

OVERVIEW OF REGULATIONS FOR POTENTIAL BENEFICIAL USE OF OILFIELD PRODUCED WATER IN CALIFORNIA

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ABSTRACT

Produced water generated during oil production by thermal (steam) recovery processes is often disposed by Class II deep well injection within the oil production zones. Such in-field injection may increase the water to oil ratio and reservoir pressure, resulting in decreased oil production. Reducing Class II injection through alternative disposition of the produced water may enhance oil field development and crude oil production.

The use of produced water involves treatment to meet specified water quality goals, delivery and storage of treated water and safe disposal of the residuals. Each of these activities is or may be subject to regulation by Federal, State and local agencies. A focus of this project, jointly funded by USDOE, Aera Energy LLC and Kennedy/Jenks Consultants, is to identify alternate end uses for produced water in the immediate vicinity of the San Ardo oilfield, located in the Salinas Valley near the Central Coast of California. This paper presents an overview of regulatory requirements and issues related to treatment, delivery, storage and waste stream management to potentially use produced water in the San Ardo area and concludes that the regulatory obstacles are, in some respects, significant. The regulatory agencies include United States Army Corps of Engineers; the California Regional Water Quality Control Board; California Department of Water Resources; California Department of Fish and Game, and Monterey County Water Resources Agency. The types of permits required vary with mode of treated water delivery and location of treated water storage facilities.

Background

Production of crude oil through enhanced steam recovery is typically associated with a large amount of produced water. Although the quality of the water produced varies, these waters typically have salinity concentrations from 1000 mg/l to more than 350,000 mg/l. The waters are generally high temperature (150 to 200 °F), and usually contain elevated levels of silica, boron, ammonia and dissolved organics. These waters are often injected into Class II wells. Such in-field injection may increase the produced water-to-oil ratio and reservoir pressure, resulting in lower oil production and higher oil production costs. Reducing Class II injection through alternative disposition or use of treated produced water may enhance oil production and increase recoverable reserves in an oilfield.

Limited water resources and increases in population have put a strain on California's water supply. Several reports indicate that the overall water demand for California will exceed supply after the year 2020. The effective and efficient treatment and use of the produced water could create a win-win situation for both oil producers and water users by increasing oil recovery while increasing much needed water resources.

This DOE funded (No.DE-FC26-02NT15463) study evaluates the potential for treatment and use of produced water from an oilfield near San Ardo in Monterey County, CA. Around San Ardo, the Salinas Valley groundwater basin provides most of the water supply needs. Due to high water demands from population growth and agriculture, groundwater extraction exceeds the sustainable yield of this basin. The dependence on groundwater has resulted in a long-term average overdraft of 19,000 acre-feet per year (AFY) in the Salinas Valley basin. The overdraft conditions have resulted in seawater intrusion for about six miles into the northern Salinas Valley, before the Salinas River empties into the Pacific Ocean. A successful produced water treatment process could make available more than 4,000 AFY of water from the San Ardo oilfield. This is about one-fifth of the annual overdraft.

This paper describes the Federal, State and local regulations related to delivery, storage and use for possible end uses of the treated oilfield produced water in the project area. It must be emphasized that the uses identified in this paper are based on initial screening of potential alternatives.

Alternative Use and Water Delivery Options

In this section, the possible uses for the treated water, based on preliminary evaluations, are presented. These possible uses, however, must satisfy stringent regulatory, economic, user-perception, and long-term reliability criteria prior to actual implementation. Furthermore, depending on the type of use, implementation may also require complex water trade arrangements with one or more water agencies. Finally, large storage facilities (hundreds of million gallons capacity) would be needed if there is a large seasonal variation in water demand for the identified end use. Such limitations may increase the overall costs of the project significantly and render the use non-viable. These uses are presented in this section only to facilitate a discussion on regulatory requirements for various alternatives in the following sections.

The potential users of treated oilfield-produced water in the San Ardo area are limited because, among other things, there are no regional conveyance facilities in the Salinas Valley other than the Salinas River. Potential uses of the treated water in the project area could include the following:

- Agricultural applications in nearby farms, including those that currently utilize groundwater, and those landowners who desire to bring land into agricultural production
- Agencies at downstream locations
- Industrial applications
- Creation of wetlands in the Salinas Basin

Agriculture

A report by Monterey County Water Resources Agency (MCWRA, 2000) indicates that approximately 48,000 acres of farmland are available in the upper Salinas Valley Basin (San

Ardo area). About 3,500 acres of farmland are located within five miles of the oilfield, downstream of the Salinas River. The key crops cultivated in these farms include broccoli, lettuce, spinach, carrots, potato, cabbage and chile peppers. Data from MCWRA indicate that the average amount of water applied for irrigation in 1995 in the Upper Salinas Valley was about 2.75 AF/acre (MCWRA, 1998). Hence, all of the treated produced water generated from this project could, theoretically, be used on less than 2,000 acres of farmland. Treated water from the oilfield might be delivered through the Salinas River or by direct pipeline.

The limitations in the use of oilfield water for agriculture include i) efforts required to convince farmers to use recycled water for irrigation; ii) need for a large storage system/alternate use arrangement during the low demand season (September – May) since the oilfield produced water is generated throughout the year; and iii) transportation / conveyance of the water to farmers.

Agencies at Downstream Locations

The MCWRA is a public agency that has been charged with the long-term management and preservation of water resources in Monterey County. In order to prevent seawater intrusion into the Salinas Valley Basin and protect agricultural water use, MCWRA has undertaken two major projects: 1) the Salinas Valley Water Project (SVWP), and 2) the Castroville Seawater Intrusion Project (CSIP). The key components of these projects are to identify alternate sources of water for agricultural use in the Salinas Valley Basin and prevent seawater intrusion by reducing groundwater drawdown at the lower Salinas Valley Basin. The main objective of the SVWP is to increase the capacity of the Nacimiento Dam reservoir by i) modifying the Nacimiento Dam spillway; and ii) constructing a diversion facility to divert part of Salinas River water for the CSIP. Under the CSIP, the excess water from the Salinas River diversion would be diverted to the Castroville service area for agricultural use. This would replace the groundwater that is currently pumped for agricultural irrigation in this area, and would help prevent seawater intrusion into drinking water aquifers. The operational objective of the project is to stop seawater intrusion into the Salinas Basin and provide up to 1000 AFY net groundwater outflow to Monterey Bay. In addition, the average annual Salinas River diversion capacity is about 12,000 AFY. By comparison, the amount of water that would be generated by treatment of produced water at the San Ardo oilfield is about 4,000 AFY. However, one of the key limitations in this use is the loss of added water during transport due to evaporation and percolation, particularly in dry weather conditions.

Industrial Use

A power plant located at King City, California was initially considered as a candidate for using treated produced water for its cooling water needs. This plant is located about 30 miles north of San Ardo, downstream of the Salinas River. For this application, delivery of water through the Salinas River is not possible due to the beneficial use requirements in 40 CFR 435.30 (discussed below). In addition, delivery of water by a new, unsubsidized 30-mile pipeline appears to be cost prohibitive. Hence, this option is no longer under consideration.

Wetlands Development and Other Applications

The treated produced water could conceivably be used to create wetlands in the Salinas Basin. Such an end use would require a biodiversity study to identify potential benefits to animal and plant species in the project area. However, potential use of treated produced water for wetlands development may require long-term reliability of water supply from the oilfield. This may be a concern if the oilfield operations are curtailed for any reason or terminated at the end of the economic life of the oilfield or for other reasons.

Water Trade/Water Delivery Issues

The following water trade/delivery scenarios were considered for alternative disposition of the treated water:

- Convey the treated water directly (through hard pipe) to agricultural growers in the vicinity of the project area and allow a partnering water agency to obtain the agricultural end-user's unused groundwater. This groundwater would be discharged into the Salinas River, which would provide the conveyance system for downstream diversion to areas impacted by seawater intrusion and declining water levels.
- Provide treated produced water to a water agency that would discharge it directly to the Salinas River for downstream diversion to areas impacted by seawater intrusion.

Regulations for Delivery, Use and Storage of Treated Produced Water

Water quality requirements vary with the use and the mode of delivery. In addition, delivery of treated water through the Salinas River must address water rights issues for downstream users. Finally, permits related to the structural integrity of the containment basin and water quality must be obtained if the water is stored during periods of low demand. This section describes the agencies and regulations related to the above activities.

Table 1. Activities regulated and responsible agencies for potential delivery, use and storage of treated produced water

Agency	Activities Regulated
Central Coast Regional Water Quality Control Board	Water/waste quality issues related to treatment, delivery, storage and end use
California Water Resources Control Board – Water Rights Division	Water rights/water allocation issues if treated water is discharged into the Salinas River
California Department of Water Resources –Division of Safety of Dams	Storage of treated water near surface waters
US Army Corps of Engineers	Storage facilities near surface waters, if federal funding is involved

Monterey County Planning and Building Inspection Department	Grading permits for storage of treated produced water
California Department of Fish and Game	Activities which alter stream flows (e.g. construction of discharge structures in the river bank)

Regulations Related to Water Quality

Central Coast Regional Water Quality Control Board

The Central Coast Regional Water Quality Control Board (CCRWQCB) is the principal regulatory agency responsible for overseeing the discharge of any water that could impact California water resources in this region. This authority comes from the Porter-Cologne Water Quality Control Act (Porter-Cologne) that established the California State Water Resources Control Board (CWRCB) and nine Regional Water Quality Control Boards. The CCRWQCB is one of these nine regional boards.

The CCRWQCB, in its role of implementing the State Policy for Water Quality Control, has adopted a Basin Plan that identifies the beneficial uses of the various existing water resources in the region, including surface and ground water. Any discharge from this project would most likely occur within the Salinas Hydrologic Unit. This hydrologic unit is subdivided into various sub-units and each sub-unit has its own set of beneficial uses.

All beneficial uses are protected by the development of water quality objectives that, in turn, are used to establish local waste discharge requirements (WDRs). The WDRs must also comply with the existing State Implementation Policy related to the National Toxics Rule (NTR) and the specific California Toxics Rule (CTR).

Authorization from the CCRWQCB is required for any discharge that may have an impact on the region's water resources. Two types of authorization are issued. The first is the National Pollutant Discharge Elimination System (NPDES) permit, a national program delegated to the State and Regional Boards for implementation. This permit affects any discharge to a water of the U.S. (primarily surface waters). The second is a set of WDRs which are a California authorization intended to protect state waters not covered by the NPDES permit program. In practice, it is common for the CCRWQCB to issue one permit that covers both program requirements.

The permit requirements under various water discharge (delivery) and water use scenarios are described below:

Water Quality Regulations Related to Delivery of Treated Produced Water through the Salinas River

In this scenario, produced water for irrigation would be treated and then discharged directly to the Salinas River. The treated water would need to meet the requirements found in the following regulations and/or policy documents:

- 40 CFR 435.30 *et seq.*,

- 40 CFR 435.50 *et seq.*,
- NTR)the CWRCB Policy for Implementation of Toxics (Resolution 2000-015 as amended by Resolution 2000-30),
- The Anti-degradation Policy (Resolution 68-16), and
- The narrative and specific numeric water quality objectives contained in the Central Coast Basin Plan for the Salinas River and any groundwater that might be impacted by the discharge.

40 CFR 435.30 *et seq.*

This is a federal regulation promulgated by the Environmental Protection Agency (EPA) in which effluent guidelines for the oil and gas extraction industry were developed. Specifically, 435.30 *et seq.* addresses discharges from the “onshore” subcategory of the oil and gas extraction industry that are located landward of the inner boundary of the territorial seas. In section 435.32, the effluent guideline states, “there shall be no discharge of waste water pollutants into navigable waters from any source associated with production, field exploration, drilling, well completion, or well treatment” to the west of the 98th meridian. Unless wastewater discharge to the Salinas River is subject to other provisions contained in 40 CFR 435 (see below), the Water Board will not allow any discharge of wastewater to the Salinas River.

40 CFR 435.50 *et seq.*

This section of the federal regulations addresses onshore facilities “located in the continental United States and west of the 98th meridian for which the produced water has a use in agriculture or wildlife propagation when discharged into navigable waters”. Onshore facilities in the San Ardo Field are located in the continental United States and they are located west of the 98th meridian. The wastewater would be treated before discharge to meet quality standards for use in agricultural applications. In 435.51, the term “use in agricultural or wildlife propagation” is defined to include produced water of sufficient quality to be used for agricultural uses. Discharge would be subject to certain limitations specified in 40 CFR 435.52, namely, that the produced water (after treatment) does not exceed a daily maximum limitation for oil and grease of 35 mg/l and other limitations as discussed below.

NTR and CTR, Water Board Implementation Policy

These two regulations and the State Board policy are intended to limit the discharge of “toxics” into navigable waters. CTR, promulgated in 2000, specifies water quality criteria for 128 priority pollutants based on their toxicity to aquatic species. These limits, presented in EPA Federal Register (USEPA, 2000), are generally lower than NPDES discharge limits based on Basin Plan criteria. Compliance with some of these limits would require significant, additional treatment processes and increased treatment cost.

Anti-degradation Policy

The CWRCB adopted this policy in the late 1960s to maintain the quality of existing water resources. Under this policy, the discharge must not cause a degradation of the existing quality of the receiving water unless it has been demonstrated that the change will be consistent with

maximum benefit to the people of California, that it will not unreasonably affect the present and anticipated beneficial use of such water, and that it will not result in water quality less than that prescribed in the policies.

Central Coast Basin Plan

The CCRWQCB is responsible for adopting and implementing the Basin Plan that defines beneficial uses of surface and groundwater in the project area and sets narrative and numerical water quality objectives for the designated use. Accordingly, the beneficial use designations for the Salinas River include Municipal and Domestic Water Supply (MUN) as well as Agricultural Water Supply (AG) and Industrial Water Supply (IND) uses among other uses. In addition, the Basin Plan defines narrative and numeric criteria for groundwater recharge and agricultural use when the water is not delivered through the river. The Water Board may require that the produced water be treated to meet the appropriate criteria of the narrative and specific numerical water quality objectives as identified in the Basin Plan prior to discharge.

Water Quality Requirements Related to Delivery of Treated Water for Agricultural Irrigation by Hard Piping

In this scenario, the end user would get deliveries of treated water for agricultural irrigation by a hard pipe. The CCRWQCB would require a WDR for this use. The treated water must meet the following water quality criteria:

- Crop water quality requirements
- Water quality requirements of the Central Coast Basin Plan

Compared with delivery through the Salinas River, there would be fewer monitoring requirements. For example, a shorter list of parameters may be issued to routinely treat and report. These differences may or may not alter the treatment process train for the produced water.

Water Quality Requirements Related to Discharge of Groundwater into the Salinas River through Water Trade Agreement with Farm Owners

Under this scenario, treated water delivered for agricultural use would be traded for groundwater. The “freed-up” groundwater would then be pumped into the Salinas River for conveyance to downstream users. The groundwater pumped into the river must meet all the requirements specified in an earlier section for the discharge into the Salinas River.

Regulations Related to Water Rights

California Water Resources Control Board – Division of Water Rights

The CWRCB Division of Water Rights (DWR) is responsible for ensuring that water is shared equitably among all downstream users, based on historical or legally determined water rights. As such, the DWR establishes removal quotas or pumping limits based on the adjudicated volumes of water provided by the various sources. The addition of new sources of water, such as treated produced water, would likely need to be allocated to downstream users. The process

requires identification of the volume of water and the potential downstream user. The permit to appropriate the released water by the identified user would be based on the amount of water delivered and potential losses during conveyance. The proposed use of the appropriated water must also be specified. The permit application must indicate the details of the diversion works (direct diversion by pump, storage dam, etc.). The permit application would have to be filed well in advance of the construction of diversion work.

The proposed project may be subject to the California Environmental Quality Act (CEQA) which requires agencies to consider environmental effects. This process may involve obtaining a certification of exemption, a negative declaration or a preparation of a full Environmental Impact Report (EIR). More details regarding the appropriation process is provided in the three pamphlets issued by the DWR (CWRCB 2000, 2000a, 2001).

Regulations Related to Storage

Due to potential differences in supply and demand for the treated produced water storage facilities may be required to store the water produced during non-peak demand period. For example, the peak water demand for agricultural use is between June and August. Depending on the location, size and funding source various agencies would be involved in the permit process for construction of storage facilities. Permit requirements from these agencies are briefly discussed below:

California Department of Water Resources – Division of Safety of Dams

The Division of Safety of Dams (DSD) would be involved with any project that creates a structure to impound water in a “navigable” water as defined by EPA if the structure is greater than 25 feet high or the impoundment contains more than 50 acre-feet of water. In this role, the DSD would ensure that the structural integrity of any jurisdictional dam (storage structure) is adequate for its intended purpose. Furthermore, the DSD would usually be the State representative for the US Army Corps of Engineers.

Water storage structures that are built solely for agricultural use and not located across a stream channel, watercourse, or natural drainage area are not considered to be a dam and not subject to the jurisdiction of the DSD. (California Water Code (CWC), Division 3, Part 1, Chapter 1, §6004(b)). The jurisdiction of the DSD normally applies to any structure that is 25 feet or more in height or has or will impound a capacity of 50 acre-feet or more. (CWC, §6002). However, the CCRWQCB would be involved because any water discharge into the storage area could have the potential to impact waters of the state, i.e. groundwater.

US Army Corps of Engineers

The Corps of Engineers is not normally involved in such projects unless there is direct U.S. Government funding for the construction of a dam. As such, the Corps of Engineers would rely upon the DSD to oversee any construction that does not involve federal funding (i.e., the COE will be directly involved only if the project receives federal funding).

Monterey County Planning and Building Inspection Department

The feasibility of local water storage in surface impoundments (ponds) on individual farmlands was explored. In order to install a pond, a farmer would be required to obtain grading permits from the Monterey County Planning and Building Inspection Department. As part of the permit process, the farmer must submit five sets of plans for each area where ponds are planned.

Central Coast Regional Water Quality Control Board

Chapter 3 of California Code of Regulations (Title 27, Division 2, Subdivision 1) classifies wastes to determine where the wastes can be discharged (stored). This chapter presents geologic and siting criteria for waste management units to store various waste streams. The CCRWQCB is responsible for defining the storage siting criteria if seasonal storage is required for treated produced water. However, an exemption from this requirement might be available if the waste (treated produced water) meets the criteria for inert waste as defined by section Ch15:§2524. An “inert waste” is a subset of waste that does not contain hazardous substances or soluble pollutants at concentrations in excess of applicable water quality objectives and does not contain significant quantities of decomposable waste.

Regulations Related to Wildlife Protection

California Department of Fish and Game

Any structure constructed for discharge of treated water into a waterway would require a stream alteration permit from the California Department of Fish and Game (CDFG). In addition, CDFG is responsible for ensuring sufficient water flow downstream of any water diversion point at all times in order to protect fish and wildlife resources. (Section 5937, Article 2, Chapter 3, Part 1, Division 6 of the California Fish and Game Code). Approval from the CDFG may be required to obtain water appropriation by an end user.

Summary

In summary, an evaluation of regulations indicates that, for delivery of treated water to agricultural land by hard pipe, the treated water quality must meet crop water quality and basin plan water quality requirements. WDRs must be obtained from the CCRWQCB. For delivering water via the river the following would be required:

- The released water must facilitate agricultural or wildlife restoration requirements.
- The water quality must be in compliance with NPDES, NTR, CTR and anti-degradation requirements.
- A permit from the CWRCB must be obtained for water appropriation.
- Approval from the CDFG may be required for the appropriation of water to verify that the loss of water will not have an adverse effect on fish and wildlife resources.

Finally, storage of water during periods of low demand may involve regulations from the DSD, Monterey County Environmental Health & Planning Department, and the CCRWQCB depending on storage location and water quality.

References

- 1) USEPA, 2000. Federal Register. 40 CFR Part 131. Part III. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule.
- 2) California State Water Resources Control Board Division of Water Rights. *Information pertaining to water rights in California*. Sacramento, CA: State Water Resources Control Board, 2000.
- 3) California State Water Resources Control Board Division of Water Rights. *How to file an application to appropriate water in California*. Sacramento, CA: State Water Resources Control Board, 2000.
- 4) California State Water Resources Control Board Division of Water Rights. *A Guide to California water rights appropriations*. Sacramento, CA: 2001
- 5) Monterey County Water Resources Agency. *1998 Ground water extraction summary report*. Salinas, CA: Monterey County, 2000