PROGRAM facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Petroleum Systems Analysis and Planning

05/2005

PRODUCED WATER FROM OIL AND NATURAL GAS OPERATIONS – *SETTING THE CONTEXT*

Background

Water consumption in the United States is ~350 gallons/day/person[1]. The western half of the United States, in particular the Rocky Mountain and Southwestern States, are becoming increasingly arid. At the same time, these areas are experiencing growing populations, especially Nevada and Arizona. An issue of great concern is that water is becoming increasingly scarce for select local/regional areas and foreseeable trends do not show signs of change.

The U.S. Department of Energy is responsible for ensuring adequate [energy] supplies for the country. Among other drivers, research and new technologies are required to deliver all forms of energy to consumers at affordable prices and to protect the environment. The National Energy Technology Laboratory has been, and remains key in the advancement of fossil fuel based technologies, including the production, processing, and transportation of crude oil and natural gas. In most circumstances, water is produced along with oil and natural gas; this water is commonly referred to as *produced water*.

To that end, NETL has initiated a new, broad assessment of produced water, in part, to further focus limited research funds and simultaneously address our country's oil and natural gas requirements—and the growing need for water resources. The current forecast complements a portfolio of ongoing water-related RD&D and results are expected to support the continuing success of the program. This *pro forma* activity is described in the following section.

Analysis and Forecasts

In short, historical produced water data related to crude oil production have been captured and water-oil ratios (WOR) determined for each of the six Lower-48 onshore Oil and Gas Supply Regions (as defined by the 2004 Annual Energy Outlook[2]). The WOR values were used to project produced water volumes for 2004-2025 for All Lands, Federal Lands and Federal Lands West of the 98th Meridian. Ratios were also derived and utilized in a similar manner for natural gas production (conventional and unconventional plays), including coalbed methane.

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1 Calculated from "Estimated Use of Water in the United States in 2000", U.S. Geological Survey Circular 1268

2 U.S. Department of Energy, Energy Information Agency, Annual Energy Outlook 2004, DOE/EIA-0383(2004) January 2004, hereinafter referred to as AEO2004.

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Daily produced water volumes from oil and natural gas operations were estimated to be approximately 59 million barrels (MM bbls) in 2004 (Figure 1) or nearly 22 billion bbls for the entire year.[3] Of that total, approximately 8.2 MMbbls/day (~14%) is expected be produced on Federal Lands[4] (Figure 2) and the bulk of that will be sourced West of the 98th Meridian. The Federal Lands water production rate is expected to remain relatively constant over the next 20 years unless there is a significant change in resource development or land management of Federal Lands. The Federal Lands [water] production is a relatively small but potentially significant fraction of the national consumption rate in that most of the production is in arid areas and could have beneficial uses.

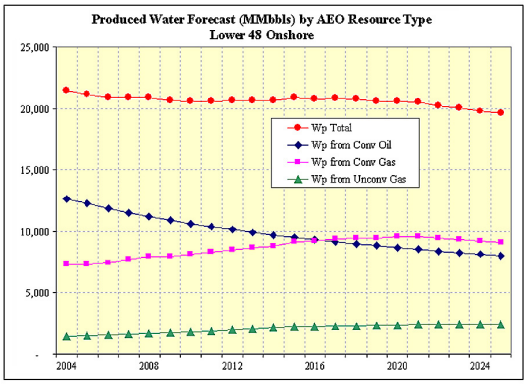

Figure 1: Forecasted Produced Water by AEO Resource Type

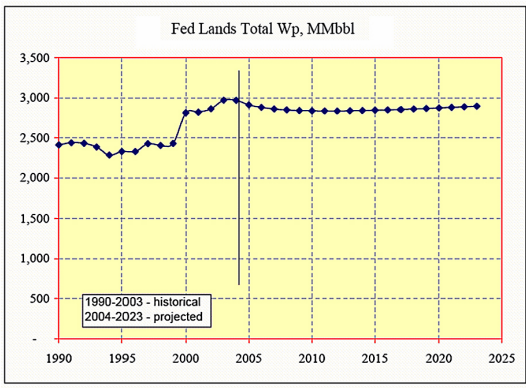

Figure 2: Projected Federal Lands Water Production

The American Petroleum Institute (API) estimates[5] that 71% of produced water is being used for Improved Oil Recovery (IOR), 21% is being injected for disposal, 5% to beneficial use such as livestock, irrigation, etc. and 3% to percolation and evaporation ponds. The potential addition to the beneficial category of ~14 MMbbls/day (24% in 2004) is not an insignificant volume and could provide some relief in select areas of the country for specialized use. In those areas where there are no IOR operations, essentially all of the produced water could be seen as an additional water resource.

What's It Mean?

Produced water issues are varied and many, highly contentious. NETL's Environmental Solutions technology program in collaboration with Fossil Energy, continues to address the technology, policy, and regulatory aspects of produced water. Risked based decision making, innovative management strategies such as produced water for power plant cooling, and advanced [water] treatment options, e.g., more efficient membranes are just a few components of DOE's broad portfolio. The effort described herein is being conducted to identify critical factors and trends in the area of energy and water — an area of national importance. Related future projections will focus on water quality whereas the current effort emphasizes volumes, location, and resource types. Interested parties are encouraged to read more about NETL's produced water RD&D as wells as the entire Environmental Solutions technology program at the following web address http://www.netl.doe.gov/scngo/petroleum/index.html

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3 Estimated based on AEO2004 projections of conventional and unconventional oil and gas production.

4 "BLM Safety Net Royalty Relief Analysis of Natural Gas and Oil Production and Public Section Revenues for United States Onshore Federal Lands" Aug 2004

(http://www.netl.doe.gov/scngo/Analysis%20&%20Planning/Pubs/NETL_BLM_final.pdf).

5 "Overview of Exploration and Production Waste Volumes and Waste Management Practices in the United States", table 2.4, pg 11, prepared by ICF Consulting for the American Petroleum Institute, Washington, DC, May 2000.