Environmental Action Center

CALIFORNIA CASE STUDY:
Injection Well Projects in Monterey and Fresno Counties

EAC

About the Environmental Action Center

The Environmental Action Center (EAC) is a non-profit organization with an office in Washington, D.C. The EAC is actively involved in environmental protection issues throughout California and the Mid-Atlantic Region of the United States. The EAC works through science, law, and policy to protect the United States' water resources from contaminants by curbing toxic releases into the natural environment.

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Executive Summary

There are many significant environmental impacts resulting from oil and gas exploration and production, however, one of the most significant is the disposal of wastewater produced during oil and gas operations. Oil and gas operations use millions of gallons of water each year, and industry operators are faced with decisions regarding how to dispose of that wastewater. One of the most economical methods of oil and gas wastewater disposal – injecting the wastewater back into underground injection wells – is also one of the most problematic. In theory, oil and gas operators inject the wastewater into underground rock formations, known by their characteristics as suitable "geologic zones." Different geologic zones are suited for wastewater disposal based on their depth, permeability, and confinement characteristics. Additionally, geologic zones used for wastewater disposal *in theory* are not considered as being potential sources of drinking water, because of chemical characteristics of the water already present in the formation.

An aquifer, or an underground source of drinking water, needs to be exempted by the United States Environmental Protection Agency or equivalent state agency to be used as a geologic zone for underground wastewater disposal. Generally, deep underground aquifers are not suitable for drinking water, while more shallow aquifers are. This presents a problem when oil and gas wells are also shallow, because the disposed wastewater is closer in proximity to underground sources of drinking water. When operators inject too much wastewater, at pressures that exceed the pressures in the injection zone, vertical fractures can form in the rock formations, which results in contaminated oil and gas wastewater migrating out of the injection zone. If allowed to migrate far enough upwards, the wastewater could potentially reach more shallow underground sources of drinking water.

In injection zones such as the Lombardi and Aurignac sands in Monterey County, which are now being considered for an aquifer exemption, overpressure problems have existed since the beginning of oil and gas wastewater disposal in the area – at least since the 1980's. The California state agency that oversees underground injection of wastewater, the Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR), has routinely overlooked wastewater injection problems in violation of the agency's own regulations, as well as federal law. Thus, at a time when California is reviewing its underground wastewater disposal program, the regulatory agencies must consider the history of oil and gas wastewater injection, and the future potential for wastewater disposal to negatively impact current and future water resources. Where wastewater disposal projects are located near underground sources of drinking water and potential future sources of drinking water, DOGGR must enforce existing legal requirements that apply to well operators. DOGGR must also use reasoned discretion and shut down injection projects where appropriate.

Table of Contents

Executive Summary ii

I. Introduction 1

II. Background 3

III. Reforming the DOGGR UIC Program 5

IV. DOGGR's Statutory & Regulatory Mandate under the Current UIC Class II Program 8

V. Evidence of Harm from Continued Waste Fluid Injection into Non-Exempt Aquifers 10

A. Case Study: Deficiencies in Water Disposal Project Operations as Evidenced by the Monterey County San Ardo Field Project 11

Project File 64406009 History 12

B. Case Study: Fresno Area Project Deficiencies in Riverdale Field Project 61400001, and Raisin City Field Project 58400001 19

VI. Recommendations 22

Figures 23

I. Introduction

In recent years, California's oil and gas industry has intensified the use of enhanced oil recovery techniques to increase yields from new and existing oil and gas wells. With the widespread use of more extreme oil and gas production techniques comes greater volumes of waste fluid. These waste fluids are subsequently disposed of by injecting them back down a well. Wells used for disposal of wastewater or waste fluids produced during oil and gas production are regulated as Class II underground injection wells, pursuant to California's Underground Injection Control ("UIC") program. Class II disposal wells inject waste fluids associated with oil and gas production – including water, wastewater, brine (salt water), and water mixed with chemicals – into deep underground porous rock formations. To ensure that these potentially toxic waste fluids injected into deep rock formations do not migrate into potential sources of drinking water adjacent to those formations, federal and state laws and regulations prescribe strict standards for the approval of Class II disposal well permitting and operations.

California's agency charged with regulating the oil and gas industry, the Division of Oil, Gas, & Geothermal Resources ("DOGGR") is currently in the process of reviewing and updating its UIC guidelines for Class II disposal wells, pursuant to California Senate Bill No. 4 ("SB4") and a federally-mandated overhaul of its UIC Class II program. DOGGR regulates oil and gas production and disposal wells in California in groups, called "projects." Each project can consist of a few oil and gas-related wells, or a few hundred oil and gas-related wells. DOGGR approves permits for individual wells within the project based on the project location, the oil production field, and the specific geology underlying the project. When this occurs, in theory, a figurative layer of regulatory safeguards and literal layers of rock strata works to protect underground sources of drinking water ("USDWs") from contamination from potentially toxic fluid migration.

Historically, DOGGR failed to require oil and gas operators to perform the legally required geologic, hydrologic and engineering studies prior to approving wastewater disposal, thus raising "concerns about whether California's [UIC] program is adequately protective of [USDWs] – defined as groundwater aquifers that are used for water supply or could one day supply water for human consumption."[1] Thus, in 2015, DOGGR began its "project-by-project" review of all Class II wastewater disposal wells in order to determine the safety of wastewater disposal projects, and potential threats to water resources.

The San Ardo Oil Field, located in DOGGR's Coastal District (formerly "District 3"), was the eighth largest producing oil field in California as of 2015.[2] An independent report commissioned by the California legislature specifically mentioned oil and gas activities in the San Ardo oil field

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[1] *See* RENEWAL PLAN FOR OIL AND GAS REGULATION: CHANGING PAST PRACTICES TO USHER IN A NEW ERA OF OIL AND GAS REGULATION, DEPARTMENT OF CONSERVATION (Oct. 2015), *available at* ftp://ftp.consrv.ca.gov/pub/oil/Publications/Renewal%20Plan%2010-08-2015.pdf; *see also* CALIFORNIA COUNCIL ON SCIENCE AND TECHNOLOGY, AN INDEPENDENT SCIENTIFIC ASSESSMENT OF WELL STIMULATION IN CALIFORNIA, VOLUME III 162 (July 2015) [hereinafter CCST REPORT VOL. III], *available at* http://ccst.us/publications/2015/160708-sb4-vol-III.pdf.

[2] 2015 REPORT OF CALIFORNIA OIL AND GAS PRODUCTION STATISTICS, DEPARTMENT OF CONSERVATION 1 (2015), *available at* ftp://ftp.consrv.ca.gov/pub/oil/annual_reports/2015/PR03_2015.pdf.

as a potential conduit for chemical contaminants to travel into water resources.[3] Notably, both surface *and* groundwater resources are at risk of contamination from the San Ardo field wastewater disposal activities. Surface water resources, such as rivers, lakes, streams, and wetlands, can become contaminated through "spills or accidental releases directly into a waterway, or on the land surface, where contaminants could run off into surface water bodies."[4] Additionally, "polluted groundwater can discharge to the surface via springs or subsurface discharge to streams (via baseflow) or other surface water bodies."[5]

DOGGR has identified approximately 255 projects within DOGGR's Coastal District boundaries that may take 10,200 hours to fully review in the project-by-project review process.[6] Once DOGGR program staff identifies the data missing from each project file, developing a compliance schedule for project operators and certifying that requirements have been completed will take an additional 12-18 months.[7] Accordingly, "the overall time to complete the project review, certify remedial work, and move the program into full regulatory compliance is estimated to be three years."[8] Coinciding with the project-by-project review, pursuant to the Aquifer Exemption Compliance Schedule Regulations, many aquifers throughout California must be exempted for injection projects to continue. The exemption process requires that aquifers that could potentially become drinking water sources be examined to determine whether injection projects should be allowed to continue.[9] Without such an exemption, an aquifer is considered "non-exempt" and must be protected from oil and gas exploration and production to preserve current and future sources of drinking water.

Furthermore, by the time DOGGR completes its project-by-project review, wells that may later be found to have been in violation will have been continuously injecting into non-exempt aquifers for several years. Many disposal wells in the Coastal District and Inland District (formerly, "District 5"), particularly in the San Ardo field, have already been flagged by DOGGR as having unacceptably high hydrostatic pressure, meaning that those disposal wells pose an unacceptable risk of acting as a conduit for, or otherwise contributing to, fluid migration out of the intended wastewater injection zone. These conditions can lead to contamination of neighboring aquifers, located in both Monterey County (the Salinas Valley Groundwater Basin)

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[3] CCST REPORT VOL. III, *supra* note 1, at 157.
[4] *Id*.
[5] *Id*.
[6] Letter from Steve Bohlen, State Oil and Gas Supervisor, Division of Oil, Gas, and Geothermal Resources, and Jonathan Bishop, Chief Deputy Director, State Water Resources Control Board, to Michael Montgomery, United States Environmental Protection Agency – Region IX, Attachment 2: Plan for Class II Program Improvements 9 (July 15, 2015), *available at* ftp://ftp.consrv.ca.gov/pub/oil/UIC%20Files/July%2015%202015%20US%20EPA%20Deliverable.pdf.
[7] *Id*.
[8] *Id*. at 10.
[9] *See* CAL. CODE REGS. 26 § 14-1779.1 ("14 C.C.R. § 1779.1"); *see also* AQUIFER EXEMPTION PROCESS GUIDANCE DOCUMENT, THE STATE OF CALIFORNIA DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES, AND THE STATE WATER RESOURCES CONTROL BOARD 10 (April 10, 2015). The Aquifer Exemption Guidance states that: "With respect to the aquifers historically treated as exempt, the State Water Board and the Division will work with USEPA to evaluate these aquifers. If any portion of these aquifers meets the criteria for exemption and the State Water Board determines that injection into the aquifers will not adversely affect existing or potential beneficial uses of groundwater, the Division will prepare and submit an exemption application to USEPA. The evaluation, application, and subsequent decision for the aquifers will be completed by February 15, 2017."

and Fresno County (Fresno Sole Source Aquifer); a potential consequence of DOGGR's failure to force well operators to comply with UIC Class II regulatory requirements.

II. Background

In 1974, Congress enacted the Safe Drinking Water Act ("SDWA"), to protect current and future underground drinking water sources from contamination.[10] The SDWA includes, *inter alia*, the UIC program that governs the permitting, operation, and closure of injection wells that place fluids underground for storage, disposal, or enhanced oil and gas recovery. Congress granted the U.S. Environmental Protection Agency ("EPA") the authority and responsibility to regulate UIC wells under the SDWA. The U.S. EPA properly delegated to the State of California, by grant of primacy through a Memorandum of Agreement ("MOA") in 1982, its SDWA authority to implement California's UIC program. The MOA was incorporated into and published as federal regulations in 1983.[11] DOGGR, the agency responsible for implementing the UIC program on behalf of the State of California, must administer the UIC program in conformance with laws and regulations at the state and federal level.

The 1982 MOA between DOGGR and EPA incorporates the requirements of the SDWA, and sets forth DOGGR's regulatory responsibilities for enacting the Class II UIC program. The MOA states in unequivocal language that "an aquifer exemption must be in effect prior to or concurrent with the issuance of a Class II permit for injection wells into that aquifer."[12] Under the SDWA's preventative approach towards protecting water resources, Class II injection wells are prohibited from injecting fluids into an aquifer that could potentially be an underground source of drinking water, unless the aquifer has previously been officially exempted from SDWA protections. The SDWA defines "underground sources of drinking water" to include 'non-exempt' aquifers containing groundwater with less than 10,000 mg/L total dissolved solids ("TDS") at a quantity sufficient to supply a public water system.[13] An aquifer may be 'exempted' only if (a) it does not currently serve as a source of drinking water; *and* (b) it cannot now and will not in the future serve as a source of drinking water.[14]

The MOA also requires that DOGGR "adhere to the compliance monitoring, tracking and evaluation" requirements pursuant to SDWA Section 1425 and "maintain a timely and effective compliance monitoring system including timely and appropriate actions on non-compliance."[15] DOGGR must perform "adequate recordkeeping and reporting" to "prevent underground injection which endangers drinking water sources."[16] The MOA additionally requires that DOGGR provide EPA with annual reports on the "recent operations of the Class II program."[17]

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[10] 42 U.S.C. § 300f et seq.; 40 C.F.R. § 144.1 et seq.
[11] *See* 40 C.F.R. 147.250 (2004).
[12] UNDERGROUND INJECTION CONTROL PROGRAM MEMORANDUM OF AGREEMENT BETWEEN CALIFORNIA DIVISION OF OIL AND GAS AND THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY REGION 9 6-7 (Sept. 29, 1982) [hereinafter 1982 MOA], *available at* http://www.conservation.ca.gov/dog/general_information/Documents/MOA_DOG_USEPA_UIC.PDF.
[13] 40 C.F.R. § 144.3.
[14] 40 C.F.R. § 146.4 (emphasis added).
[15] 1982 MOA, *supra* note 12, at 3.
[16] 42 U.S.C. § 300h-4(b).
[17] 1982 MOA, *supra* note 12, at 4.

Five different types of underground injection wells are subject to regulation under the SDWA, and a permit is required to operate each type of well. Class II wells, mentioned above, involve injections related to oil and gas operations, and include enhanced recovery injection wells (80%), wastewater disposal wells (20%), and hydrocarbon storage wells (nominal).[18] Class II injection wells dispose of waste fluids brought to the surface in the process of oil and gas extraction ("produced water"), and fluids used in enhanced recovery of oil or natural gas ("flowback fluids"). Produced water and flowback fluids contain harmful contaminants including benzene, heavy metals, and other chemicals that are associated with adverse human health consequences, and include some substances that are known carcinogens.

Class II wells are regulated under the SDWA because of their potential to contaminate USDWs with the chemicals mentioned above. As such, the SDWA's "aquifer contamination prevention principle" includes a statutory structure designed to ensure that underground sources of drinking water are not and will not be endangered by this waste fluid injection. Congress' approach in drafting the SDWA attempted to balance oil and gas operations with aquifer safety, but established an overarching directive favoring aquifer safety whenever oil and gas operations could endanger an aquifer. This balancing approach is evident in Section 300h(b)(2) of the SDWA, which provides that UIC program requirements should not interfere with oil and gas production "unless such requirements are essential to assure that underground sources of drinking water will not be endangered by such injection."

The House of Representatives Committee Report elaborates the "prevention principle" and Congress' balancing approach:

> "This amendment prohibits regulations for State UIC programs from prescribing requirements which would interfere with production of oil or natural gas or disposal of by-products associated with such production, *except that such requirements are authorized to be prescribed if essential to assure that underground sources of drinking water will not be endangered by such activity*."[19]

While both DOGGR and EPA have statutorily prescribed duties to protect California's underground water resources, DOGGR must also administer California's oil and gas laws "so as to prevent, as far as possible . . . damage to underground oil and gas deposits from infiltrating water and other causes; loss of oil, gas, or reservoir energy, and damage to underground and surface waters suitable for irrigation or domestic purposes by the infiltration of, or the addition of, detrimental substances."[20] Thus, historically, DOGGR's oil and gas regulatory scheme required operators to be protective not only of USDWs, but also adjacent hydrocarbon production zones. In contrast, the SDWA focuses exclusively on the protection of water resources. Federal law provides that, "[n]o owner or operator shall construct, operate, maintain, . . . or conduct any other injection activity in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that

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[18] United States Environmental Protection Agency, *Class II Oil and Gas Related Injection Wells*, https://www.epa.gov/uic/class-ii-oil-and-gas-related-injection-wells (last visited Oct. 20, 2016).
[19] H.R. Report #93-1185, p.31 (emphasis added).
[20] CAL. PUB. RES. CODE § 3106(a).

contaminant may cause a violation of any primary drinking water regulation under 40 CFR part 142 or may otherwise adversely affect the health of persons."[21] Federal law also requires that all state UIC programs must be administered in conformance with that section.[22] Similarly, DOGGR's other oversight responsibilities with respect to Class II well operations include ensuring that permit applicants "satisfy [the] State that underground injection will not endanger drinking water sources."[23]

In addition to federal regulatory requirements, California law establishes DOGGR's statutory duties in regards to oil and gas activities, and specifically the Class II UIC program. DOGGR is charged broadly with the regulation of drilling, operation, maintenance, and plugging and abandonment of onshore and offshore oil, gas, and geothermal wells within the State of California.[24] DOGGR has a duty "to[, among other things,] prevent, as far as possible, damage to life, health, property, and natural resources . . . and damage to underground . . . waters suitable for irrigation or domestic purposes by the infiltration of, or the addition of, detrimental substances."[25]

Additionally, California regulations outline the engineering, geologic, and injection data required to be submitted with each UIC Class II wastewater disposal well application. Pursuant to the California Code of Regulations ("CCR"), the applicant must submit to DOGGR, and DOGGR must possess in its Administrative Record, a detailed engineering study with the reservoir and fluid characteristics for each injection zone, and operational diagrams including casing details for all wells within the area affected by each project.[26] Additionally, the applicant must submit to DOGGR a detailed geologic study, including detailed cross-sectional data with the identification of all geologic units, formations, freshwater aquifers, and oil or gas zones.[27]

However, the regulatory requirements for UIC Class II projects in theory is not the same as what DOGGR has historically required in practice. DOGGR has, for decades, routinely approved UIC Class II projects and individual well permits without the information required under federal and state law.

III. Reforming the DOGGR UIC Program

In 2010, EPA reviewed DOGGR's implementation of California's UIC Program, and ordered an audit of the program by the Horsley Witten Group. In June 2011, the Horsley Witten Group published its *California Class II Underground Injection Control Program Review, Final Report* (the "2011 Audit Report" or "the Report"), which evaluated the DOGGR's performance in its implementation of California's UIC Program. In the 2011 Audit Report, the Group cited serious

[21] 40 C.F.R. § 144.12(a).
[22] 40 C.F.R. § 145.11(a)(5).
[23] 42 U.S.C. § 300h(b)(1)(B); 42 U.S.C. § 300h-4(a).
[24] CAL. CODE REGS. Title 14, Division 2, Chapter 4. Development, Regulation, and Conservation of Oil and Gas Resources.
[25] CAL. PUB. RES. CODE § 3106(a).
[26] CAL. CODE REGS. tit. 14, §§ 1781(f), 1724.7(a).
[27] CAL. CODE REGS. tit. 14, § 1724.7(b).

issues with the UIC Program management of the application process.[28] The 2011 Audit Report recommended "a full review" of wastewater injection permits because it was unknown and uncertain whether "only Class II fluids are injected into Class II commercial disposal wells."[29] The 2011 Audit Report further cited serious technical review deficiencies for UIC well applications, including failure to properly evaluate aquifer conditions, in District 3, District 4, District 5, and District 6.[30] The Report explicitly challenged claims made by District 4 that the District fully reviews all new Class II UIC injection disposal well applications, citing serious concerns regarding the lack of qualified staff.[31]

The 2011 Audit Report also cited the failure of several Districts to properly require and review mechanical integrity tests ("MITs"). MITs are used to demonstrate that fluids are not migrating into or between USDWs because of structural or engineering failures of injection wells.[32] MITs are essential to establish that no damage to well equipment has occurred, and thus DOGGR and well operators can confirm that, pursuant to California law, "injection fluid is confined to the intended zone or zones of injection."[33] The 2011 Audit specifically cited District 2's lack of appropriate verification of the MITs; by the District's own admission, "less than five percent of MITs are witnessed, which is well below the federal UIC guidelines to witness at least 25 percent of MITs."[34]

Both during and following the issuance of the 2011 Audit Report, California resources agency officials publicly recognized the issues with California's injection well permitting program.[35] In his testimony before the California Senate Natural Resources & Water Committee and the Environmental Quality Committee, the California Natural Resources Agency Secretary John Laird admitted that DOGGR had failed to properly regulate wastewater injection, by improperly approving permits to inject wastewater into nonexempt aquifers. During his testimony, Secretary Laird explained that "[t]he challenge that we have before us is the unwinding of actions based on flawed decision making and a lack of deference to basic management protocols that go back as far as 1983."[36]

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[28] HORSLEY WITTEN GROUP, FINAL REPORT: CALIFORNIA CLASS II UNDERGROUND INJECTION CONTROL PROGRAM REVIEW ES-13, 59 (2011) [hereinafter HORSLEY WITTEN REPORT], *available at* http://www.conservation.ca.gov/dog/Documents/DOGGR%20USEPA%20consultant's%20report%20on%20CA%20underground%20injection%20program.pdf..

[29] *Id*. at 198.

[30] *Id*. at 98, 136, 169, 186 and 198.

[31] *Id*. at 132.

[32] United States Environmental Protection Agency Region 5 – Underground Injection Control (UIC) Section Regional Guidance #5, Determination of the Mechanical Integrity of Injection Wells (revised Feb. 2008), *available at* https://www.epa.gov/sites/production/files/2015-09/documents/r5-deepwell-guidance5-determation-mechanical-integrity-200802.pdf.

[33] CAL. CODE REGS. tit. 14, § 1724.7(c)(3).

[34] *See* HORSLEY WITTEN REPORT, *supra* note 28, at 78.

[35] "Ensuring Groundwater Protection: Is the Underground Injection Control Program Working?", Oversight Hearing of the Senate Natural Resources and Water and Environmental Quality Committees (March 10, 2015) [hereinafter 2015 GROUNDWATER OVERSIGHT HEARING], *available at* http://sntr.senate.ca.gov/sites/sntr.senate.ca.gov/files/3_10_14_uic_background.pdf (referencing June 2014 GAO Report, at 38).

[36] Joint Oversight Hearing: Senate Natural Resources and Water and Environmental Quality Committees (March 10, 2015), *available at* http://senate.ca.gov/media-archive?title=&startdate[value]=&enddate[value]=&page=8#.

During the same hearing, the Director of the California Department of Conservation stated that the scores of wells requiring review face the following administrative issue:

> "It is important for the committees to understand the nature of the challenge we have in reforming the UIC Program. We are examining wells that have already been permitted. Some of those may have been permitted in areas not previously approved for injection, but which are appropriate for injection. *Others [other wells] may be wells that should never have been approved*. We need to review the past approvals and we need to use a protective filter that errors on the side of well closure when water supply sources are potentially at risk. We also must recognize that some injection wells are nowhere near water supply wells and present no risk to beneficial uses of groundwater. The water board is currently testing wells in question to determine whether there is any risk to public health. So far there has been none. However, we must make sure we don't issue cease and desist orders in a blanket fashion, *given that some approved wells might actually be appropriate and safely injecting*." [Emphasis added].

Pursuant to SB4, the California Natural Resources Agency had also commissioned the report, *An Independent Scientific Assessment of Well Stimulation in California*, prepared by the California Council on Science and Technology ("CCST"). The report identified documented disposal into potentially protected groundwater, citing the 2014 shutdown of 11 disposal wells in Kern County.[37] Additionally, the report found that "[d]ata on wastewater disposal and management are incomplete" and cited problems with wastewater reporting, finding cases where "information was missing or meaningless." According to the report authors:

> "[i]t was apparent during our investigations that information submitted to the state was not subject to systematic quality checks or verified, and, as a result, datasets resulting from these submissions contained errors and inconsistencies. . . . Analysis of uncorrected data can and will result in significant errors in interpretation.[38]

The report found that the chemical data submitted by operators "includes errors and omissions" and "more than 50% of reported well stimulation chemicals in California have unknown environmental and health profiles."[39] Additionally, the report found that many of the chemicals found in well stimulation fluids could result in acute toxicity to fish and invertebrates.[40] Similarly, several compounds were identified as hazardous to human health.[41]

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[37] CALIFORNIA COUNCIL ON SCIENCE AND TECHNOLOGY, AN INDEPENDENT SCIENTIFIC ASSESSMENT OF WELL STIMULATION IN CALIFORNIA, VOLUME II 107 (July 2015) [hereinafter CCST REPORT VOL. II], *available at* http://ccst.us/publications/2015/160708-sb4-vol-II.pdf..

[38] *Id*. at 153, 158.

[39] *Id*. at 153, 155, 406-07.

[40] *Id*. at 78.

[41] *Id*. at 409. Compounds hazardous to human health identified in produced waters include: "chlorides, heavy metals, and metalloids (e.g., cadmium, lead, arsenic), volatile organics (e.g., benzene, toluene, ethylbenzene, and xylene), bromide, barium, and, depending upon the geochemistry of the target reservoir, naturally occurring radioactive materials (e.g., radium-226 and radon) and other compounds (Alley et al., 2011; Maguire-Boyle and Barron, 2014; Nelson et al., 2014). Many of these naturally occurring compounds have moderate to high toxicity and can induce health effects when exposure is sufficiently elevated (Balaba and Smart, 2012; Haluszczak et al., 2013). It should be noted that no studies to date have analyzed the chemical constituents of recovered fluids and produced water from well-stimulation-enabled oil wells in California."

Subsequently in 2015, DOGGR Supervisor Steve Bohlen and Chief Deputy Director Jonathan Bishop acknowledged directly to EPA Region IX that DOGGR did not know whether 490 wells were potentially degrading underground or surface water that is known to be, or may be, suitable for irrigation or domestic purposes.[42] Thus, DOGGR began the journey to reform its UIC program to conform to federal statutory and regulatory requirements. In early 2015, DOGGR began a course of action in coordination with EPA, laying out a schedule of required activities and deliverables with target milestones and compliance deadlines.[43] Ultimately, EPA established February 15, 2017 as the final compliance deadline for Class II wells currently injecting into non-exempt aquifers.[44]

IV. DOGGR's Statutory & Regulatory Mandate under the Current UIC Class II Program

In addition to the aforementioned legal and regulatory requirements, the California Public Resources Code and the California Code of Regulations further define DOGGR's responsibilities in protecting potential USDWs from injected fluids. As previously mentioned, Section 3106(a) of the California Public Resources Code requires DOGGR "to prevent, as far as possible, damage to life, health, property, and natural resources" and "damage to underground . . . waters suitable for irrigation or domestic purposes by the infiltration of, or the addition of, detrimental substances."[45] Sections 3236 and 3236.5 of the Public Resources Code provide that an operator "who violates, fails, neglects, or refuses to comply with any provisions" of the Code (and, by necessary implication, its regulations) is guilty of a misdemeanor and may be fined $25,000 for each violation.[46]

Section 1775 of Title 14 of the California Code of Regulations, which implements section 3106 of the Public Resources Code, also prohibits the disposal of "oilfield wastes" in a manner that may cause damage to "life, health, property, freshwater aquifers or surface waters, or natural resources, or be a menace to public safety."[47] The California Code of Regulations also mandates that injection "shall be stopped" if there is evidence that "damage to life, health, property, or natural resources is occurring by reason of the project."[48]

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[42] Letter from Steve Bohlen, State Oil and Gas Supervisor, Division of Oil, Gas, and Geothermal Resources, and Jonathan Bishop, Chief Deputy Director, State Water Resources Control Board, to Jane Diamond, Director, Water Division Region IX, United States Environmental Protection Agency 4 (Feb. 6, 2015), *available at* ftp://ftp.consrv.ca.gov/pub/oil/UIC%20Files/FINAL_Dual%20Letterhead_US%20EPA%20Letter.pdf. This could be as high as 1,500.

[43] Letter from United States Environmental Protection Agency Region IX, to Jonathan Bishop, Chief Deputy Director, California State Water Resources Control Board and Steven Bohlen, State Oil and Gas Supervisor, Division of Oil, Gas, and Geothermal Resources, California Department of Conservation (March 9, 2015), *available at* http://www.conservation.ca.gov/dog/general_information/Documents/UIC%20%20SDWA%20Compliance%20Ltr%203-9-15.pdf.

[44] *Id.*

[45] CAL. PUB. RES. CODE § 3106(a).

[46] CAL. PUB. RES. CODE §§ 3236, 3236.5.

[47] CAL. CODE REGS. tit. 14, § 1775(a).

[48] CAL. CODE REGS. tit. 14, § 1724.10(h).

To minimize the potential for water contamination from disposal activities, the UIC Class II program regulatory scheme requires that each application for a new Class II injection well project include minimum data regarding engineering, geologic and injection plan studies.[49] For example, among other required information, the engineering study submitted by well operators to DOGGR must include reservoir characteristics and reservoir fluid data for each injection zone.[50] The geologic study must include a structural contour map drawn on a geologic marker at or near the top of each injection zone in the project area, an isopachous map of each injection zone or subzone in the project area, and at least one geologic cross section through at least one injection well in the project area.[51] The wastewater injection plan data must include the treatment of water to be injected, source and analysis of the injection liquid, and location and depth of each water-source well that will be used in conjunction with the project.[52]

The specific review DOGGR must perform to ensure safe injection practices, and protection of adjacent water resources, is the Area of Review ("AOR"). The AOR is not defined in California law or regulations; rather, DOGGR uses the AOR requirements found in federal SDWA regulations.[53] Accordingly, the AOR distance is either a minimum fixed radius of 1/4 mile from the well bore, unless an approved mathematical model is used to determine the "zone of endangering influence."[54] Each AOR must consider the number, type, and condition of all wells within the one-quarter mile radius, including analyses of the extent of each geologic zone, the porosity and permissivity of the strata, and the potential for EOR or disposed fluids to migrate out of those zones.[55] (Figure 1). However, there are no *per se* corrective action requirements for the area of review for new injection wells, other than operators must prove that plugged and abandoned wells will not have an adverse effect on the project or cause damage to life, health, property, or natural resources.[56]

As described more fully above, DOGGR has a nondiscretionary duty to protect underground water resources. This includes preventing underground injection that could potentially degrade underground or surface water that is known to be, or may be, suitable for irrigation or domestic purposes, pursuant to California law.[57] Once Class II wells have initially been permitted, regulatory requirements govern the wells to ensure their continued safe operation throughout the wells' active lifespan. After DOGGR has initially approved a wastewater disposal project, based on the submitted project data and associated AOR, the operator must also provide a chemical

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[49] CAL. CODE REGS. tit. 14, § 1724.7.
[50] CAL. CODE REGS. tit. 14, § 1724.7(a).
[51] CAL. CODE REGS. tit. 14, § 1724.7(b).
[52] CAL. CODE REGS. tit. 14, § 1724.7(c).
[53] *UIC Application Guidance*, CALIFORNIA DEPARTMENT OF CONSERVATION, DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES, http://www.conservation.ca.gov/dog/general_information/Pages/UICApplicationGuidance.aspx (last visited Oct. 20, 2016).
[54] *Id*. (referencing 40 C.F.R. § 146.6).
[55] 40 C.F.R. § 146.24.
[56] *See* UNITED STATES GOVERNMENT ACCOUNTABILITY OFFICE, REPORT TO CONGRESSIONAL REQUEST, EPA PROGRAM TO PROTECT UNDERGROUND SOURCES FROM INJECTION OF FLUIDS ASSOCIATED WITH OIL AND GAS PRODUCTION NEEDS IMPROVEMENT 80 (June 2014) [hereinafter JUNE 2014 GAO REPORT), *available at* http://www.gao.gov/assets/670/664499.pdf.
[57] CAL. PUB. RES. CODE §§ 3106, 3107; CAL. CODE REGS. tit. 14, § 1724.7, 1724.10.

analysis to DOGGR whenever the source of the injection liquid has changed.[58] Should DOGGR later find that the injection project is negatively impacting protected water resources, the California Code of Regulations mandates that injection "shall be stopped" if there is evidence that "damage to life, health, property, or natural resources is occurring by reason of the project."[59]

Both water disposal project files and individual well files show the lack of DOGGR's oversight of the oil and gas industry's wastewater disposal projects. DOGGR's own records show that entire wastewater disposal projects were permitted without critical data and documentation, such as engineering studies, geologic studies, and injection plans required by law. The following case studies demonstrate how a lack of data on wastewater disposal projects can negatively impact water resources that should be protected as current or future potential sources of drinking water under federal and state law.

V. Evidence of Harm from Continued Waste Fluid Injection into Non-Exempt Aquifers

As discussed above, both federal and state lawmakers have initiated in-depth investigations into California's UIC Class II program, its management, and associated reporting requirements. A 2014 United States Governmental Accountability Office report, entitled *EPA Program to Protect Underground Sources from Injection of Fluids Associated with Oil and Gas Production Needs Improvement*, surveyed several states where EPA had relinquished primacy for the UIC program, including California.[60] The report highlighted three critical issues with California's UIC program: (1) California allowed fluids to be injected at a pressure that exceeds the fracture pressure, against stated California regulations; (2) there are only very limited chemical reporting requirements for injected fluids in the California regulations; and (3) California consistently underreported incidences of contamination. For example, California reported only nine water contamination violations in 2009, twelve violations in 2010, and only three violations in 2012.[61] California reported zero water contamination violations in 2008 and 2011.[62]

An accurate assessment of the harms caused by DOGGR's failure to address continued injection into non-exempt aquifers is made impossible by the lack of data collected by DOGGR, and poor quality and inconsistency of the data where it exists. Additionally, there is very little understanding of the distribution of freshwater underground aquifers, and associated baseline monitoring data. The Department of Water Resources' ("DWR") ability to utilize this data is hampered by a significant delay in DOGGR's information sharing, specifically that nearly half the paper records have not been scanned or shared in a timely manner. Although in some cases oil producers have detailed models of subsurface conditions, the regulatory agencies lack access to the information. Even if industry and state regulators do collaborate on sharing the data

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[58] CAL. CODE REGS. tit. 14, § 1724.10(d). This section provides, "A chemical analysis of the liquid being injected shall be made and filed with the Division whenever the source of injection liquid is changed, or as requested by the Supervisor."
[59] CAL. CODE REGS. tit. 14, § 1724.10(h).
[60] JUNE 2014 GAO REPORT, *supra* note 56.
[61] 2015 GROUNDWATER OVERSIGHT HEARING, *supra* note 35 (referencing JUNE 2014 GAO REPORT, at 38).
[62] JUNE 2014 GAO REPORT, *supra* note 56, at 38.

needed for environmental risk analysis, it is recommended that the accuracy of this information should be subject to peer review and extensive verification.[63]

More importantly, DOGGR's historic and current approach towards wastewater disposal project permitting and management is potentially subjecting future sources of drinking water to additional pollution and degradation. The absence of required records for entire well projects, in addition to the absence of required records for each individual wastewater disposal well, precludes DOGGR from fully assessing the impacts of wastewater disposal projects on water resources and the environment. As mentioned above, the actual impacts of UIC wastewater disposal project mismanagement are well documented by federal, state, and private reports. However, a review of actual wastewater disposal project files, and a review of individual wastewater disposal well files, illustrates the problems *in practice* with DOGGR's UIC Class II wastewater disposal program. This analysis demonstrates why DOGGR's project-by-project review is an inadequate solution to address continued wastewater disposal into non-exempt aquifers, and provides recommendations for both short-term and long term solutions to address protecting California's water resources.

A. Case Study: Deficiencies in Water Disposal Project Operations as Evidenced by the Monterey County San Ardo Field Project

The Monterey County San Ardo Oil Field, which overlies the Monterey Shale Formation, was specifically identified by the 2011 CCST report as a potential conduit for contaminants to water resources.[64] (Figure 2). There are 1,090 UIC wells in Monterey County, 46 of which are wastewater disposal wells.[65] There are three distinct injection zones utilized in the San Ardo field for wastewater disposal, the deepest being the Aurignac sands, followed by the shallower Lombardi sands, then the Santa Margarita sand.[66] (Figure 3). Injection wells in the San Ardo field are particularly shallow because of the underlying geology of these injection zones (or "sands").

The Salinas Valley Groundwater Basin is the largest coastal groundwater basin in Central California, and is drained by the Salinas River.[67] The Upper Valley Area of the Salinas Valley Groundwater Basin, which includes the San Ardo Oil Field, recharges primarily from percolation through channel deposits of the Salinas River and tributary drainages.[68] The water disposal

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[63] *See* Testimony of Preston Jordan from Lawrence Berkeley National Lab, Dr. Bradley Esser from Lawrence Livermore National Lab, Dr. Kim Taylor from USGS, Transcript of Video Recording of SWRCB Workshop 31-32, 52-53, 57-58, 60, 64-65, 77 (Apr. 8, 2015); *see also* CCST REPORT VOL. II, *supra* note 37, at 153-56, 159-60.
[64] CCST REPORT VOL. III, *supra* note 1, at 157.
[65] REPORTING PERIOD OF OCTOBER 1, 2015, TO MARCH 31, 2016, UNDERGROUND INJECTION CONTROL PROGRAM REPORT ON PERMITTING AND PROGRAM ASSESSMENT, CALIFORNIA DEPARTMENT OF CONSERVATION, DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES 13 (2016), *available at* http://www.conservation.ca.gov/dog/Documents/SB%2083%20Report%202016%20Mid-Year.pdf.
[66] CALIFORNIA OIL AND GAS FIELD VOLUME II – SOUTHERN, CENTRAL COASTAL, AND OFFSHORE CALIFORNIA OIL AND GAS FIELDS, DEPARTMENT OF CONSERVATION DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES 448 (1992), *available at* ftp://ftp.consrv.ca.gov/pub/oil/publications/Datasheets/Dtasheet_vol_2.pdf.
[67] MONTEREY COUNTY WATER RESOURCES AGENCY, MONTEREY COUNTY GROUNDWATER MANAGEMENT PLAN 1-3 (May 2006).
[68] *Id*. at 3-11.

project #64406009, currently operated by Chevron U.S.A., operates within a ¼ mile of the Salinas River, and accordingly within the Salinas Valley Groundwater Basin.

In areas where wastewater disposal wells are shallow rather than deep, such as in the San Ardo field, concerns exist regarding the pressure of the injection zone. Specifically, if an injection zone is overpressured, injection fluid may be forced into adjacent geologic zones, away from the intended injection zone. In some cases, vertical fractures in the rock formations can allow for unintended fluid migration out of the intended injection zone. Thus, federal and state regulations mandate that maximum allowable injection pressures for an individual well cannot exceed fracture pressure, or the pressure at which the fluid injection will cause fractures in the rock formation.[69]

In addition to vertical fractures resulting from overpressuring the injection zone, other potential pathways for USDW contamination from Class II wastewater disposal wells include lack of well casing integrity, faulty cementing of the well allowing fluid movement up the annulus, movement from the formation itself into the confining formation, abandoned or poorly plugged wells acting as a conduit, movement from one part of a formation to the other, and injection directly into the USDW itself.[70] In theory, contamination pathways are restricted by properly engineered wells, and by certain permit conditions that DOGGR places on the wells. However, when both DOGGR and industry operators lack the proper engineering, geologic, and injection data, protection of water resources cannot be ensured.

The following wastewater disposal ("water disposal" or "waste disposal") project was initially permitted in the mid-1950's, and very few restrictions on the project have been put into place to ensure the integrity of surrounding water resources. Both DOGGR and the project operators have been expressing concerns with excessive pressure in the project area for over 30 years, and in attempts to reduce the overpressure problems in the associated injection zones, operators in the field have tried to intermittently take wastewater disposal wells off-line, have tried to drill new wastewater disposal wells, or have reactivated old, issue-prone wastewater disposal wells to make up for the reduced disposal capacity. However, none of these attempted fixes have presented a solution that can normalize the pressure in the injection zones long-term. Moreover, for several recently-drilled wells, the operator incorrectly identified the injection zone for wastewater disposal. Thus, the analysis required to be submitted to DOGGR regarding fluid confinement, contamination risks, and pressurization risks, so that DOGGR could evaluate the impacts of the new wells on the overall wastewater disposal project and associated injection zones, was rendered meaningless.

Project File 64406009 History

Beginning in the 1980's and continuing until present day, waste fluid injection into the San Ardo Oil Field in the Salinas Valley Groundwater Basin in Monterey County has experienced regular technical failures and inconsistent enforcement. These failures include of scores of injection well and project issues such as excessive hydrostatic pressures, continued injection despite inadequate storage capacity and other project failures.

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[69] 40 C.F.R. § 146.23(a)(1).
[70] 2015 GROUNDWATER OVERSIGHT HEARING, *supra* note 35.

The 1980s (Texaco)

The San Ardo Oil Field was discovered in 1947, though the Texas Company's "Lombardi" 1 well.[71] Subsequently in 1956, Texas Co. notified the Division of Oil and Gas (DOGGR's predecessor), that it was going to begin wastewater disposal into the Lombardi zone in the San Ardo field.[72] By 1982, DOGGR had sent notices to Texaco stating that the maximum allowable surface pressure was exceeded for at least three disposal wells.[73] Not only did Texaco acknowledge the wastewater disposal problems in the project, it noted that a search for a suitable water injection zone, to replace the Lombardi zone, had been underway for two years prior.[74] However, in the same breath, Texaco stated that the wells that continue to be in violation would not be shut-in until wastewater disposal capacity was developed in new wastewater disposal wells.[75]

DOGGR replied by stating that Texaco's decision to phase those wells out of injection service "came none too soon", given the fact that the wells "backflowed either upon completion or after having been shut in for some time and also the fact that it is not possible to survey them to the top of the injection zone . . .."[76] However, Texaco responded by stating that a considerable amount of testing and evaluation was required before a new disposal site could be developed as an alternative for the disposal wells in violation, and thus injection would continue in those wells for more than one year.[77] Following this revelation, DOGGR did nothing to stop Texaco from injecting waste fluids into those three wells, in violation of its own regulations.

The overpressure problems in the water disposal project, acknowledged by both DOGGR and Texaco, were compounded by issues in classifying the correct injection zone for waste water disposal. In 1983, the water disposal project was changed to include injection into the Aurignac zone as well as the Lombardi zone, "as the result of the Aurignac sand taking a significant amount of the injection fluid in well 'Rosenberg (NCT-1)' WI-8."[78] Subsequently in 1984,

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[71] CALIFORNIA OIL AND GAS FIELD VOLUME II, *supra* note 66, at 449.
[72] Letter from L. E. Chatfield, The Texas Company, to W.C. Bailey, Division of Oil and Gas (April 26, 1956) (on file with author, 64406009 Project File Part I, at 292).
[73] Letter from John L. Zulberti, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources, to Leo McCann, Drilling and Production Manager, Texaco Inc. (Sept. 24, 1982) (on file with author, 64406009 Project File Part I, at 241); Letter from John L. Zulberti, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources, to Leo McCann, Drilling and Production Manager, Texaco Inc. (Oct. 4, 1982) (on file with author, 64406009 Project File Part I, at 240).
[74] Letter from Leo McCann, Drilling and Production Manager, Texaco Inc., to John L. Zulberti, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources (Nov. 11, 1982) (on file with author, 64406009 Project File Part I, at 234).
[75] *Id*. at 234-35.
[76] Letter from John L. Zulberti, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources, to Leo McCann, Drilling and Production Manager, Texaco Inc. (Dec. 6, 1982) (on file with author, 64406009 Project File Part I, at 233).
[77] Letter from Leo McCann, Drilling and Production Manager, Texaco Inc., to John L. Zulberti, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources (Dec. 28, 1982) (on file with author, 64406009 Project File Part I, at 229-30).
[78] Letter from K. P. Henderson, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources, to R. Riley, District Manager, Texaco Inc. (May 18, 1983) (on file with author, 64406009 Project File Part I, at 226).

Texaco submitted to DOGGR its interpretation of a step-rate test done in well WI-9.[79] However, DOGGR concluded that Texaco was injecting above the fracture pressure gradient.[80] Later in 1984, DOGGR noted that "Texaco has been trying to reduce pressure on the San Ardo injection wells by drilling more wells, *not very successful* [sic]."[81]

Texaco then applied to DOGGR for a variance to increase the injection pressure for three disposal wells to above fracturing pressure, despite California regulations that require maximum allowable surface injection pressure to be less than fracture pressure.[82] Texaco noted that "injection at pressures in excess of fracture pressure may result in vertical fracturing which may cause contamination of the overlying fresh water zones."[83] However, Texaco conditioned this statement by stating that the Aurignac and Lombardi zones, which are relatively shallow reservoirs with high permeability and heavy oil in place, "will preferentially fracture in a horizontal plane."[84]

DOGGR notified Texaco that it was necessary to reduce injection pressures to approved pressures for the wells in question until DOGGR decided on the variance request, and also stated that the approval process for allowing injection above fracture pressure "may take at least 60 days, and possibly longer because the California Water Resources Control Board is strongly opposed to injecting produced wastewater above fracture pressure."[85] The California Water Resources Control Board ("CWRCB") subsequently commented on the proposed variance, stating that they "believe that injection above fracture pressure substantially increases the potential for ground water degradation," and both the Code of Federal Regulations and the California Administrative Code "speak clearly to limiting injection pressure to prevent fluid movement into underground drinking water sources."[86] Specifically, under federal law,

> "[i]njection pressure at the wellhead shall not exceed a maximum which shall be calculated so as to assure that the pressure during injection does not initiate new fractures

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[79] Letter from R. Riley, District Manager, Texaco, Inc., to K.P. Henderson, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources (Jan. 13, 1984) (on file with author, 64406009 Project File Part I, at 221). *See Oilfield Glossary: Definition of "step rate test"*, SCHLUMBERGER, http://www.glossary.oilfield.slb.com/Terms/s/step_rate_test.aspx (last visited Oct. 20, 2016). A step-rate test is defined in the Schlumberger Oilfield Glossary as "[a] test performed in preparation for a hydraulic fracturing treatment in which an injection fluid is injected for a defined period in a series of increasing pump rates. The resulting data are used to identify key treatment parameters of the fracturing operation, such as the pressure and flow rates required to successfully complete the treatment."

[80] DOGGR notes on Texaco injection pressure calculations (June 5, 1984) (on file with author, 64406009 Project File Part I, at 220).

[81] Memorandum of Telephone or Personal Conversation (August 8, 1984) (on file with author, 64406009 Project File Part I, at 217) (emphasis added).

[82] 14 C.C.R. § 1724.10(i).

[83] San Ardo Waste Water Disposal Project Injection Above Fracture Gradient, Discussion and Request (on file with author, 64406009 Project File Part I, at 155).

[84] *Id*.

[85] Letter from K. P. Henderson, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources, to R. Riley, District Manager, Texaco Inc. (August 13, 1984) (on file with author, 64406009 Project File Part I, at 215).

[86] Letter from Kenneth R. Jones, Executive Officer, California State Water Resources Control Board, to Ken Henderson, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources (Oct. 10, 1984) (on file with author, 64406009 Project File Part I, at 134) (referencing 40 C.F.R. 146.23(a)(1), California Administrative Code Title 23, Chapter 3, Subchapter 15, Section 2513(b)).

> or propagate existing fractures in the confining zone adjacent to the USDWs. In no case shall injection pressure cause the movement of injection or formation fluids into an underground source of drinking water."[87]

Similarly, parallel California regulations had been interpreted to set injection pressure at 75% of the fracture pressure.[88] Accordingly, the CWRCB requested that "project approval prevent injection pressures that could initiate new fractures or propogate existing fractures in the injection zone."[89]

Texaco submitted a letter to DOGGR with the results of a pressure test to support their request for the injection pressure variance, stating that the results were inconclusive and that reliable estimates of reservoir pressure could not be determined.[90] However, despite a lack of understanding about reservoir pressures or the applicability of using leak-off tests to determine safe injection pressures, DOGGR ultimately granted Texaco's application to increase the injection pressure at five of its disposal wells.[91] DOGGR conditioned their approval by requiring that "[t]he well injection rates and pressures shall be controlled in a manner that will not raise reservoir pressure in the vicinity of the project above hydrostatic pressure."[92] Excessive hydrostatic pressure can lead to fractures in the rock formation and/or fluid migration out of the injection zone. Notably, because DOGGR used the results of the two leak-off tests to approve injection at higher gradients, the variance procedure that included Water Quality Control Board comments, public notice, and a draft project approval letter, mentioned above, were not ultimately utilized in approving the higher injection pressures.[93]

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[87] 40 C.F.R. 146.23(a)(1).

[88] Letter from Kenneth R. Jones, Executive Officer, California State Water Resources Control Board, to Ken Henderson, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources (Oct. 10, 1984) (on file with author, 64406009 Project File Part I, at 134) (referencing 40 C.F.R. 146.23(a)(1), California Administrative Code Title 23, Chapter 3, Subchapter 15, Section 2513(b)).

[89] *Id*.

[90] Letter from R. Riley, District Manager, Texaco, Inc., to K.P. Henderson, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources (Oct. 10, 1984) (on file with author, 64406009 Project File Part I, at 127).

[91] *See* Memorandum by S. Fields for P. Truocchio, California Department of Oil, Gas, and Geothermal Resources, regarding Leak-off Test (Oct. 17, 1984) (on file with author, 64406009 Project File Part I, at 120) (noting that "the results on WI-12 may be misleading as it is possible that the operator drilled too far below the shoe and exposed both cap rock and injection zone. The lower fracture pressure may reflect the influence of the exposed injection zone on the test results."); *see also Id*. at 121 (stating that "the leak-off test is potentially as accurate . . . [h]owever problems such as drilling into the injection zone or damaging the open hole do exist. Moreover, the leak-off test cannot be applied to wells being converted to injection."); *see also* Letter from K. P. Henderson, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources, to R. Riley, District Manager, Texaco Inc. (Oct. 26, 1984) (on file with author, 64406009 Project File Part I, at 118). *See generally Oilfield Glossary: Definition of "leakoff test"*, SCHLUMBERGER, http://www.glossary.oilfield.slb.com/Terms/l/leakoff_test.aspx (last visited Oct. 20, 2016). A leak-off test is defined as "[a] test to determine the strength or fracture pressure of the open formation, usually conducted immediately after drilling below a new casing shoe. During the test, the well is shut in and fluid is pumped into the wellbore to gradually increase the pressure that the formation experiences. At some pressure, fluid will enter the formation, or leak off, either moving through permeable paths in the rock or by creating a space by fracturing the rock. The results of the leakoff test dictate the maximum pressure or mud weight that may be applied to the well during drilling operations. To maintain a small safety factor to permit safe well control operations, the maximum operating pressure is usually slightly below the leakoff test result."

[92] *See* Oct. 26, 1984 Letter from K.P. Henderson, *supra* note 91.

[93] Letter from K. P. Henderson, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources, to M. C. Cadet, Agent, Texaco Inc. (Jan. 29, 1986) (on file with author, 64406009 Project File Part I, at 117).

In 1987, DOGGR notified Texaco that injection into its well WI-12 had not been approved for injection into the granodiorite rock in Monterey, and thus "the situation must be resolved by: (1) collecting a native fluid sample from the granodiorite and filing for an aquifer exemption if necessary or, (2) plugging back the well in a manner as to prevent injection fluid from entering the granodiorite."[94] Also in 1987, the annual Review of Water Disposal Project for Texaco's Lombardi & Aurignac Sands project reflected additional concerns about the capacity of the project. Specifically, DOGGR noted that an aquifer exemption would be needed, as "Texaco has plans to expand to the north outside the field boundaries."[95] Additionally, DOGGR noted that "[a]s this water disposal project continues toward fill up, Texaco searches for other water disposal alternatives. Injection underground continues to be the most cost effective."[96]

In 1989, DOGGR was again noting concerns about specific wells in the project. Prior to the annual project review in January 1989, DOGGR noted that they would "probably give Texaco 6 months to get out of these wells."[97] During the 1989 Project Review, DOGGR noted that "[i]n the North Area, the Lombardi and Aurignac zones are becoming overpressured," and "Texaco will have to look for disposal alternatives in the next few months."[98] Additionally, "[t]he Division will send out a letter to discontinue injection in the North Area in 6 months. However, if it can be proved that the North area is not overpressured, injection may be allowed to continue with regular monitoring of zone pressures."[99]

Weeks later, DOGGR sent Texaco a letter stating that results of requested pressure falloff tests of the injection wells in the project indicate that the injection zone is becoming overpressured, and accordingly ordered Texaco to discontinue injection into the wells before August 1, 1989.[100] On July 7, 1989, DOGGR modified their order after a meeting with Texaco representatives, to allow "continued disposal operations in the subject project, provided that zone pressures continue to dissipate and the project continue to be monitored."[101]

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[94] Memorandum of Telephone or Personal Conversation (May 5, 1987) (on file with author, 64406009 Project File Part I, at 109).
[95] Review of Water Disposal Project, San Ardo Field, North Area, Lombardi & Aurignac Sands, Texaco Inc. (June 3, 1987) (on file with author, 64406009 Project File Part I, at 117).
[96] *Id*.
[97] Letter from R.W. Hill, McKittrick Area Manager, Texaco Inc., to Division of Oil & Gas (Dec. 6, 1988) (on file with author, 64406009 Project File Part I, at 106).
[98] Review of Water Disposal Project, San Ardo Field, North Area, Lombardi & Aurignac Sands, Texaco Inc. (Jan. 24, 1989) (on file with author, 64406009 Project File Part I, at 97).
[99] *Id*.
[100] Letter from Hal Bopp, Deputy Supervisor, Division of Oil & Gas, to R. W. Hill, Agent, Texaco Inc. (Jan. 26, 1989) (on file with author, 64406009 Project File Part I, at 94).
[101] Letter from Hal Bopp, Deputy Supervisor, Division of Oil & Gas, to R. W. Hill, Agent, Texaco Inc. (July 7, 1989) (on file with author, 64406009 Project File Part I, at 95).

The 1990s (Texaco)

By the project's annual review in 1990, the project was shut-in except when running injection profile surveys.[102] Additionally, Texaco was in the process of eliminating injection into the Lombardi sands, because "[t]hey feel that water is migrating into the Main Area and hampering the effectiveness of the Lombardi steamflood."[103] By 1992, Texaco had not planned to reactivate injection into the Lombardi zone.[104]

DOGGR noted in the 1995 annual project report that while pressures bottomed out in the North Area Aurignac zone in 1993, high volume injection resumed in late 1994, and pressure rose accordingly.[105] Thus, DOGGR concluded that "[b]ecause of the relatively high injection pressures, the Division will eventually have to do pressure fall-off surveys on some of the injection wells. This may impact the operator by having to shut in some wells that are on production."[106]

In the 1996 annual review, DOGGR noted that pressures in the area continued to rise, and that Texaco was concerned about the pressure rises in the Aurignac zone in the North area.[107] Accordingly, a new source of injection would be needed, however, at the time, Texaco "[did] not have any other outlets for disposal and continue[d] to pursue the feasibility of a reverse osmosis plant."[108]

The 2000s to Present (Chevron)

By 2001, Texaco had established a continuous pressure monitoring system on three of its wells, and the pressure surveys appeared to indicate that pressure increases in the Aurignac zone were not due to injection in water disposal wells in the North Area.[109] However, Aera Energy, another operator in the field, expressed concerns about the continuing increase in pressure in the Aurignac zone.[110]

By 2002, pressures in the Aurignac zone had stabilized,[111] and by 2003 ChevronTexaco was looking to start a new injection project in the Lombardi zone in the Main area of the field.

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[102] Review of Water Disposal Project, San Ardo Field, North Area, Lombardi & Aurignac Sands, Texaco Inc. (May 25, 1990) (on file with author, 64406009 Project File Part I, at 87).
[103] Review of Water Disposal Project, San Ardo Field, North Area, Lombardi & Aurignac Sands, Texaco Inc. (May 25, 1990) (on file with author, 64406009 Project File Part I, at 88).
[104] Review of Water Disposal Project, San Ardo Field, North Area, Lombardi & Aurignac Sands, Texaco Inc. (June 5, 1992) (on file with author, 64406009 Project File Part I, at 75).
[105] Review of Water Disposal Project, San Ardo Field, North Area, Lombardi & Aurignac Sands, Texaco Inc. (Nov. 8, 1995) (on file with author, 64406009 Project File Part I, at 69).
[106] *Id*.
[107] Review of Water Disposal Project, San Ardo Field, North Area, Lombardi & Aurignac Sands, Texaco Inc. (April 3, 1996) (on file with author, 64406009 Project File Part I, at 65).
[108] *Id*.
[109] Review of Water Disposal Project, San Ardo Field, North Area, Lombardi & Aurignac Sands, TEPI. (Jan. 25, 2001) (on file with author, 64406009 Project File Part I, at 56).
[110] *Id*.
[111] Review of Water Disposal Project, San Ardo Field, North Area, Lombardi & Aurignac Sands, TEPI. (March 13, 2002) (on file with author, 64406009 Project File Part I, at 55).

According to DOGGR, the project "would help postpone the eventual fill up of the reservoir in the North Area," however at the time, DOGGR stated that it would "meet this project with some resistance and [DOGGR expected] vigorous opposition from Aera."[112]

In 2005, Chevron had started to execute its plans for the reverse osmosis plant in the San Ardo field, and sent a letter to DOGGR requesting approval of their new water disposal plan for the North Area Aurignac, North Area Lombardi, and Main Field Aurignac Zones.[113] Specifically, Chevron proposed to use produced water treated through the reverse osmosis process for beneficial re-use. However, the reverse osmosis process would also produce a concentrated produced-water brine, and Chevron anticipated that the water management plan "could generate up to a ten-fold increase in brine concentration."[114] Salts removed from the reclaimed water during the reverse osmosis process would be concentrated as brine and injected into the disposal wells.[115] Accordingly, Chevron proposed a permit salinity increase to allow for disposal of the production waste stream, and associated regeneration brines and backwash from water treatment equipment.[116]

Then again in 2009, DOGGR and Chevron realized that six wells had incorrectly listed injection pool codes on the notices to drill for those wells.[117] Each injection pool code on the notice of intent to drill new wells is included in order to indicate the maximum pressures allowed for each individual injection well. Because of the error, the maximum allowable surface injection pressure ("MASP") had to be recalculated for those wells. However, the MASP was recalculated using a psi/ft gradient derived from the potentially flawed leak-off test on well WI-12 (discussed above).[118]

Since 2009, Chevron applied, and was approved for, permits to drill at least eight new wastewater disposal wells in the same project.[119] Notably, one well, WI-16, failed a standard annulus pressure test meant to confirm that injected fluid is confined to the approved zone.[120] Chevron subsequently cancelled a supplement to change the tubing and packer configuration for the well, as the well would "require an area of review . . . to keep the hole open to the Santa Margarita formation and the tubing & packer configuration would not pass as sufficient isolation from the Santa Margarita."[121] DOGGR then gave Chevron verbal permission to set the bridge

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[112] Review of Water Disposal Project, San Ardo Field, North Area, Lombardi & Aurignac Sands, ChevronTexaco E&P, Inc. (Jan. 28, 2003) (on file with author, 64406009 Project File Part I, at 53).
[113] Letter from Wayne McKay, Supervisor, Chevron, to William E. Brannon, District Deputy, Division of Oil, Gas, and Geothermal Resources (June 21, 2005), (on file with author, 64406009 Project File Part I, at 49).
[114] *Id*.
[115] *Id*.
[116] *Id*.
[117] Letter from Patricia A. Abel, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources, to Richard Seaman, Agent, Chevron U.S.A., Inc. (May 13, 2009) (on file with author, 64406009 Project File Part II, at 59).
[118] Letter from Patricia A. Abel, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources, to Jesse Morris, Agent, Chevron U.S.A., Inc. (August 17, 2009) (on file with author, 46606009 Project File Part II, at 56).
[119] *See* Permit to Conduct Well Operations P309-244 (9/29/09); P309-242 (9/29/09); P309-243 (9/29/09); P309-292 (9/29/09); P309-291 (9/29/09); P309-290 (9/29/09); P315-0025 (2/6/2015); P315-0027 (2/3/2015).
[120] Letter from Patricia A. Abel, Deputy Supervisor, Division of Oil, Gas, and Geothermal Resources, to Kelsey Helberg, Agent, Chevron U.S.A. Inc. (Feb. 19, 2013) (on file with author, 46606009 Project File Part II, at 15).
[121] Email from Kory Izard, Chevron U.S.A., to DOGGR Dist3@DOC (Oct. 17, 2012) (on file with author, Project File Part II, at 16).

plug below the well casing holes for temporary isolation of the injection zone.[122] This represented a temporary solution, however, the record does not indicate that DOGGR ever required the appropriate review to determine isolation of the injection zone.

In 2013, the Department of Conservation formally sent Chevron an order to remediate mechanical integrity failure in its WI-20 well, and to conduct mechanical integrity testing.[123] In its Report on Operations (No. T 313-0227), DOGGR notified Chevron that its prior radioactive tracer survey mechanical integrity failed, in that it demonstrated the injection fluid entering the identified well was not "confined to the approved zone because upward movement of injection fluid past the cup packer at 2451 feet was observed with the casing open (indicating failure of the packer)."[124] Thus, Chevron "was failing to maintain data establishing that no damage to life, health, property, or natural resources," was occurring by reason of the injection project.[125]

Finally, in mid-2015, DOGGR sent a letter notifying Chevron that the Lombardi, Santa Margarita, and Aurignac zones would need aquifer exemptions for the wastewater disposal wells injecting into those zones to come into compliance with federal regulations.[126]

For the entire life of this wastewater disposal project, the operators' characterization of the issues surrounding wastewater injection in to the Lombardi and Aurignac zones necessarily under-emphasized the significant pressure problems caused by the project. Not only did the operators attempt to minimize overpressuring concerns multiple times, but DOGGR also failed to exercise caution in approving, permitting, and expanding the water disposal project. Instead of re-testing wells to procure accurate pressure data, DOGGR and industry operators relied on the results of a potentially flawed and poorly understood leak-off test to increase the maximum allowable surface pressure for several wells in the project, years after the initial test was conducted.

Such lack of control over waste fluid injection projects indicates DOGGR and industry failure to properly manage fluid pressures, creating an increased risk of waste fluid migration out of the intended injection zone. The above case study exemplifies DOGGR's unwillingness to force industry to cease injection, even where evidence of contamination risks exists. The below case study explores DOGGR's willingness to permit entire injection projects without critical data and documentation required under California law.

B. Case Study: Fresno Area Project Deficiencies in Riverdale Field Project 61400001, and Raisin City Field Project 58400001

Well records demonstrate that DOGGR has permitted entire wastewater disposal projects, and thus likely harmful wastewater injection, without the majority of the documents required

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[122] *Id*.
[123] Tim Kustic, State Oil and Gas Supervisor, Order to: Remediate Mechanical Integrity Failure, Conduct Mechanical Integrity Testing, No. 1042, State of California, Natural Resources Agency, Department of Conservation, Division of Oil, Gas, and Geothermal Resources (May 29, 2013).
[124] *Id* at 4.
[125] *Id*.
[126] Letter from Patricia A. Abel, District Deputy, Department of Oil, Gas, and Geothermal Resources, to David Lopez, Agent, Chevron U.S.A. Inc. (July 15, 2015) (on file with author, 46606009 Project File Part II, at 1-2).

pursuant to federal and state law. Specifically, based on public available information, DOGGR allowed Project 61400001, located in the Riverdale Field, to operate without required engineering data, geologic data, wastewater injection data, wastewater chemical analysis data, and without an evaluation of the project risks to adjacent aquifers.[127]

Wastewater disposal project 61400001 is located in the Riverdale Oil Field, in the City of Riverdale, Fresno County, California.[128] Fresno County is in the San Joaquin River Basin, and is adjacent to the Tulare Lake River Basin. Fresno County lies atop the Fresno "Sole Source Aquifer," a classification that means that the aquifer supplies at least 50 percent of the drinking water for its service area, and there are no reasonably available alternative drinking water sources should the aquifer become contaminated.[129] (Figure 4). Accordingly, the Fresno Sole Source Aquifer provides groundwater to Fresno County's nearly one million residents.

The City of Riverdale has a population of more than 2,500 residents, and is located 23 miles from the City of Fresno. Importantly, Riverdale is located within the Fresno Sole Source Aquifer's recharge area, designated because of its characteristics allowing surface water to percolate unimpeded into groundwater. Oil and gas operations in the Riverdale Field are regulated by the DOGGR District 5; in the 2011 Horsley Witten Report, DOGGR District 5 officials identified projects in the Riverdale Field as high-priority for inspections due to the presence of fresh water and/or underground sources of drinking water.[130]

Well records provided by DOGGR estimate that the formation surrounding the point of wastewater injection is generally characterized as a mix of sand and shale, with the ratio of sand to shale varying between a few hundred feet to over 7,000 feet.[131] The mineralogy was estimated using a gamma ray logging tool, or an "electric log", which measures the radioactive isotope content of the rock within the borehole. The estimated confining layers assumed to prevent vertical fluid migration were determined to be at approximately 5,250 feet (McLure formation) and again at 5,500 feet (Temblor formation). These estimates were based on an electric log taken on September 6, 1942.[132] A second electric log was performed in 1989; however, the estimate of confining layers continues to be based on the 1942 estimates.

However, this limited engineering and geologic data is not sufficient to thoroughly evaluate a project's impact on surrounding water resources. Specifically, project records include only electric logs based on a single sidewall core, and pressure tests. These tests provide information regarding mineralogy, but fail to provide the required characteristics of each injection zone, or data on water quality. Similarly, the electric logs provide data that represent a single geologic cross section of the injection zone, but do not provide any contour characteristics or an isopachous map, as required by Section 1724.7(b)(1)&(2). The project operator, and presumably

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[127] Letter from DOGGR District 5 to White Knight Production, LLC (Oct. 5, 2015).
[128] The well is identified as API Number 01905649, with a lease name "Young" 4-15, operated by White Knight Production, LLC. (formerly Longview Production Company).
[129] *Overview of the Drinking Water Sole Source Aquifer Program*, UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, https://www.epa.gov/dwssa/overview-drinking-water-sole-source-aquifer-program#What_Is_SSA (last visited Oct. 20, 2016).
[130] HORSLEY WITTEN REPORT, *supra* note 28, at 175.
[131] *See* sidewall core description, Injection Project File 61400001 (Aug. 9, 1942) (on file with author).
[132] *See* Letter from DOGGR District 5 to White Knight Production, LLC, *supra* note 127.

DOGGR, assumed that confining layers and other geologic formation characteristics are consistent horizontally, and do not allow migration of fluids from the core. As described above, without contour and isopachous maps provided pursuant to the geologic data requirements, it is impossible to determine the lateral dimensions of the injection zone, or provide the proper information for useful geologic modeling. Without the appropriate data regarding injection zone characteristics or water quality, regulators lack the requisite data to determine the risks of migration and contamination of adjacent aquifers.

Moreover, the operator failed to provide reservoir characteristics to establish that the project is sited in an area that will not potentially degrade underground or surface waters that are known to be, or may be, suitable for irrigation or domestic purposes. As mentioned above, the Fresno Sole Source Aquifer, and the boundaries of both the San Joaquin River Basin and the Tulare Lake River Basin are all within the proximity of the project. The Riverdale Public Utility District supplies thousands of residents from three domestic water wells located within one mile of this Well.

One individual well in the project, API #01905649 (the "Well"), was initially drilled in 1942 as an oil production well. In 1990, the Well was converted from an oil production well to a wastewater disposal well. Since 2009, nearly 200,000 barrels of waste fluids have been injected into the Well each year. While the well records initially submitted included a brief narrative of the wastewater source to be injected, the operator did not provide information regarding specific source descriptions, treatments and depths, or any data regarding the analysis or characterization of source fluids, as required by Section 1724.7(c)(6)-(8). Without this data, DOGGR permittees lacked the requisite information to determine whether injection fluids were appropriate for Class II designation, or if the wastewater contained hazardous levels of chemical constituents.

Similarly, the operator failed to file a new chemical analysis when the source of injection fluids changed. Based on DOGGR's 2015 request for documentation, the Well began injecting fluids from a "new source," thus triggering the requirement that the operator must report and provide a chemical analysis of the new injection fluids.[133] However, the letter indicates that the well records and project file do not include any information regarding new sources of wastewater being injected into the well. Because the source of the injection liquid changed from the source of wastewater identified in the initial injection well permit application, DOGGR should have insisted on a new report and chemical analysis of the injected waste.

DOGGR continued to improperly allow this project to operate, including improper injection into the suspect Well, without the review required by California law. More importantly, however, this is not a practice that is limited to one project or one well. Only a few miles northeast of Riverdale, the Raisin City projects (project numbers 58400001 through 58400013) similarly lacked critical data and documentation such as injection fluid analysis, and geologic, hydrologic and engineering studies when initially permitted, and at the time of records review in 2016.[134] Other projects, such as in the San Ardo Oil Field, discussed above, similarly evidence the pattern and practice of operators improperly submitting information for, and DOGGR improperly permitting, wastewater disposal wells.

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[133] *See id*; *see also* CAL. CODE REGS. tit. 14, § 1724.10(d).
[134] *Id*.

VI. Recommendations

DOGGR's own admission and acknowledgement of the issues surrounding the UIC Class II program, as seen through DOGGR officials' recorded testimony, establishes that Class II UIC injection well permit applications were approved without DOGGR considering required engineering studies, geology studies and injection plans.[135]

Thus, to ensure the safety of health and water resources in California, DOGGR should suspend all operations at wells that cannot be demonstrated to have been properly permitted, and that pose even a moderate risk of migration of waste fluids out of the intended injection zone. The project-by-project review, which optimistically may be completed in three years, is an insufficient measure to protect against the immediate and demonstrated harms of UIC Class II wastewater disposal projects. DOGGR retains the ability to terminate approval to inject for any project.[136] Such authority should be exercised when and where evidence exists to demonstrate a risk of waste fluid migration out of intended injection zones.

In addition to individual projects where pressure testing demonstrates excessive hydrostatic pressure, entire geologic zones such as the Lombardi and Aurignac sands have similarly exhibited pressure issues. Where these geologic zones show evidence of excessive pressures, they must be evaluated for cessation of injection throughout the affected portion of each zone. That is, DOGGR must not allow project operators to drill new wells or simply increase injection volumes in neighboring wells.

Coupled with the widespread recordkeeping issues that have allowed permitting of injection wells and projects without critical data and documentation, the likelihood of waste fluid migration – and ultimately, contamination – remains high. Where waste fluid injection projects are located near underground sources of drinking water and potential future underground sources of drinking water, DOGGR must use greater caution and exercise its authority to shut down injection projects where appropriate.

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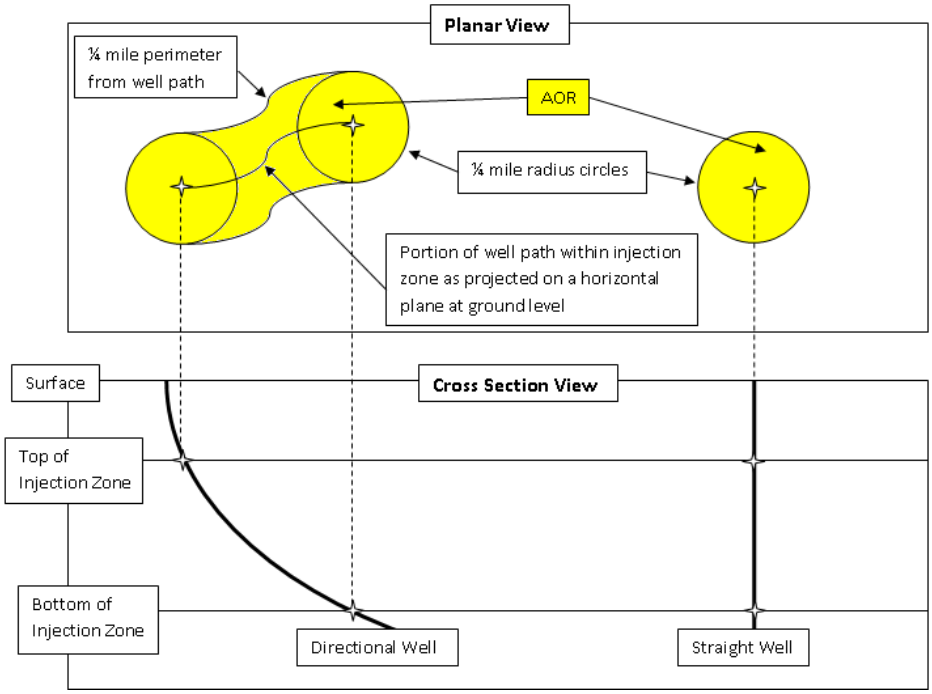
[135] CAL. CODE REGS. tit. 14, § 1724.7(a)-(c).
[136] HORSLEY WITTEN REPORT, *supra* note 28, at 118.

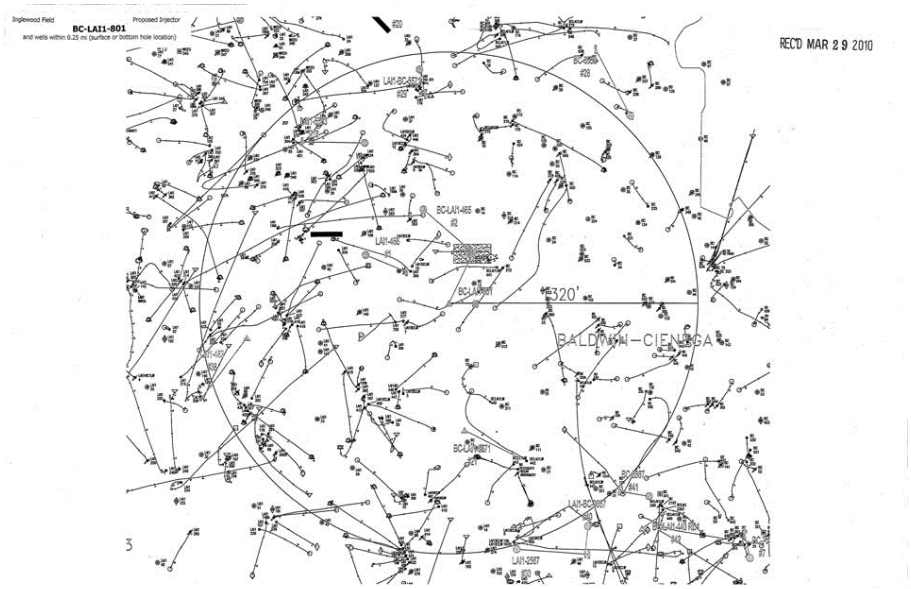
Figures

Figure 1: (a) Conceptual Diagram of the Area of Review and Cross Section (top) and (b) Plat Map with Direction Well Course (bottom).[137]

(a)

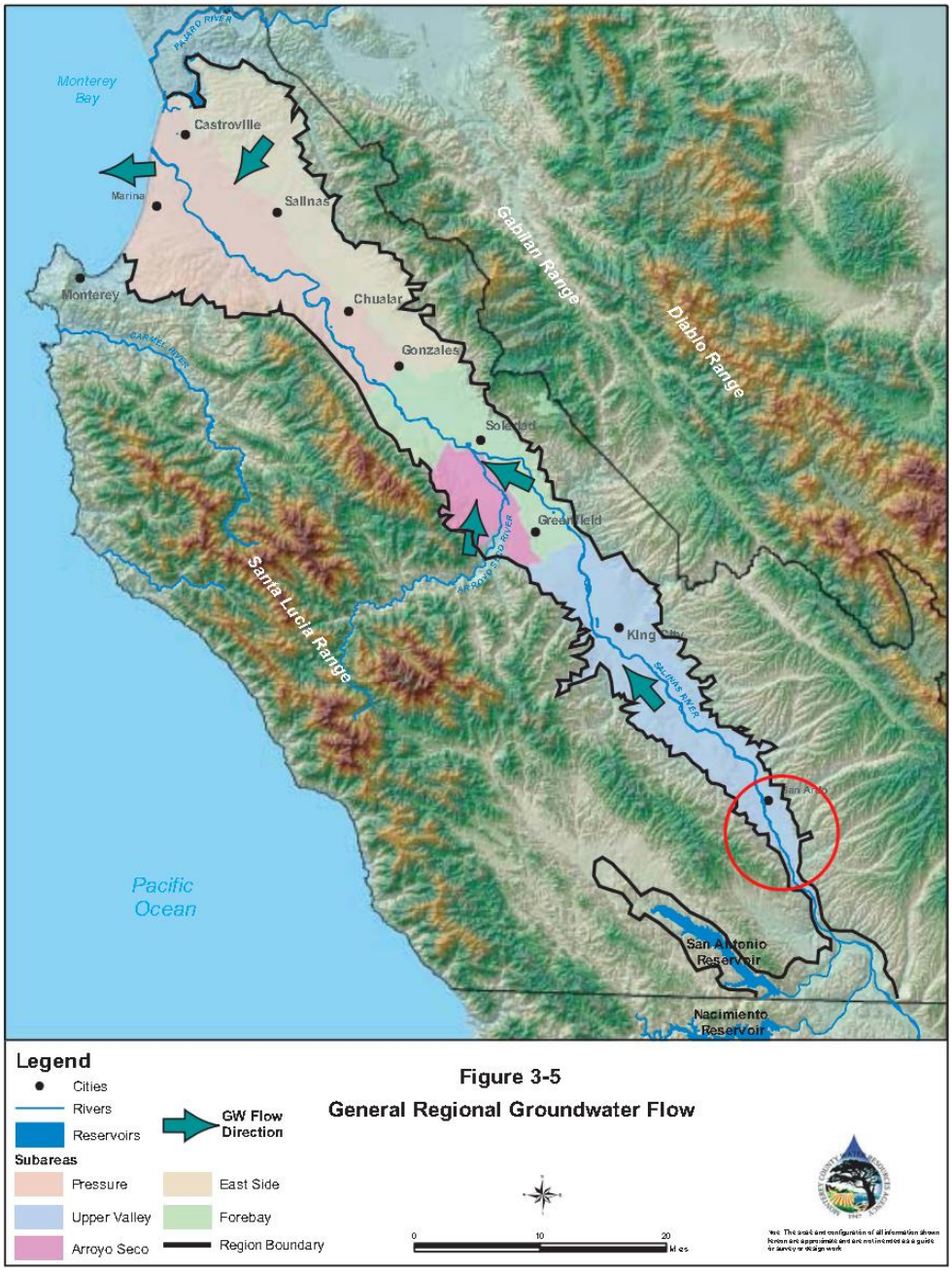


(b)



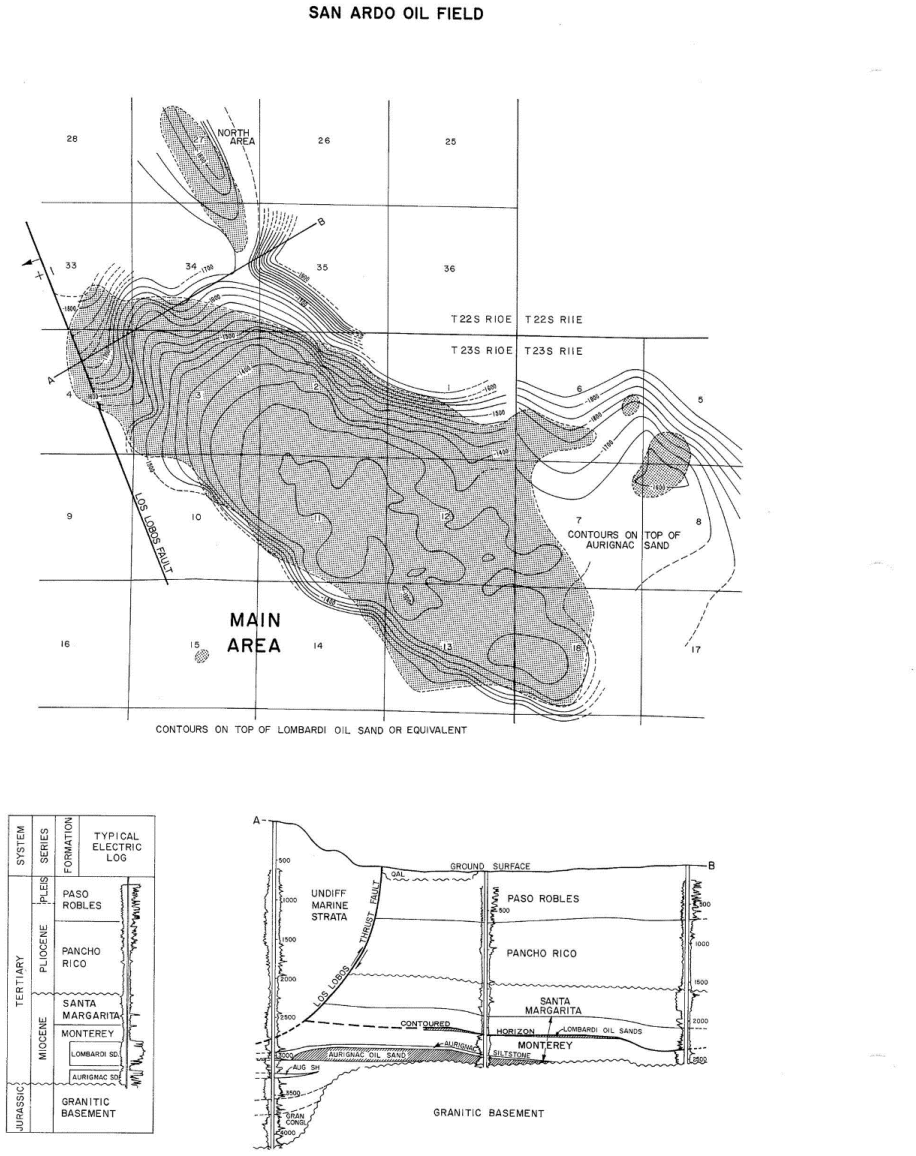
[137] DIVISION OF OIL, GAS AND GEOTHERMAL RESOURCES, UIC APPLICATION GUIDANCE. Available at ftp://ftp.consrv.ca.gov/pub/oil/UIC%20Files/UIC_APP_B1.pdf.

Figure 2: San Ardo Oil Field (circled in red) in relation to the Salinas Valley Groundwater Basin.[138]



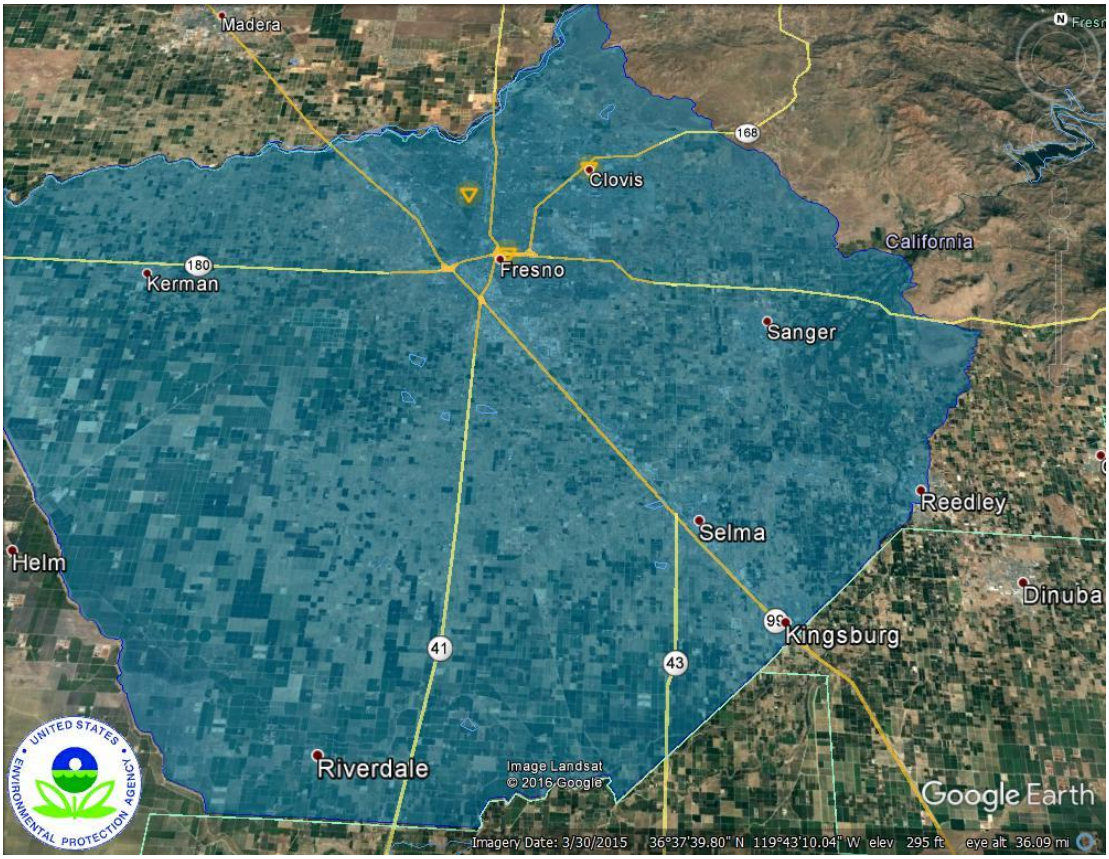
[138] Monterey County Water Resources Agency, MONTEREY COUNTY GROUNDWATER MANAGEMENT PLAN, Appendix H (2006).

Figure 3: Contour and cross-section views of the San Ardo Oil Field.[139]



[139] CALIFORNIA OIL AND GAS FIELD VOLUME II – SOUTHERN, CENTRAL COASTAL, AND OFFSHORE CALIFORNIA OIL AND GAS FIELDS, DEPARTMENT OF CONSERVATION DIVISION OF OIL, GAS, AND GEOTHERMAL RESOURCES 448 (1992), available at ftp://ftp.consrv.ca.gov/pub/oil/publications/Datasheets/Dtasheet_vol_2.pdf.

Figure 4: Fresno Sole Source Aquifer Recharge Area.[140]



[140] GROUNDWATER, U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION IX, https://www3.epa.gov/region9/water/groundwater/ssa.html (last visited Oct. 20, 2016).