

U.S. Produced Water Volumes and Management Practices

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Acknowledgments

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- NETL- Strategic Center for Natural Gas and Oil
- My co-author, Dr. Corrie Clark



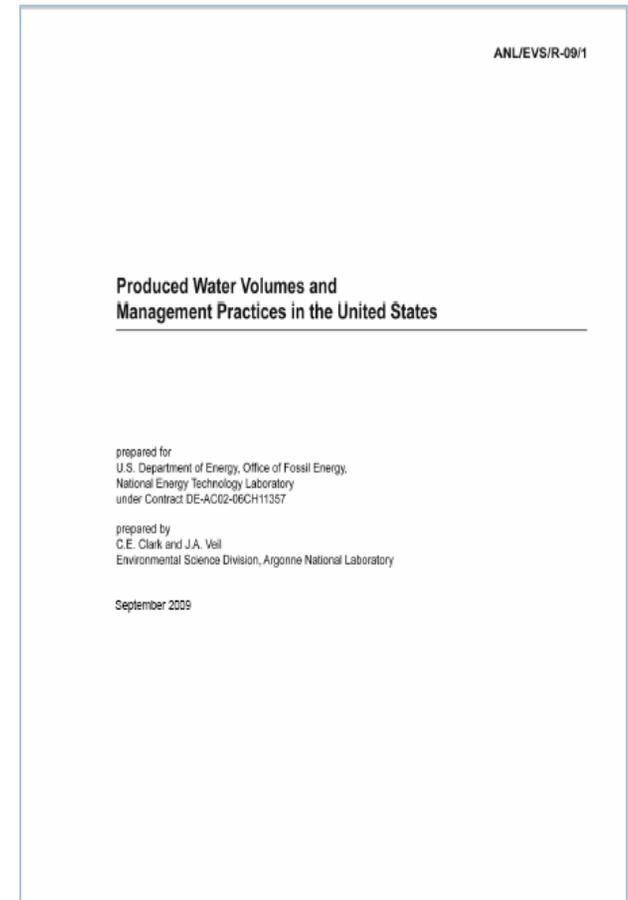
Topics for Discussion

- How much produced water is generated in the U.S. in 2007?
- How did we collect the data?
- Differences between states
- Oil-to-water and gas-to-water ratios
- Management practices



New Report on Produced Water

- Argonne National Laboratory released a new report, funded by DOE's National Energy Technology Laboratory, in early September 2009.
- The report contains detailed produced water volume data for States, Federal Lands, and offshore.
- The report also provides estimates of water-to-oil and water-to-gas ratios.
- The report summarizes the practices that operators use to manage the produced water.



To download a copy of the report, go to:
http://www.ead.anl.gov/pub/dsp_detail.cfm?PubID=2437



Previous Produced Water Volume Estimates

Reference and Year of Estimate	U.S. Produced Water Volume
API (1985 year)	21 billion bbl/year
API (1995 year)	18 billion bbl/year
Veil et al. 2004 (2002 year)	14 billion bbl/year

Khatib and Verbeek (2003) estimated about 77 billion bbl for the entire world.



Produced Water Volume Estimate for 2007

- Produced water from oil, gas, and CBM production in the United States is estimated at 21 billion bbl/year (~57 million bbl/day or 2.4 billion gallons/day).

COMPARISONS

- The Washington D.C. government and surrounding jurisdictions provide about 300 million gallons per day of drinking water to local residents, businesses, and other users.
 - A backyard swimming pool that is 20 ft wide by 50 ft long and 5 ft deep. The volume of water needed to fill such a pool is about 37,000 gal or about 900 bbl.
- Wide range of salinity and other chemical constituents.
 - Nearly fresh water to >200,000 mg/L total dissolved solids.



Approach for Data Collection

- Wrote to oil and gas agencies in all 30 states, that have production and EPA, BLM, and MMS
- Asked for information on volume and management practices

Table 1. Produced Water Volume Information

Type of Hydrocarbon	# Wells Producing That Type of Hydrocarbon	Total Volume of Produced Water (bbl/year)	Volume of Hydrocarbon Produced (bbl/year or Mmcf/year)	Ratio of Water to Hydrocarbon (bbl/bbl or bbl/Mmcf)
Crude oil				
Conventional gas				
Coal bed methane				
Unconventional gas				
Other				
Total				



Data Request for Produced Water Management

Table 2. Produced Water Management Information

Management Practice	# Wells Using That Practice	Total Volume of Produced Water Managed by That Practice (bbl/year)	Percentage of Produced Water Managed by That Practice
Injection for enhanced recovery			
Injection for disposal			
Surface discharge			
Evaporation			
Offsite commercial disposal			
Beneficial reuse			
Other			



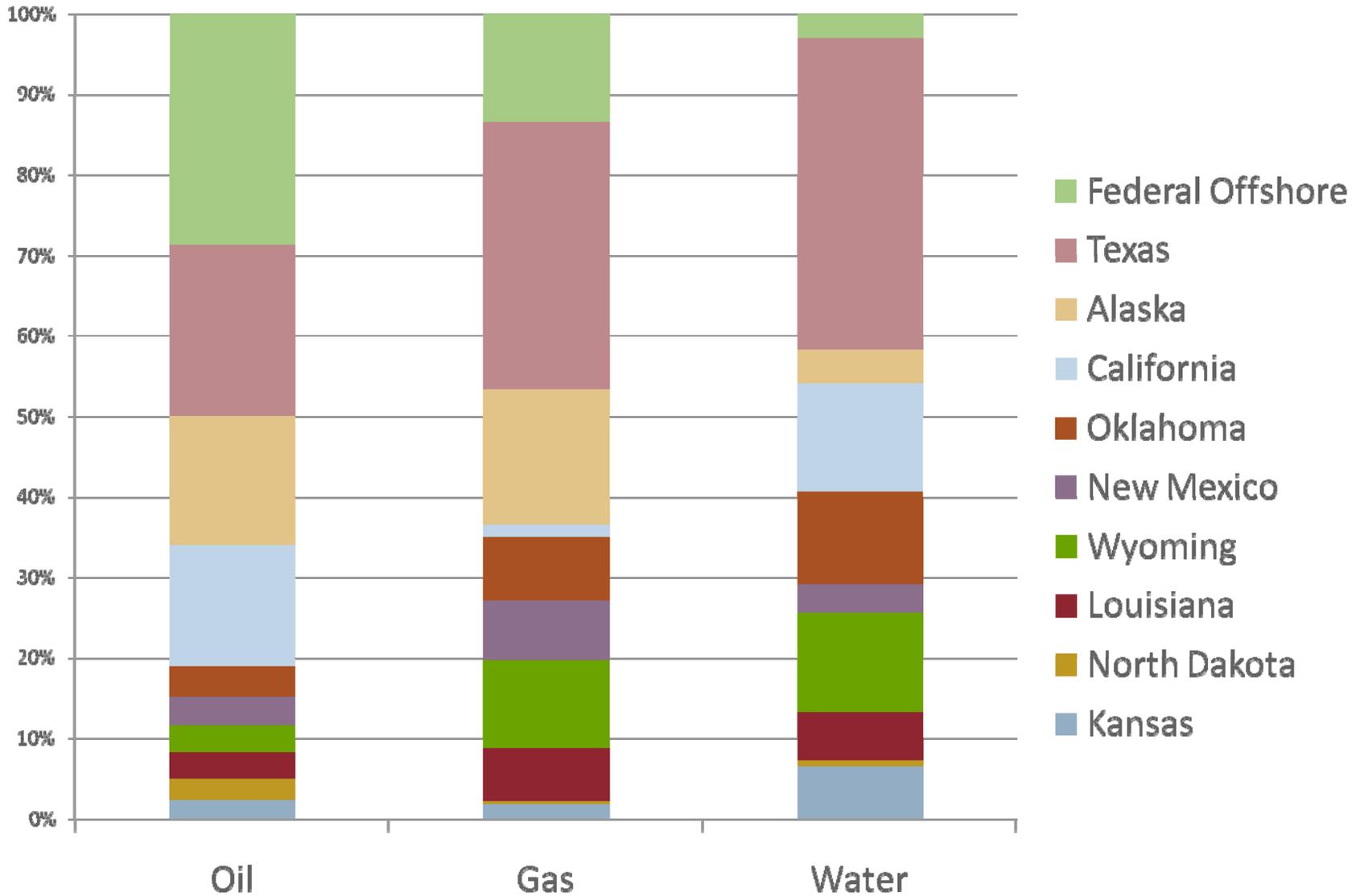
Results

- States have quite different levels of data collection and management.
- No state filled in all the boxes on the tables.
- Most states were not able to differentiate water volume by hydrocarbon type.
- Some states had no information at all on produced water volume.
 - We had to extrapolate estimates using other methods.

	Crude Oil (bbl/yr)	Natural Gas (Mmcf/yr)	Produced Water (bbl/yr)
State Total	1,273,759,000	21,290,000	20,258,560,000
Federal Offshore	467,180,000	2,787,000	587,353,000
Tribal Lands	9,513,000	297,000	149,261,000
Federal Total	476,693,000	3,084,000	736,614,000
Total	1,750,452,000	24,374,000	20,995,174,000



Top Oil, Gas, and Water Producers



Ratio of Water to Hydrocarbon

	Water to Crude Oil (bbl/bbl)	Water to Gas (bbl/Mmcf)
Onshore Ratio	7.6	260
Federal Offshore	1.04	86.0
Total Ratio	5.3	182

Caveat: these ratios are based on data from only 14 states (oil) and 11 states (gas). Some of the largest producing states are not represented.



U.S. Produced Water Volume by Management Practice for 2007 (1,000 bbl/year)

	Injection for Enhanced Recovery	Injection for Disposal	Surface Discharge	Total Managed	Total Generated
State Total	10,676,530	7,144,071	139,002	18,057,527	20,258,560
Federal Offshore	48,673	1,298	537,381	587,353	587,353
Tribal Lands	No data	No data	No data	No data	149,261
Total	10,725,203	7,145,369	676,383	18,644,880	20,995,174



Summaries Available for Each State and Federal Agency

- **Example – Texas**
- “Produced water injection data for 2007 were provided by the Railroad Commission of Texas, and hydrocarbon production data was obtained from the commission’s website. In 2007, Texas wells produced 342,086,945 bbl of crude oil and 6,878,016 Mmcf of natural gas (RRC 2009). There were more than 216,000 active oil and gas wells statewide, which managed produced water via injection into more than 50,000 permitted oil and gas injection and disposal wells (RRC undated). While CBM production activities occur in Texas, such activities are not distinguished from conventional gas production (Deleon 2009). “



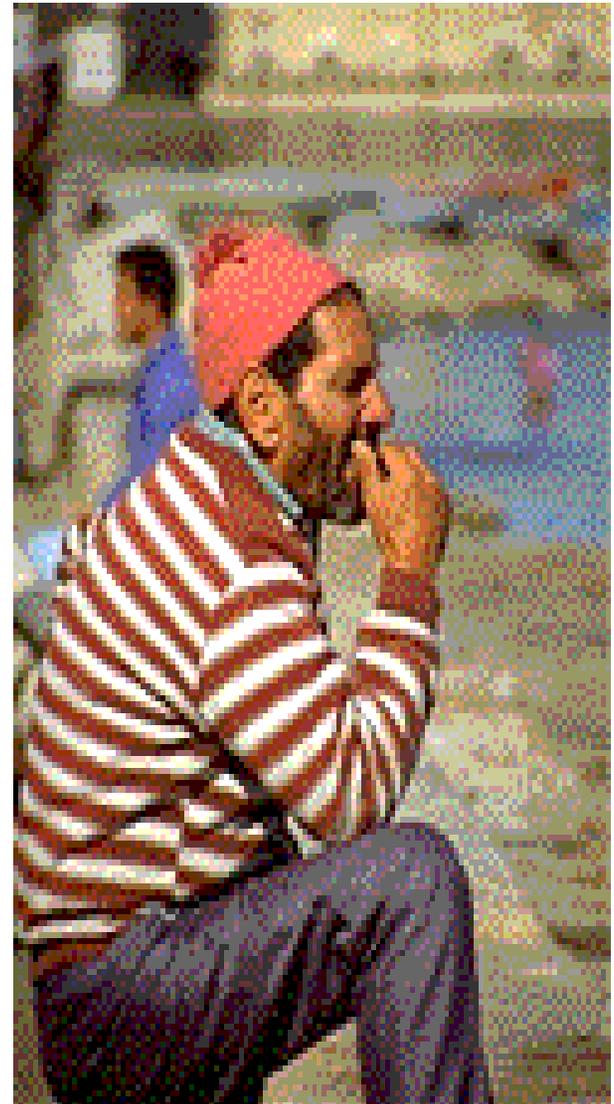
Texas Summary-continued

- “Currently, injection reports for 2007 are still being added to the commission’s database. As of April 2, 2009, the total reported liquid injection volume for 2007 was 4,254,037,585 bbl. From the current total, 1,364,096,989 bbl (32% of reported total) were disposed into nonproducing formations, 757,606,954 bbl were (18% of reported total) disposed into producing formations, and 2,132,117,391 bbl (50% of reported total) were injected for enhanced recovery. For the sake of comparison to other state totals, we combined the percentage disposed into producing formations with the percentage injected for enhanced recovery (68%). The projected volume for the state for 2007 is 7,376,912,883 bbl (Deleon 2009). The total volume injected includes salt water, brackish water, and fresh water injection into Class II disposal wells.”
- “While a small amount of produced water was managed through tidal discharge, the vast majority of produced water generated in Texas was managed through injection. We assume the projected injected volume for 2007 (7,376,912,883 bbl) is comparable to the actual volume of produced water generated in Texas. Following the percentage allocation assumption described above, we considered 32% of the projected total (2,360,612,122 bbl) as the volume injected for disposal. We considered 68% of the projected total (5,016,300,761 bbl) as the volume for enhanced recovery.”



Conclusions

- The report provides the most detailed and current information on the volume of produced water generated in the United States.
 - The 2007 volume is the highest of those estimates, and should be a more representative estimate than the earlier ones because of the approach used to collect and extrapolate the data.
- Information on management practices has not changed significantly from previous studies.
 - The majority of produced water is managed through injection with 59% of the onshore produced water volume being injected to increase production output.
 - More than 91% of offshore produced water is treated and discharged to the ocean



Conclusions - continued

- There is no easy way to obtain national estimates of produced water generation.
 - The estimates presented in the report took months of investigation, numerous contacts with oil and gas agency staff members, and extensive follow-up.
 - Some states had useful produced water information either published in reports or readily available through state databases.
 - However, many other states had only minimal information about produced water volumes or how the produced water was managed.
 - No federal regulatory program requires agencies to track produced water volume. Consequently, when regulatory and data management resources are limited, some states do not maintain produced water information.

