A CCST PEER-REVIEWED STUDY

COMPLETED: AUG. 2019

AN ASSESSMENT OF OIL AND GAS WATER CYCLE REPORTING IN CALIFORNIA

Evaluation of Data Collected Pursuant to California Senate Bill 1281

One Pager

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SUMMARY

In the context of severe drought, **Senate Bill 1281** (2014, Pavley) expanded reporting requirements for the California oil and gas industry regarding produced water—intended to ensure the ability to assess impacts on California's water resources, public health, and the environment. After two years of data collection, the California Geologic Energy Management Division* (**CalGEM**) contracted with **CCST** to conduct a study to evaluate how well the data collected meet this intent. In order to assess the utility of the data to answer policy-relevant questions, the authors of this analysis addressed four overarching questions related to water resources, characteristics of produced water, potential opportunities for beneficial reuse of produced water, and potential impacts to public health and the environment (see backside).

BACKGROUND

In the context of severe drought conditions, California legislators raised concerns that the oil and gas industry may be using excessive amounts of high-quality water and that these uses could instead be satisfied by the produced water generated on-site. These concerns led to the recognition that publicly-available data were insufficient to quantify the industry's uses, treatment, storage, and ultimately disposal of fresh and produced water in its operations. To fill these data gaps, the California Legislature passed **Senate Bill (SB) 1281** (Pavley, 2014), expanding reporting requirements for California oil and gas producers.

California was the fourth largest producer of crude oil in the U.S. in 2017. More than 70 percent of annual oil production in California takes place in Kern County, a region where high-quality water sources are scarce. Water is an important byproduct of oil extraction, and because California oil fields are mature and many contain heavy crude, they produce a greater proportion of water per barrel than most other U.S. producing regions (18 barrels of water for each barrel of oil in 2017 and increasing annually; see Figure below).

Defined as "**produced water**," water extracted from oil and gas production is generally not suitable for direct domestic or agricultural use due to high levels of salt, boron, and other constituents that are toxic to plants and exceed some drinking water standards. The salt level (salinity, reported as total dissolved solids, or TDS) is generally higher than 10,000 milligrams per liter (mg/L), or almost a third of the salt content of seawater.

More than 96 percent of the state's produced water is generated in five of its ten geographically-defined oil basins. These five basins include the San Joaquin, Los Angeles, Santa Barbara-Ventura, Santa Maria, and Monterey basins, and contain almost all active oil wells (about 135,000) in California.

While the annual volume of produced water generated is small compared to California's annual water use for irrigation (equivalent to about 1% of the 34 million AF used for agriculture in 2015), this produced water currently satisfies a significant portion of water uses needed by oil and gas field operators, including recycling for use in **enhanced oil recovery** (**EOR**). Where TDS levels are low (< 1,000 mg/L), some produced water is of suitable quality to meet local demands for agricultural uses, including food crop irrigation.

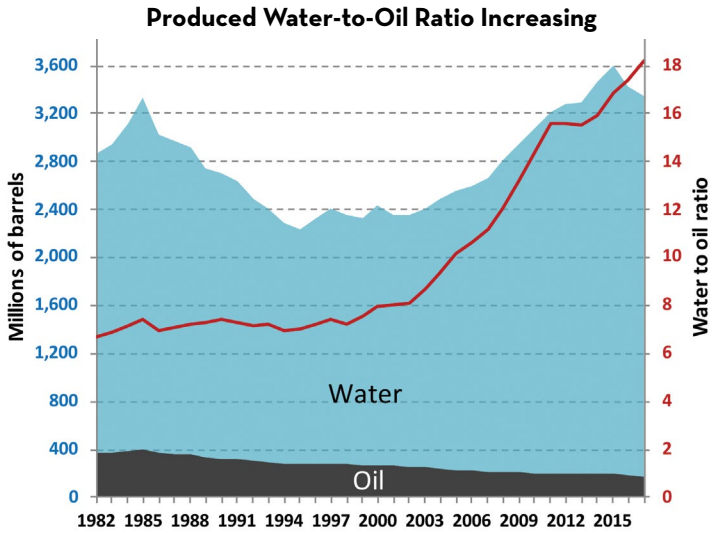

Figure: California average produced water-to-oil ratio from 1982–2017. Produced water is primarily saline in quality. Oil production has been declining since about 1985. Water production began increasing in the early-mid 1990s. The water-to-oil ratio has increased steadily.

See Figure ES.1.

Source: Reproduced from Jordan (2019), original data from CalGEM* (2018a, 2018b).

*At the time, the Division of Oil, Gas, and Geothermal Resources

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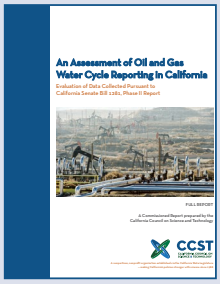

FULL REPORT

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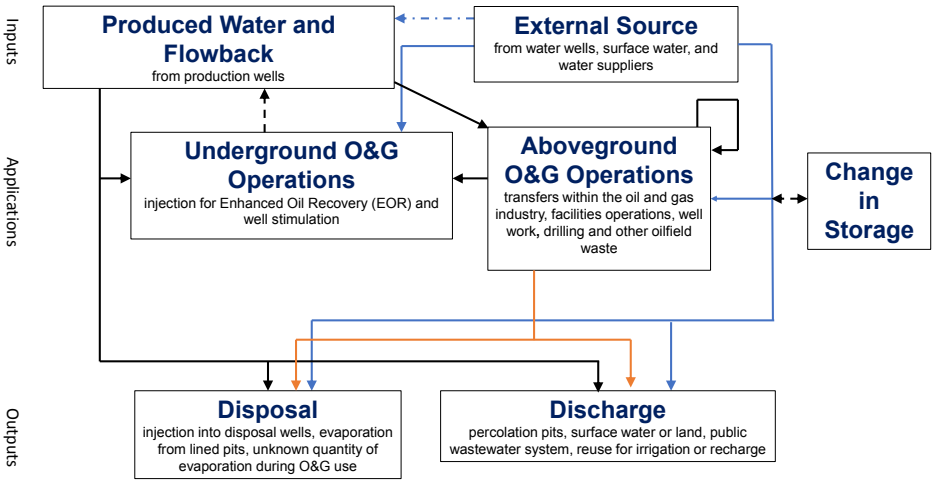

Figure: Water cycle diagram for California's oil and gas industry.

Executive Summary (ES)
CONCLUSIONS

What are the sources, volumes, and quality of water used for oil and gas (O&G) development and production in California?

Conclusion ES.1. The SB 1281 dataset **provides an accounting of O&G industry water use, reuse, and disposal quantities** on an annual basis beyond what was available prior to its collection, but improved reporting is required to increase accuracy, utility, ease of use, and assessment of both reuse opportunities and risks associated with disposal.

What are the characteristics/quality of produced water across the State, and how do these vary over time?

Conclusion ES.2. The SB 1281 dataset only contains one water quality parameter, TDS, which is reported as a binary value (less than or equal to 10,000 mg/L, or more than 10,000 mg/L). **The lack of more extensive water quality data severely limits the value of the SB 1281 dataset** to assess further reuse opportunities, as well as to identify the potential hazards associated with surface disposal.

What are the potential reuse options for produced water both within and outside of the oilfields, taking into consideration treatment technologies?

Conclusion ES.3. The opportunities for expanded off-site reuse of produced water with a modest level of treatment are limited and **occur mostly at the local level in proximity to active fields producing low salinity produced water.** Currently, over 38,000 acre-feet per year (AFY) (approximately 10% of the annual volume of produced water) is being reused for irrigation, primarily in the eastern San Joaquin Valley.

What are the potential and actual hazards, risks, and impacts to environmental and human health from various dispositions of produced water reuse and discharges to land, water, and subsurface injection?

Conclusion ES.4. Because of widespread use of chemical additives in routine O&G operations, including various forms of well stimulation, more detailed assessment is needed to evaluate the reuse potential for produced water. In addition, human health and environmental risk characterization of produced water that is discharged to the surface and reused outside of the oilfield is hindered by the **lack of necessary water quality data** for this waste stream.

Conclusion ES.5. Wastewater disposal by the O&G industry in unlined produced water ponds presents a known but poorly quantified risk to groundwater quality. The **exact volume of produced water disposed of in these unlined produced water ponds at the surface is uncertain.**

More details, including additional findings, conclusions, and recommendations can be found in the **full report**. ■

Executive Summary
RECOMMENDATIONS

Using the findings, conclusions, and recommendations from the full report, the Steering Committee developed the following Executive Summary (ES) recommendations:

ES.1. A NUMBER OF MODIFICATIONS TO THE SB 1281 DATASET SHOULD BE MADE.

This includes reducing redundancies beween monthly and SB 1281 datasets, reporting of field-wide data by aggregation rather than well-by-well basis, increasing dataset usability by reducing the number of reports from three to one, inclusion of spatial identification for all off-site disposal options, and the modification of treatment categories.

ES.2. INCLUDE ACTUAL TDS OR ELECTRICAL CONDUCTIVITY DATA IN SB 1281 DATASET.

A select number of additional water quality parameters should be reported for those fields in which produced water quality indicates strong potential for irrigation reuse, based on criteria established in Chapter 2 (Full Report).

ES.3. DISTINGUISH BETWEEN INJECTION FOR ONSITE EOR AND OFFSITE INJECTION FOR PERMANENT DISPOSAL.

In the context of assessing reuse opportunities, the SB 1281 dataset should distinguish between injection for purposes of onsite enhanced oil recovery and offsite injection for permanent disposal of produced water in injection wells.

ES.4. CONSIDER PROTOCOLS CURRENTLY BEING APPLIED FOR OTHER WATER RECYCLING ACTIVITIES.

For more widespread reuse. Such protocols include indirect and direct potable reuse of treated wastewater in those cases considered to pose high risk of human or ecological exposure.

ES.5. DEVELOP AN UNLINED DISPOSAL SITE RISK PRIORITIZATION SYSTEM.

Agencies with jurisdiction should develop an unlined disposal site risk prioritization system to evaluate which sites are most in need of investigations to determine the nature and extent of current or potential future impacts. Given these uncertainties, reduction or elimination of this disposal practice should be the subject of thorough review by the appropriate agencies where these agencies find that produced water disposal poses unacceptable risks of groundwater quality degradation.