# Water Disposal: A Growing Challenge*

**Owen C Pinnell**[1]

Search and Discovery Article #80286 (2013)**
Posted May 31, 2013

*Adapted from oral presentation given at AAPG Geoscience Technology Workshop, Solving Water Issues in the Oil Field: Using Geology and More, Fort Worth, Texas, February 26-27, 2013


[1]CEO Anterra Corporation, Santa Paula, CA (pinnello@anterraenergy.com)

## Summary

- Deep well disposal still is the lowest cost disposal option.
- Tight oil and gas development are driving the need for more Class 2 disposal (only of fluids associated with oil and gas production).
- Class 2 facilities are being asked to handle a broader range of fluids.
- Some competition from treatment technologies exist in high-cost markets.
- Levels of regulatory oversight (State and Local) are increasing.
- Capital investment in Class 2 facilities is trending higher.
- Class 2 injection is becoming associated with “fracing” in some markets.
- The industry enjoys an exemption from EPA RCRA regulations.

# WATER DISPOSAL

# A GROWING CHALLENGE

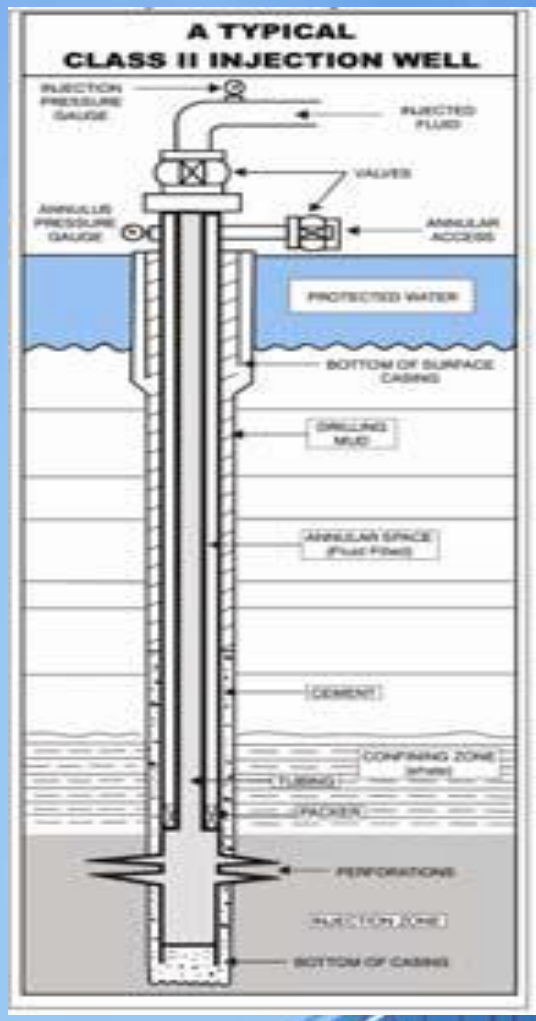
Owen C Pinnell

# WHAT IS CLASS 2 DISPOSAL

The EPA classifies different types of injection wells, Class 2 disposal wells can only be used to dispose of fluids associated with oil and gas production. The intent of the SDWA *Underground Injection Control (UIC) protocols is to protect aquifers from* contamination

Often saltier than seawater, brine can also contain toxic metals and radioactive substances. It can be very damaging to the environment and public health if it is discharged to surface water or the land surface. By injecting the brine deep underground, Class II wells prevent surface contamination of soil and water.

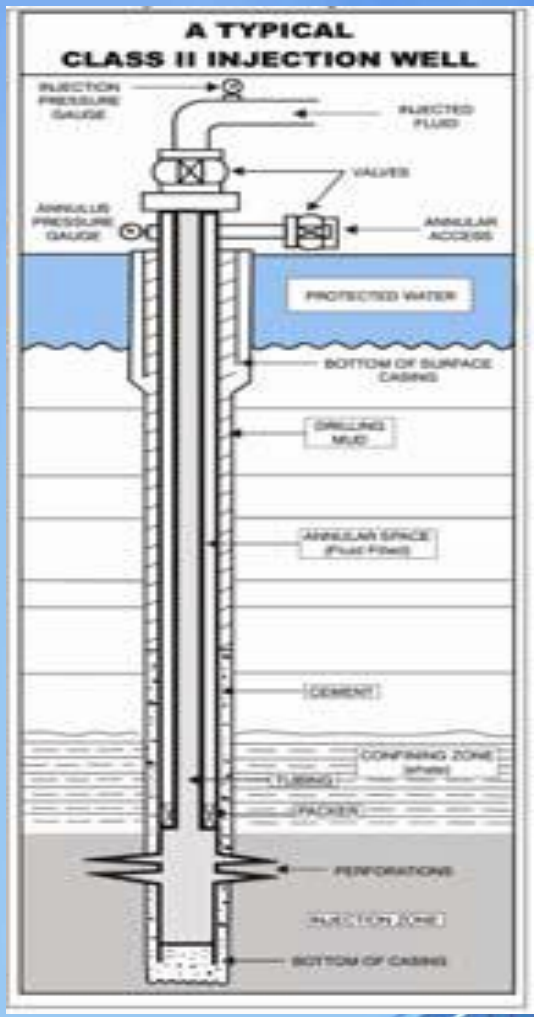
Injection zone isolated from groundwater by impermeable formations and steel and cement



# WHO REGULATES?

The EPA awarded State regulatory bodies primary enforcement responsibility over oil and gas injection and disposal wells in 1982.

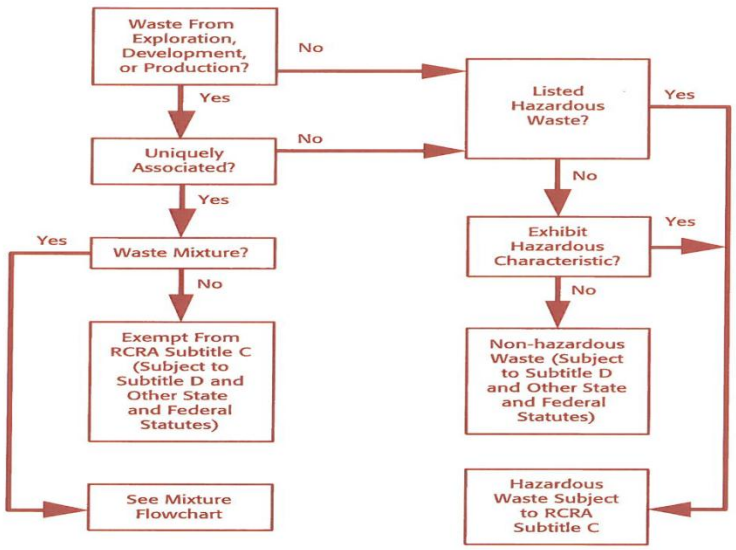
The States follow national guidelines under the Federal Drinking Water Act for surface and groundwater protection. Deep-well injection must satisfy the requirements of the 1974 *Safe Drinking Water Act (SDWA)*



# THE RCRA EXEMPTION

- In 1978, Congress exempted oilfield waste from RCRA Subtitle C hazardous waste regulations pending further study
- In 1988 the EPA issued a regulatory determination stating that control of E and P waste under RCRA Subtitle C regulations is not warranted
- The 1980 legislative amendments expanded the exemption to include drilling fluids, produced water and other wastes associated with oil and gas exploration and development

# WHAT WASTES ARE EXEMPT?



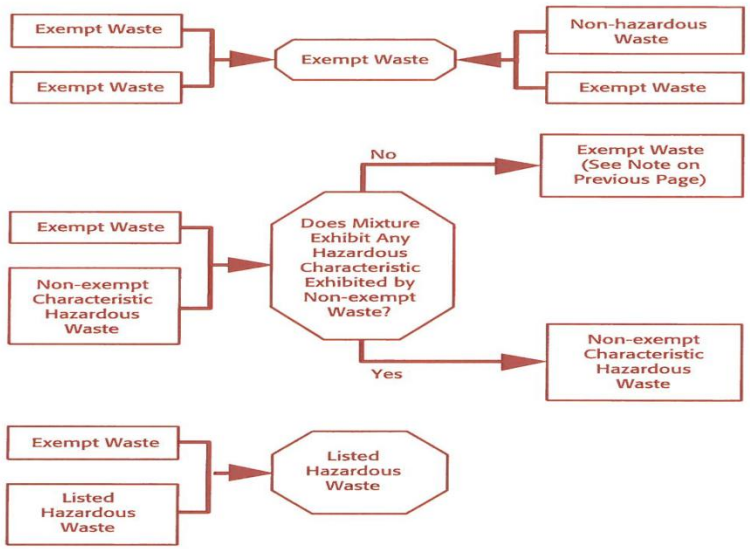
# EXEMPT WASTES

## Exempt E&P Wastes

- Produced water
- Drilling fluids
- Drill cuttings
- Rigwash
- Drilling fluids and cuttings from offshore operations disposed of onshore
- Geothermal production fluids
- Hydrogen sulfide abatement wastes from geothermal energy production
- Well completion, treatment, and stimulation fluids
- Basic sediment, water, and other tank bottoms from storage facilities that hold product and exempt waste
- Accumulated materials such as hydrocarbons, solids, sands, and emulsion from production separators, fluid treating vessels, and production impoundments
- Pit sludges and contaminated bottoms from storage or disposal of exempt wastes
- Gas plant dehydration wastes, including glycol-based compounds, glycol filters, and filter media, backwash, and molecular sieves
- Workover wastes
- Cooling tower blowdown
- Gas plant sweetening wastes for sulfur removal, including amines, amine filters, amine filter media, backwash, precipitated amine sludge, iron sponge, and hydrogen sulfide scrubber liquid and sludge
- Spent filters, filter media, and backwash (assuming the filter itself is not hazardous and the residue in it is from an exempt waste stream)
- Pipe scale, hydrocarbon solids, hydrates, and other deposits removed from piping and equipment prior to transportation
- Produced sand
- Packing fluids
- Hydrocarbon-bearing soil
- Pigging wastes from gathering lines
- Wastes from subsurface gas storage and retrieval, except for the non-exempt wastes listed on page 11
- Constituents removed from produced water before it is injected or otherwise disposed of
- Liquid hydrocarbons removed from the production stream but not from oil refining

# MIXING OILFIELD WASTE

**Possible Waste Mixtures and Their Exempt and Non-Exempt Status**



# BUT?

- In some jurisdictions (California) some oilfield waste should be treated as hazardous

  "If the toxicity is determined based on criteria other than Toxic Characteristic Leaching Procedure ("TCLP"), or the waste meets any of the other three characteristics or hazardous waste, namely ignitability, corrosivity, and reactivity"

- Some oily sludge demonstrates hazardous waste characteristics
- Current profiling practices, however, are unable to identify hazardous characteristics

# EXTENT OF CLASS 2 DISPOSAL

- More than 150,000 Class 2 wells in 33 states injected 10 trillion gallons of fluid
- Numbers increased rapidly in recent years, driven by expanding use of fracing
- According to the DOE, water production in the US is 14 million bbl/day
- Implicit costs of lifting and disposing of produced water is around $4 trillion/year
- Numbers suspect as recording accurate volumes not priority for producers or regulators
- No one does a full-system material balance

# THE SCOPE OF THE DISPOSAL BUSINESS

- Originally Class 2 disposal was for produced water only.
- In many jurisdictions, Class 2 oilfield waste includes mud and tank bottoms.
- The oilfield disposal plant is turning into a full service treatment facility.
- In Canada, most Class 2 disposal facilities are oil-pipeline connected.

# PRE-TREATMENT BEFORE INJECTION

- Water injectate  needs to be compatible with the receiving formations.
- Control  excessive solids, dissolved oil, corrosion, chemical reactions, or growth of microbes.
- Solids are usually treated by gravity settling or filtration.
- Residual amounts of oil contribute to plugging of receiving formations
- Corrosion can be exacerbated by various dissolved gases - primarily oxygen, carbon dioxide, and hydrogen sulfide.
- Oxygen scavengers and other treatment chemicals are available to minimize levels of undesirable dissolved gases.
- Bacteria, algae, and fungi can be controlled through filtration or the addition of biocides.

# WHAT GOES DOWN THE WELL?

- The overwhelming majority of injected fluid is oilfield brine.
- Small quantities of chemicals from drilling, completion and production operations.
- Small amounts of residual hydrocarbons can also be found in the produced water.
- Small amounts of undissolved solids (must filter) .
- Polymers from mud processing.

# WHAT CAN GO WRONG?

- Inadequate injection zone (low permeability and porosity).
- Scale and fouling in the well lowers well capacity.
- Seismic activity (broken casing, injection causes earthquakes?).
- Water surfacing from nearby wells and polluting land.
- Loss of mechanical integrity in the well (failed packer, hole in casing).
- Public relations due to sloppy operating practices, noise, odor, etc.

# HISTORIC PROBLEMS

- Fundamental safeguards are sometimes being ignored or circumvented.
- State regulators often do little to confirm what pollutants go into wells.
- Regulators rely heavily on an honor system.
- Companies are supposed to report:
  - what they are pumping into the earth
  - whether their wells are structurally sound
  - whether they have violated any rules
  - whether they have injected at excessive pressure levels
  - injection of fluid illegally or without a permit.
- Not meeting requirements to identify old or abandoned wells near injection sites.
- Sloppy housekeeping
- VOC emissions

# THE NEED FOR HIGHER STANDARDS

- “Fracking” and Class 2 disposal are becoming associated
- Plant design and operations coming under more scrutiny
- Facilities now need vapour collection and many have liners
- As a result public and regulatory oversight of Class 2 facilities is increasing
- Sloppy housekeeping encourages regulators to dig deeper


# ECONOMIC CONSIDERATIONS

**CAPEX**

- Capital cost of disposal well, drilled or re-completed
- Need for a back-up well
- Surface equipment, tanks, pumps, filters, specialty process equipment
- Providing trucking to facility

**OPERATING COSTS**

- Power consumption
- Personnel costs (24-hour operation)
- Fuel, chemical and lubricants
- Well maintenance (acid jobs, workovers, etc.)
- Regulatory compliance, emergency response

# PERMITTING REQUIREMENTS

- A map showing all nearby wells that penetrate the injection formation
- Average and maximum daily injection rate
- Detailed geologic data on the injection zone
- Detailed wellbore and facilities design
- Proposed well-stimulation program
- Actions required on nearby wells that penetrate the injection zone
- Calculated fracture gradient
- Injectivity tests to establish fracture pressure and operating pressure
- Mechanical Integrity test
- Approval of operating procedures
- Filling and verifying that tubing/casing annulus is liquid-full
- Instrumentation to continuously record pressure and volume
- Regular Bradenhead tests

# REGULATORY OVERSIGHT

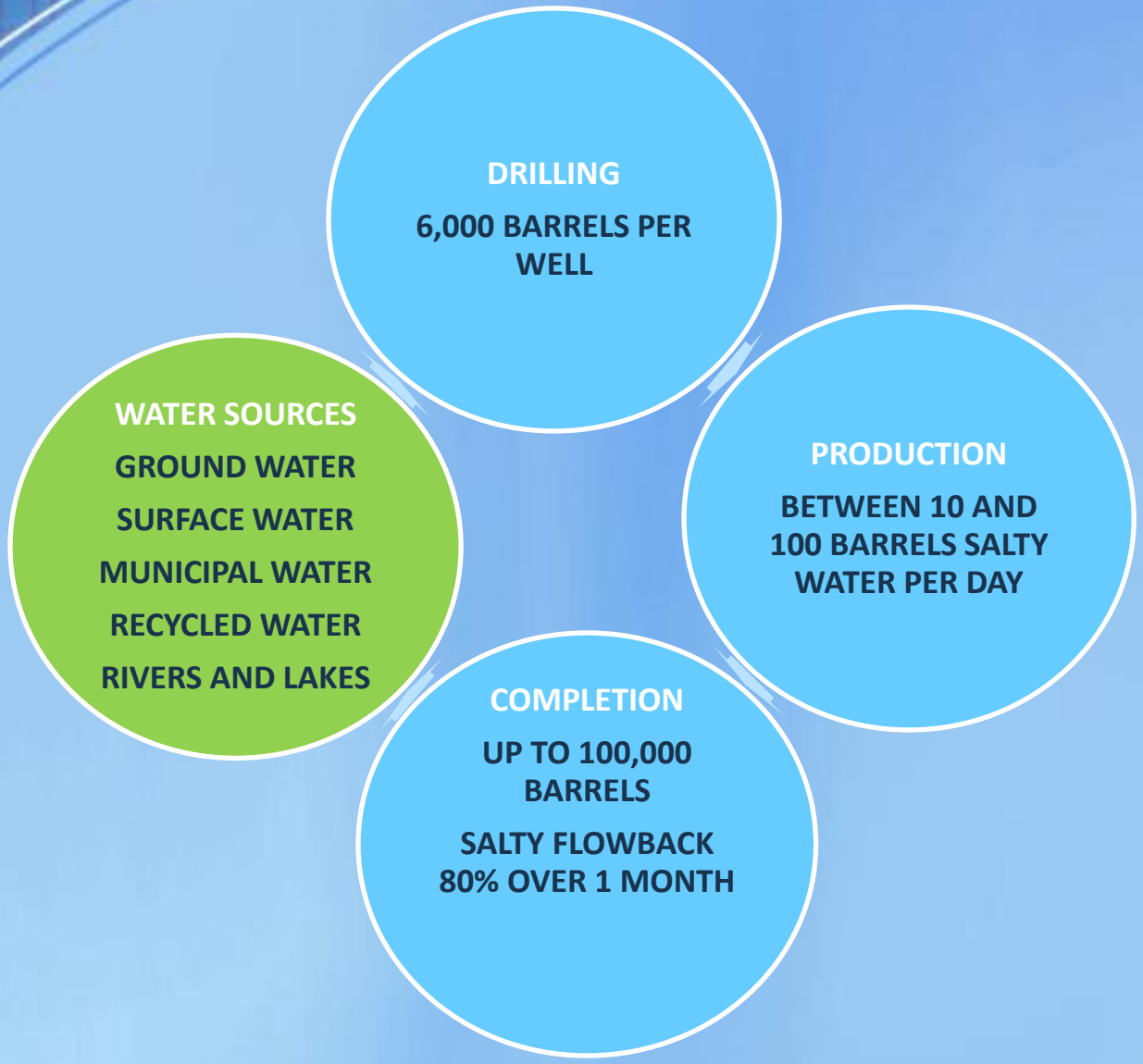
- Is the operator eligible for a permit (has no past due franchise taxes, has the required financial assurance, has no outstanding compliance problems applicable to the proposed injection operation)?
- Have affected persons been properly notified? (adjacent and mineral owners)
- A protest may be filed, operator advised of right to a hearing on the application.
- That the proposed injection well is properly completed to protect groundwater.
- Verify that there are no improperly completed, improperly plugged or unplugged and abandoned oil and gas wells of public records with ¼ mile of the proposed injection well.
- For a commercial disposal facility, there may be additional requirements:
  - restricted access through 24-hour security guard or a gated and locked facility
  - leak and overflow protection requirements
  - Vapor recovery

# PUBLIC NOTICE

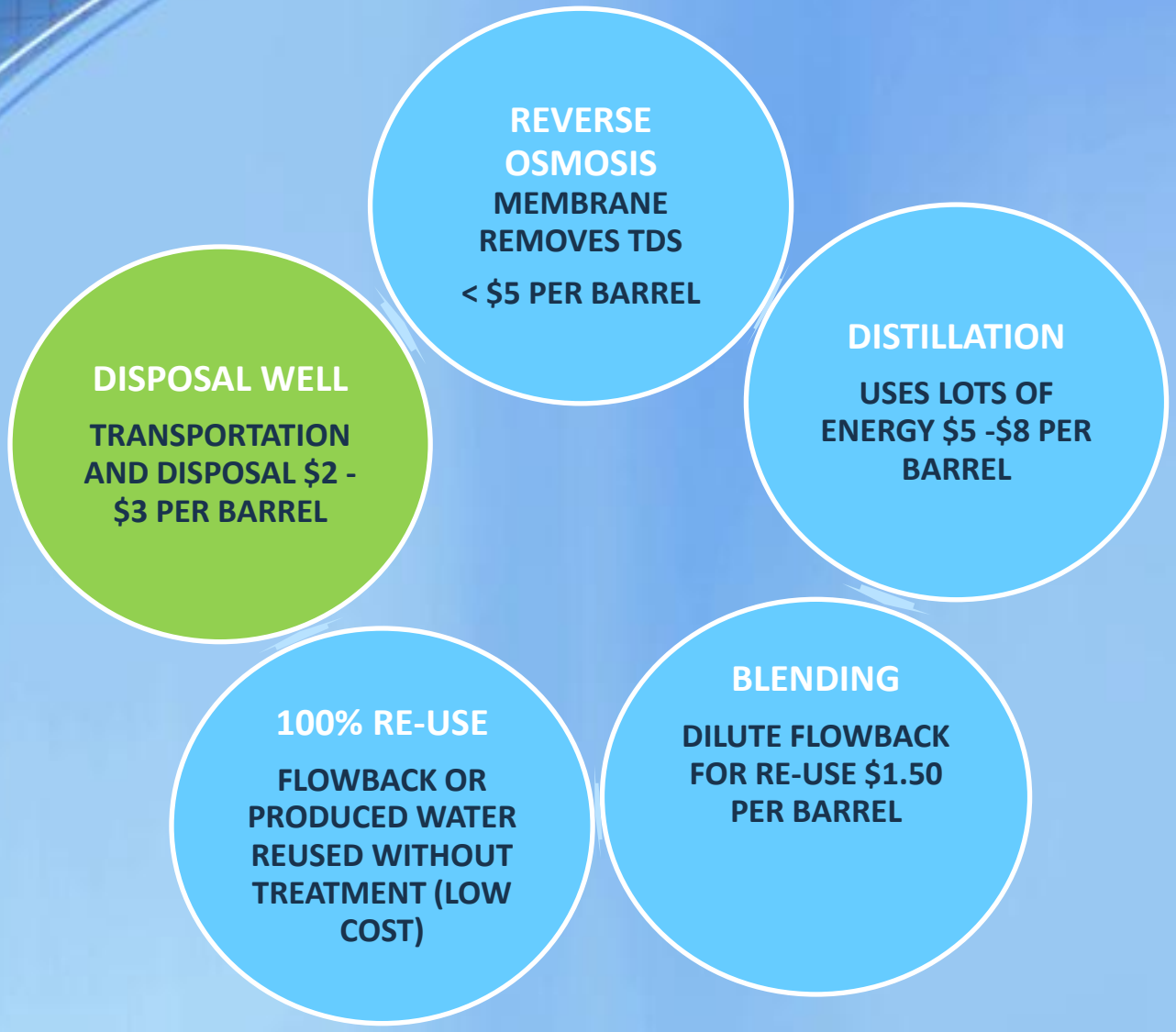
- After an injection well application is received and reviewed and is deemed complete, the regulator typically sends public notice letter and attached notice to the operator.
- Typically required to run a public notice for one day in a local newspaper.
- The public generally has 15 calendar days to file objections or comments .
- The operator must submit original-proof-of-publication to regulator.
- Objections must be relevant to public health, safety, or conservation practices.
- The result may be a public hearing, if objections are valid.

# WHAT ARE THE PERMITTING ISSUES?

# OIL AND GAS WELL LIFE CYCLE WATER USE



# CLASS 2 FLUID DISPOSAL OPTIONS



# TRENDS IN THE WATER DISPOSAL BUSINESS

- More stringent regulations (EPA, Clean Water Act, States).
- Increasing design and environmental protection standards – better facilities.
- Higher standard of pre-injection treatment leads to longer life of well.
- Competition for freshwater withdrawals leading to water re-use and recycling.
- Oil industry is seeking to reduce fresh water  through use of treating technology.
- Improved water use efficiency--leads to energy savings and lower operating costs.
- Carbon reduction goals driving the industry to mitigate their greenhouse gas emissions.
- Class 2 disposal facilities being asked to handle a broader range of disposal needs.
- Implementing water tracking and material balance.
- Better residuals management (solids, oil, vapors).

# BARRIERS AND CHALLENGES

- High levels of regulatory oversight create a barrier to entry.
- Deep well disposal remains the most cost-effective disposal option for Class 2 fluids.
- Increasing public and regulatory body oversight.
- Competition from water treatment and reuse technologies.
- Increasing regulatory standards lead to higher capital and operating costs.
- Contaminants and residuals management.
- Need to handle a broader range of Class 2 fluids.

# SUMMARY

- Deep well disposal still the lowest cost disposal option.
- Tight oil and gas development driving need for more Class 2 disposal.
- Class 2 facilities being asked to handle a broader range of fluids.
- Some competition from treatment technologies in high-cost markets.
- Levels of regulatory oversight (State and Local) increasing.
- Capital investment in Class 2 facilities trending higher.
- Class 2 injection becoming associated with “fracing” in some markets.
- The industry enjoys an exemption from EPA RCRA regulations.