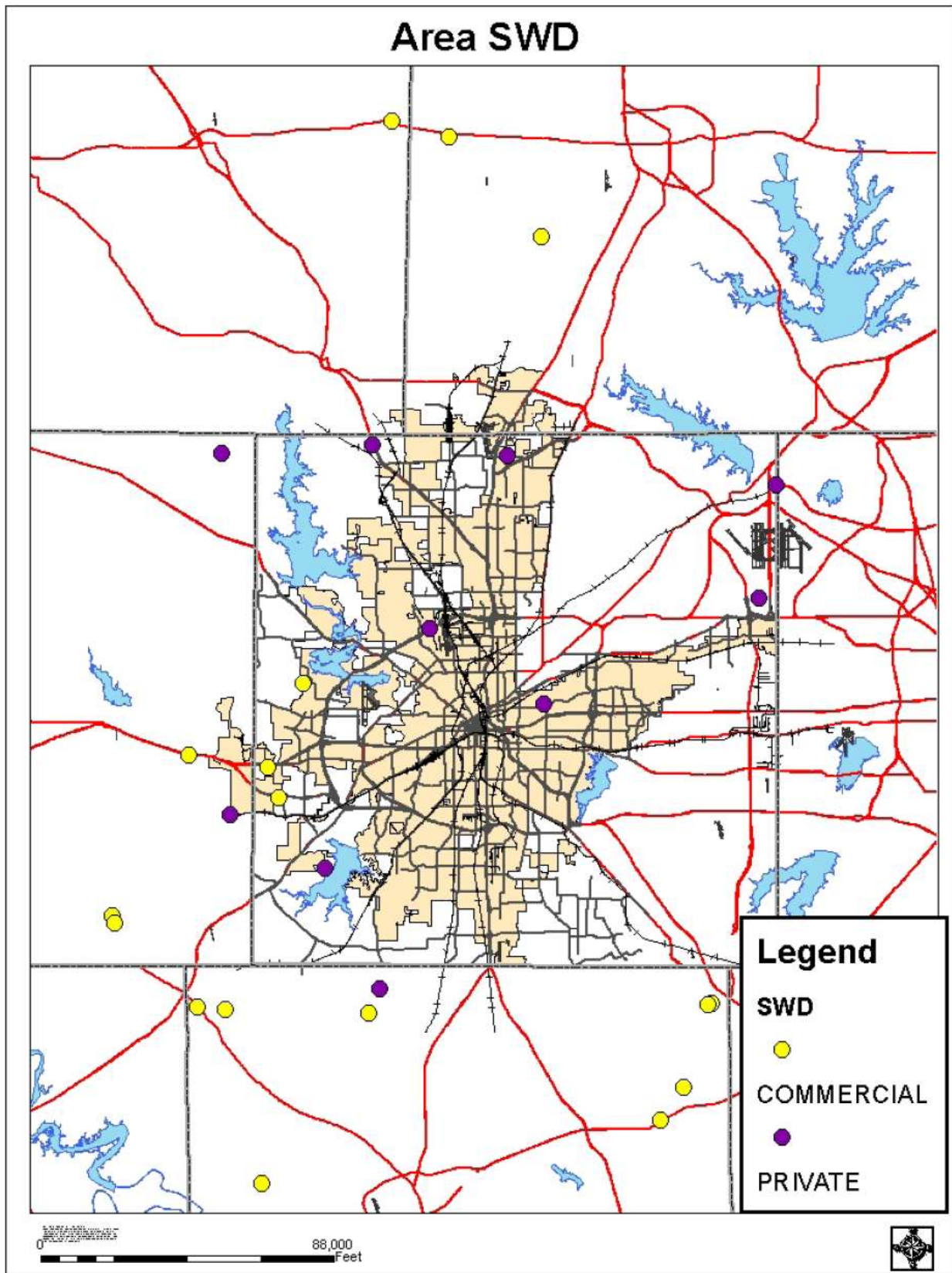
**EPA Information Regarding Underground Injection Wells**

<http://water.epa.gov/type/groundwater/uic/index.cfm>

**Hydraulic Fracturing Chemicals**

<http://fracfocus.org/chemical-use>

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## GAS DRILLING ORDINANCE – STAFF PROPOSAL

**29. Salt Water Wells.** Commercial salt water disposal wells may not be permitted within the city limits. The city may issue a permit for a salt water disposal well when used exclusively by one operator as identified on the Railroad Commission form W-14. All permit and notification requirements to obtain a state permit must first be submitted to the Gas Inspector prior to the operator obtaining a state permit. The city may then issue a permit for saltwater disposal when:

- a. The salt water disposal well is located in a “J” Medium Industrial, or “K” Heavy Industrial Zoned District;
- b. Notice that an application for a permit for a salt water disposal well has been made to the city be sent to all residences within one thousand, (1000) feet of the site and all neighborhood associations within a one half (1/2) mile;
- c. The maximum permitted sound levels conform to Section 15-42, Paragraph D.1. Compressor Noise Regulations of this Article;
- d. Access to the salt water disposal well is provided by a street(s) having an industrial collector classification or greater;
- e. The existing or planned salt water pipeline infrastructure is shown to reduce truck traffic on city roadways;
- f. A state permit is obtained from the Commission to dispose of non-hazardous oil and gas waste by injection into a porous formation not productive of oil and gas;
- g. The salt water disposal well waste is injected into the Ellenberger Formation, or deeper;
- h. The salt water disposal well is cased and cemented to the surface;
- i. The disposal well permit must be approved by the City Council if the property line of the well is located within one thousand (1,000) feet of a Protected Use;
- j. The disposal well is in compliance with all conditions of the state permit;
- k. The salt water disposal well site meets the requirements of Section 15.43 “Fences and Landscaping” of this Article;
- l. The disposal well is in compliance with any restrictions placed on the city permit; and
- m. Tank heights are no higher than 30 feet in “J” Medium Industrial and “K” Heavy Industrial Zoned Districts.

The City shall have the right to terminate the salt water disposal permit and require the well to be plugged and abandoned within thirty (30) days after notice of noncompliance.