

Produced water from oil and gas production

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Produced Water

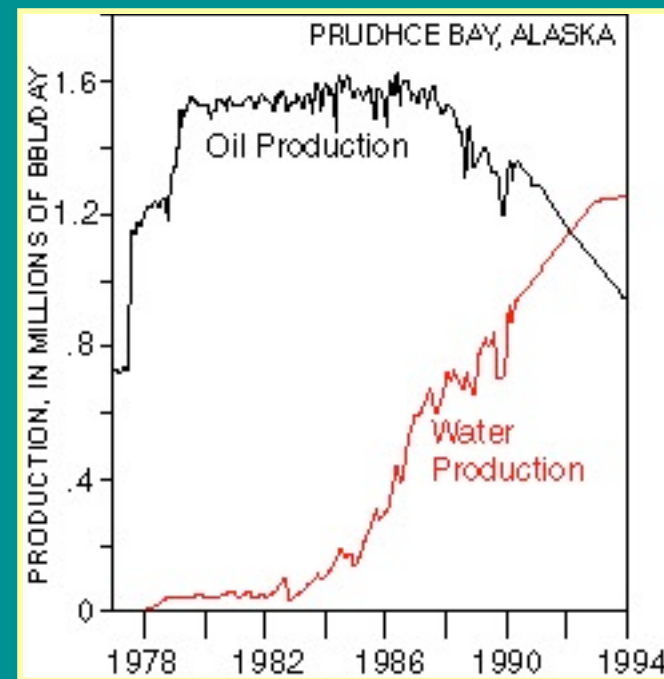
- Any water that is produced to the surface along with oil or gas
- It is the largest waste stream generated by the oil and gas industry

Produced Water Quantity

- On average, about 7 - 10 barrels (bbls), (which is 280 - 400 U.S. gallons) of produced water generated per barrel of crude oil.
- Natural gas wells typically produce much less water than oil wells.

Water quantity

- Typically, for conventional oil and gas wells, water production increases over time.



Source: USGS. 1997. *USGS Research on Saline Waters Co-Produced with Energy Resources*

What's in produced water?

Major components include:

1. hydrocarbons
2. salts
3. metals
4. radionuclides
5. production chemicals

Hydrocarbons and organic compounds

- Include oil, grease, and dissolved organic compounds such as: benzene, naphthalene, toluene, phenanthrene, and pentachlorophenol.
- Generally, as the weight of organic compounds decreases they are more difficult to remove using oil/water separators.

Salts

- Salts in produced water are primarily chlorides and sulfides of Ca, Mg, and Na. Produced water may contain high levels of chlorides - as much as 10 times more than seawater.

Metals and trace elements

- Lead, chromium and nickel are often among the most abundant. Also, barium, manganese, iron, strontium, zinc, silver, cadmium, lithium, copper, mercury, arsenic, selenium, boron and antimony may also be present in produced water.

Total dissolved solids

The U.S. Geological Survey has a database of produced water constituents from various oil and gas producing regions across the country

- it contains good information on total dissolved solids (TDS)
- it does not contain detailed information on hydrocarbons, radionuclides or metals

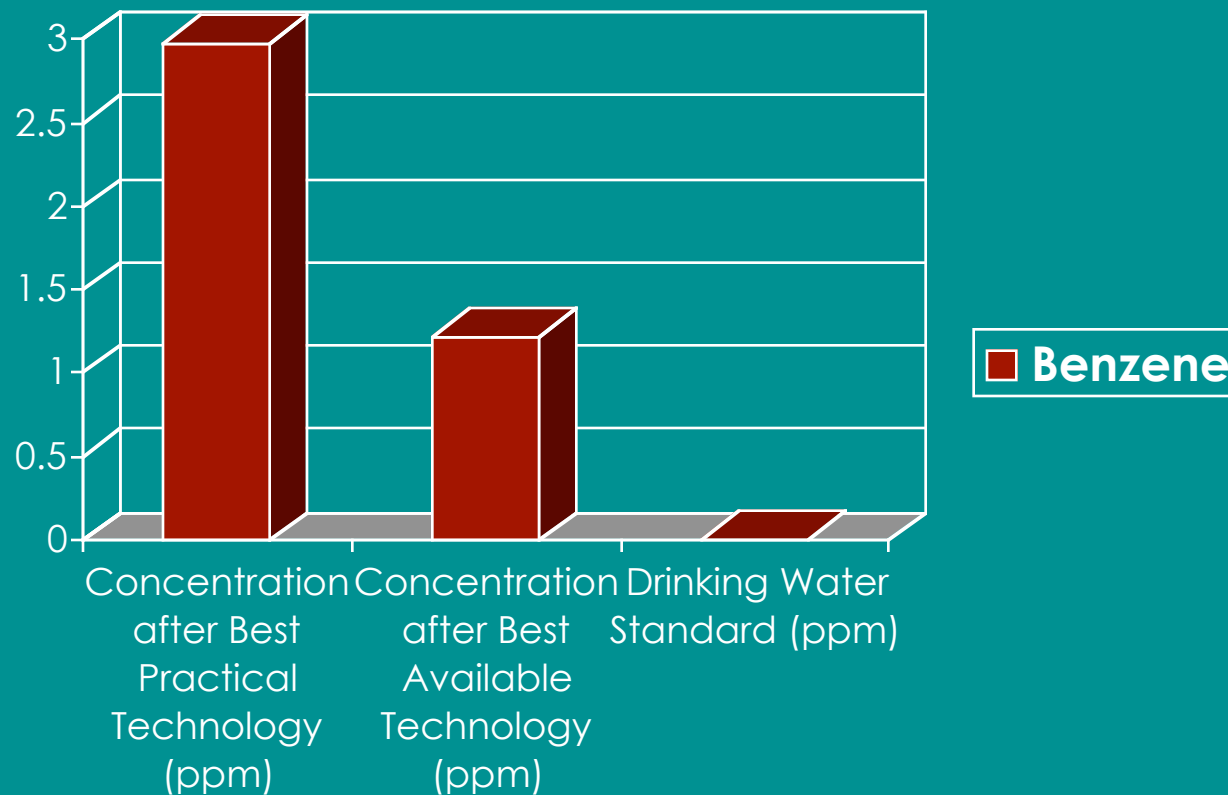
<http://energy.cr.usgs.gov/prov/prodwat/tds.htm>

Comparison of water quality

Parameter	Drinking water criteria	CBM produced water	Natural gas produced water
pH	6.5 – 8	7 - 8	6.5 – 8
TDS (mg/L)	500 (taste)	4,000 – 20,000	20,000 – 100,000
Benzene (ppb)	5	< 100	1,000 – 4,000
Na ⁺ (mg/L)	200	500 – 2,000	6,000 – 35,000
Barium (mg/L)	-	0.001 – 0.1	0.1 - 40
Cl ⁻ (mg/L)	-	1,000 – 2,000	13,000 – 65,000
HCO ₃ ⁻	-	150 – 2,000	2,000 – 10,000

Source: Hayes, T. and Arthur, D. 2004. *Overview of Emerging Produced Water Treatment Technologies.*

Benzene in water after treatment



Source: Argonne National Laboratory. 2004. *A White Paper Describing Produced Water of Crude Oil, Natural Gas and Coalbed Methane.*

Produced water contamination

Prior to the institution of Federal regulations in the 1970's, large volumes of these waters were discharged into rivers, streams, and unlined evaporation ponds, contaminating surface and ground waters and soils in energy producing States.

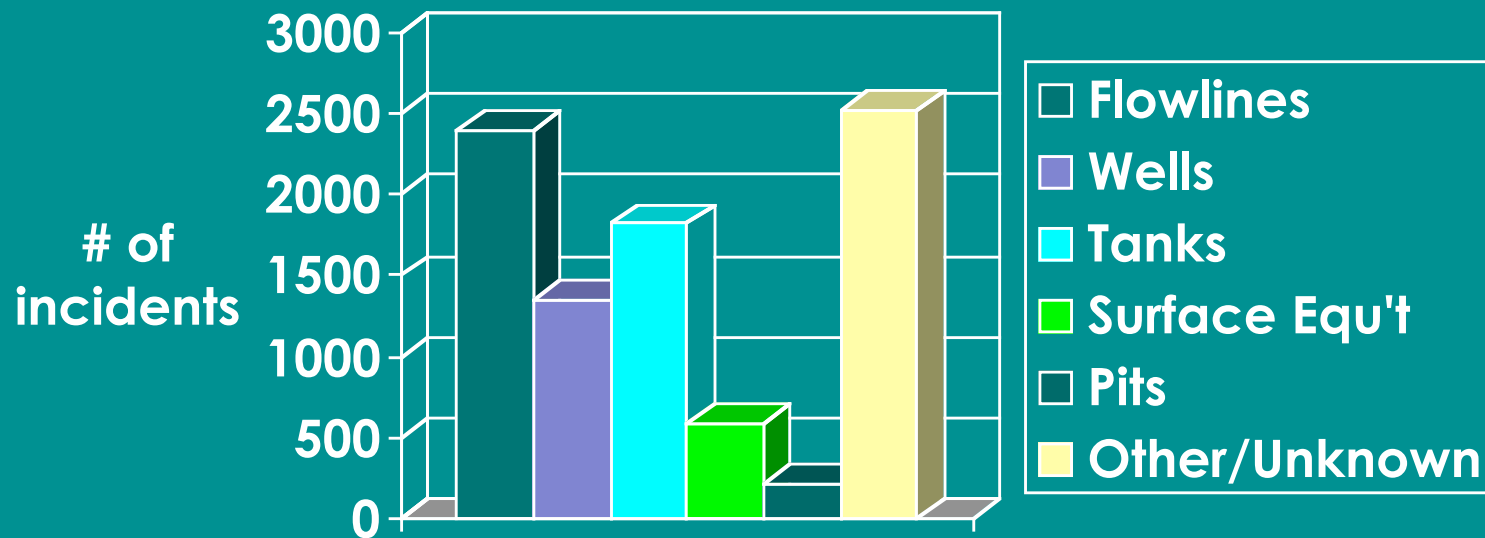
Source: USGS, 1997. *USGS Research on Saline Waters Co-Produced With Energy Resources.*

Produced water incidents

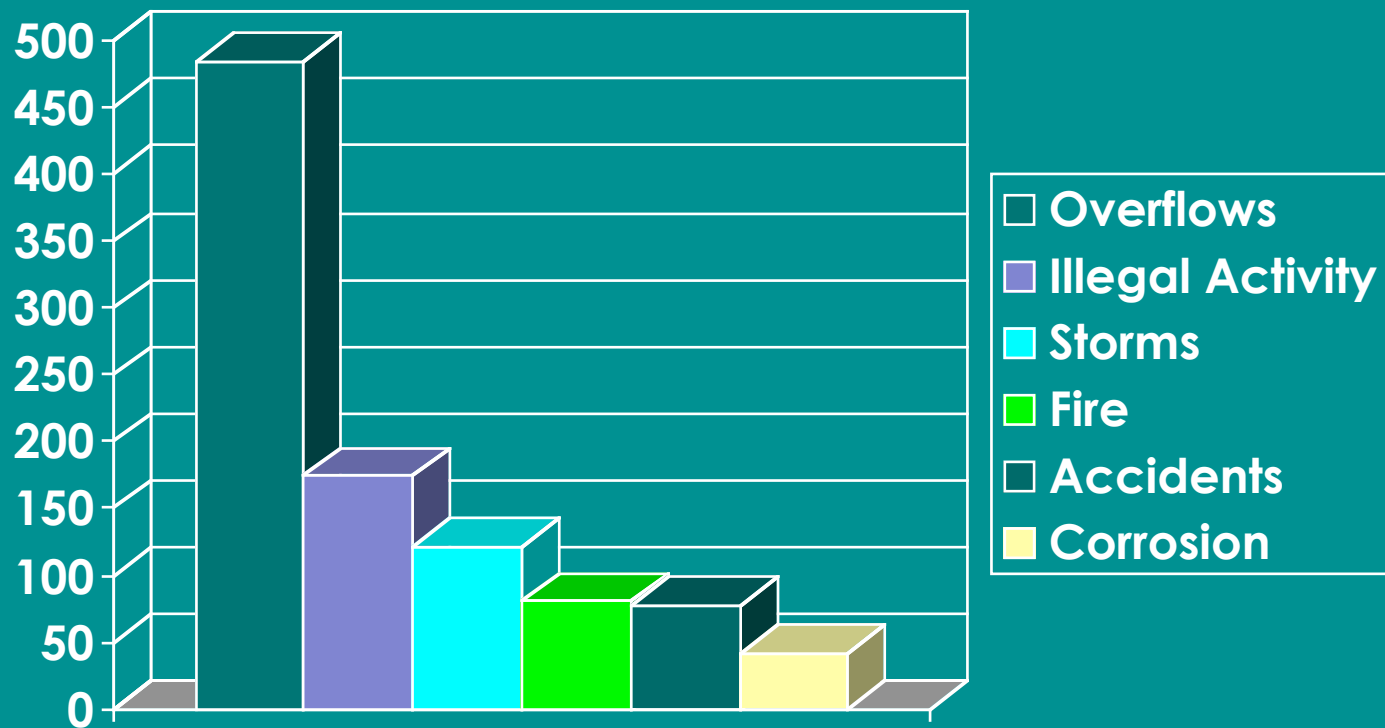
- Study by Fisher and Sublette
- Fluid releases in OK between 1993 - 2003
- An average of 790 releases a year
- 50% were less than 40 bbls; 25% were between 40 and 100 bbls; the remaining 25% were > 100 bbls (4,000 U.S. gallons).

Source: Fisher, J.B. and Sublette, K.L. 2005. *Environmental Releases from exploration and production operations in Oklahoma: Type, volume, causes and prevention.*

Most frequent source of produced water release



Most frequent cause of release





overflowing tank



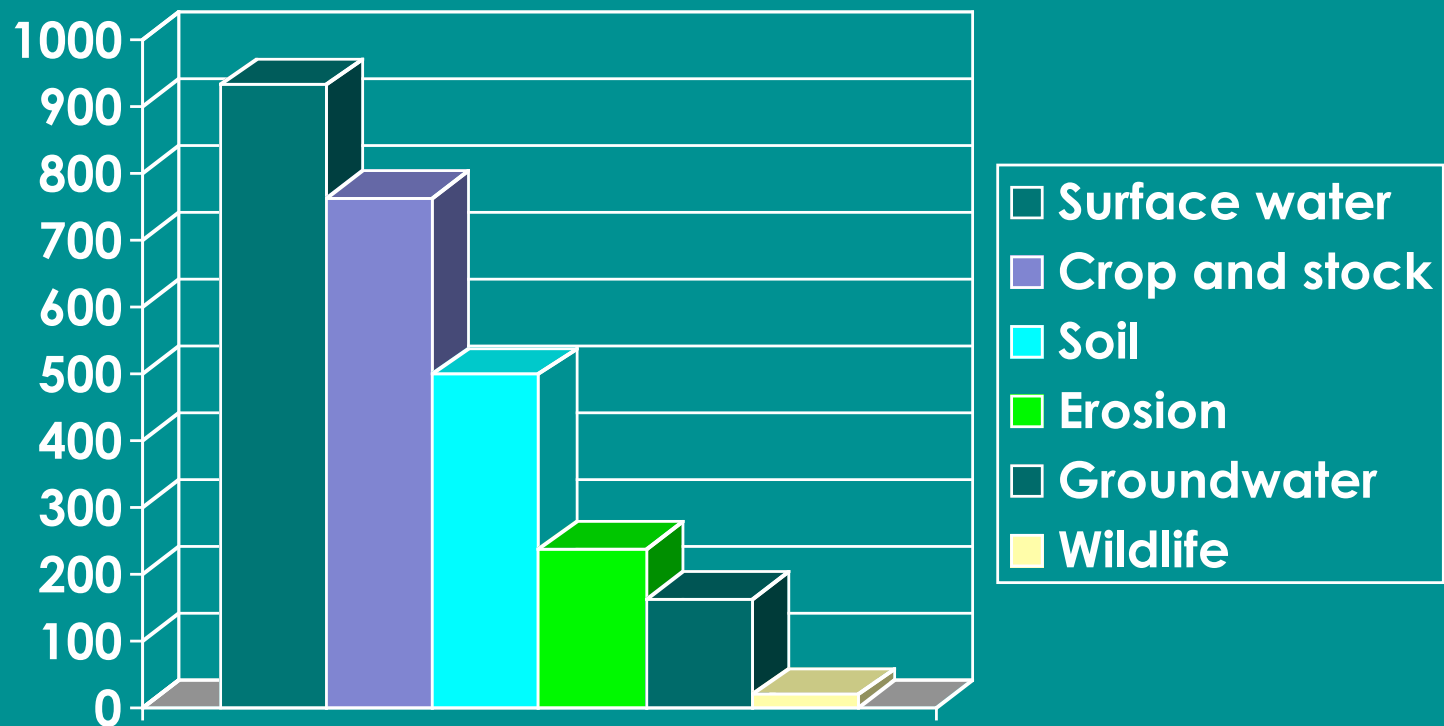
tank corrosion



Accidental cause
of produced
water spill ?

One of the causes of
releases outlined in the
study was livestock or
wildlife opening
produced water valves.

Impact of releases



Spills



produced water spill



sterilized soil



Produced water disposal today

- Surface or stream disposal
- Evaporation pits/ponds
- Underground injection for waterflooding and maintaining field pressures
- Underground injection for disposal

Pits and ponds



brine pit in SE NM



rips in liner

Injection wells

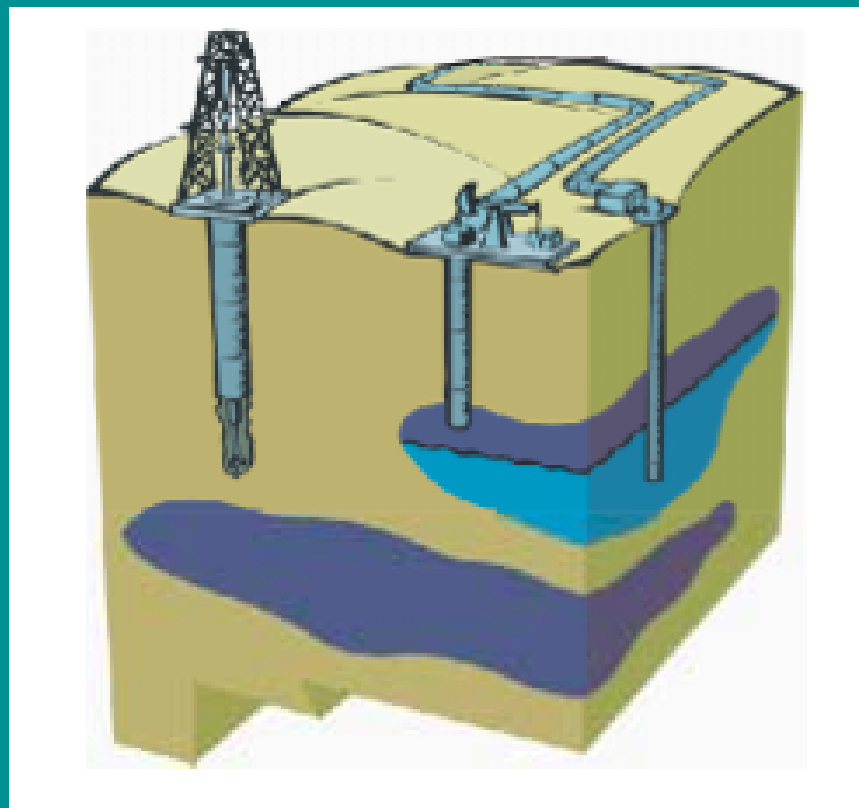
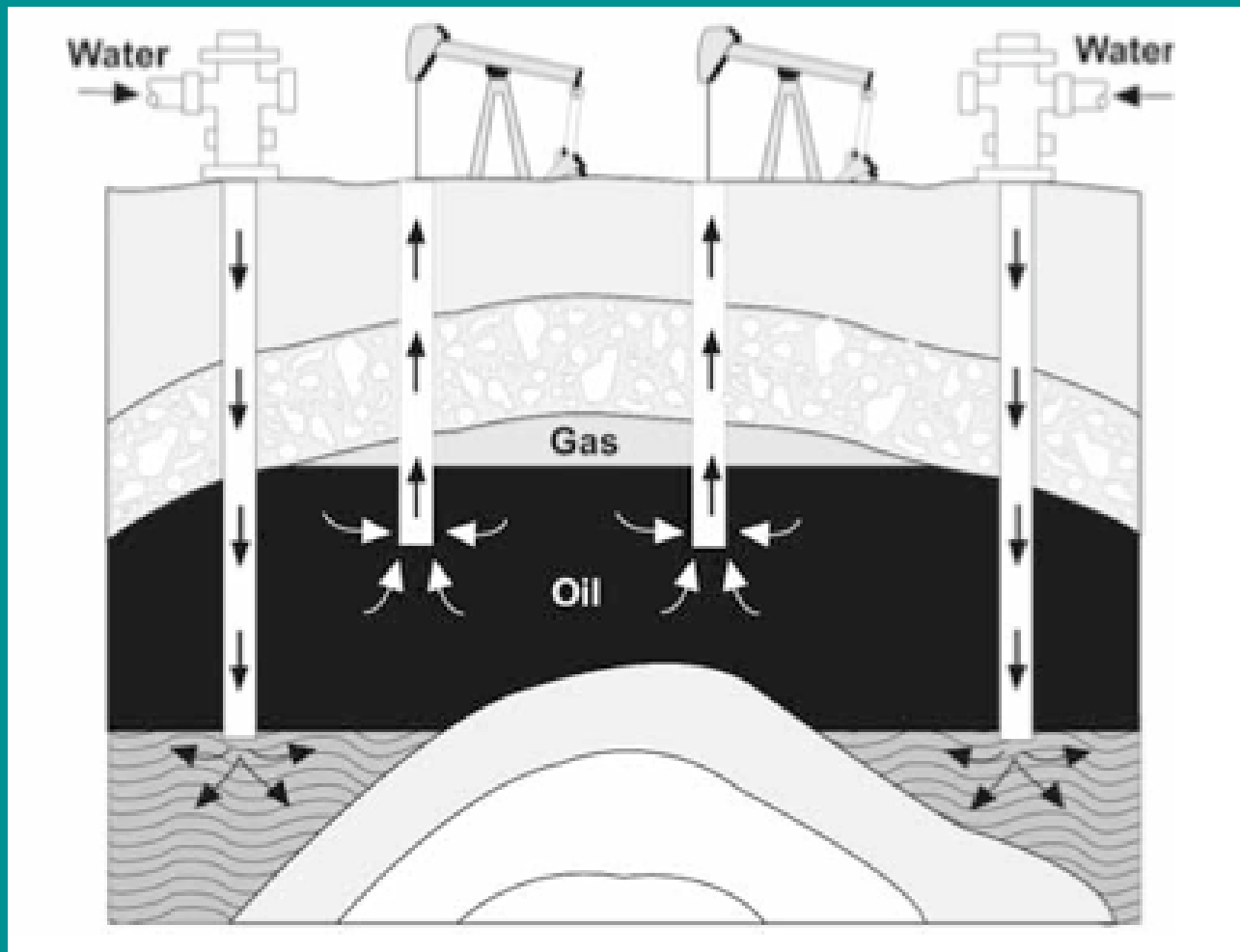


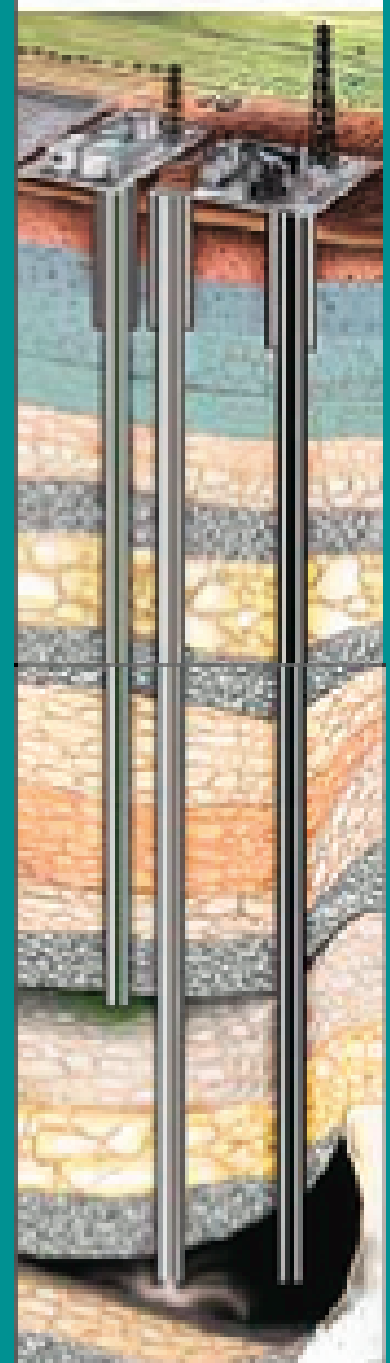
Diagram credit: NM Oil Conservation Division

Enhanced Recovery Wells



Pathways for contamination

- leaks or cracks in injection well casing
- improperly plugged abandoned oil and gas wells within the radius of influence created by injection wells
- natural or induced fractures, which connect the injection zone with adjacent water zones



GAO Study

- Study found 23 confirmed cases of groundwater contamination from produced water injection wells
- *“for most of the 23 confirmed cases, the drinking water sources that were contaminated will remain so for years until natural processes restore water quality.”*

GAO. 1989. *Safeguards Are Not Preventing Contamination from Oil and Gas Wells.*

Natural fracture?

Simon Land and Cattle Injection Well,
La Plata County, CO

- 1989 - SL&C injection well installed
- 1993 - increase in injection pressure
- 1996 - sharp decrease in injection pressure
- 1997 - ↑ flow and temperature at hot springs
- 1999 - (January) injection ceases
- 1999 - (August) hot springs water temperature and flow rate decrease

Conclusion

- Produced water is the largest volume waste produced by the industry
- Produced water contains constituents that are harmful living organisms
- There are risks to human and environmental health involved with every method of disposal