



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

August 30, 2017

Kenneth A. Harris Jr.
State Oil and Gas Supervisor
Division of Oil, Gas, and Geothermal Resources
California Department of Conservation
801 K Street, MS 18-05
Sacramento, CA 95814-3530

Re: Aquifer Exemption Request for the Kern Front Oil Field, Kern County, California

Dear Mr. Harris:

Based on a thorough review of the supporting documents submitted by the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources and the State Water Resources Control Board, the U.S. Environmental Protection Agency (EPA) hereby approves the aquifer exemption request for a portion of the Vedder Formation in the Kern Front Oil Field in Kern County, California.

The approved aquifer exemption boundaries and depths, along with EPA's analyses and rationale in support of the approval, are detailed in the enclosed Record of Decision, also available at: <https://www.epa.gov/pacific-southwest-media-center/epas-oversight-californias-underground-injection-control-uic-program>. In accordance with applicable regulations at 40 C.F.R. Parts 144, 145, and 146, we find that this aquifer exemption request is a non-substantial program revision, and the requested formation meets federal exemption criteria:

- The portion of the formation proposed for exemption in the field does not currently serve as a source of drinking water; and
- The portion of the formation proposed for exemption in the field has more than 3,000 milligrams per liter (mg/L) and less than 10,000 mg/L total dissolved solids content, and is not reasonably expected to supply a public water system.

If you have any questions, please contact David Albright, Acting Assistant Director, Water Division, at (415) 972-3971.

Sincerely,

A handwritten signature in blue ink, appearing to read "Tomás Torres", written over a horizontal line.

Tomás Torres August 30, 2017
Director, Water Division

Enclosure: Aquifer Exemption Record of Decision for Kern Front Oil Field

cc: Jonathon Bishop, Chief Deputy Director, State Water Resources Control Board

US Environmental Protection Agency (EPA) Region 9
Underground Injection Control (UIC) Program
AQUIFER EXEMPTION RECORD OF DECISION

This Record of Decision (ROD) provides the EPA's decision to approve an aquifer exemption (AE) for a portion of the Vedder Formation of the Kern Front Oil Field, background information concerning the AE request, and the basis for the AE decision.

Primacy Agency: California Division of Oil, Gas, & Geothermal Resources (DOGGR)

Date of Aquifer Exemption Request: July 21 2017

Exemption Criteria: DOGGR requests this exemption because it has determined that it meets the criteria at 40 CFR § 146.4(a) and § 146.4(c).

Substantial or Non-Substantial Program Revision: Non-Substantial

Although the EPA must approve all revisions to the EPA-approved state UIC programs, the process differs depending on whether the EPA finds the revision to be a substantial or non-substantial program revision. The EPA determined this is a non-substantial program revision because it is associated with an active oil field and is not a state-wide programmatic change or a program revision with unique or significant implications for the State's UIC program. The decision to treat this AE request as a non-substantial program revision is also consistent with the EPA's "Guidance for Review and Approval of State Underground Injection Control (UIC) Programs and Revisions to Approved State Programs" ("Guidance 34"), which explains that the determination whether a program revision is substantial or non-substantial is made on a case-by-case basis.

Operators: California Resources Corporation, Badger Creek Limited, and Bellaire Oil Company.

Well/Project Name: Vedder Formation, Kern Front Oil Field.

Well/Project Permit Number: The exemption is requested for a portion of the aquifer in the Kern Front Oil Field. There are currently no active disposal/injection wells in the Vedder Formation in the Kern Front Oil Field, however, there are active Class II wells in two other formations in the field, including wells for cyclic and continuous steam injection into the Etchegoin and Chanac Formations for enhanced oil recovery (EOR).

Well/Project Location: The AE is located in: Township 28S Range 27E, Sections 3, 10, 11, 14-16, 21-28, and 33-36 and Township 29S Range 27E, Sections 3 and 4, Mount Diablo Base and Meridian (MDB&M). [Refer to Figures 1 and 2.]

County: Kern **State:** California

Well Class/Type: Class II produced water disposal wells.

DESCRIPTION OF PROPOSED AQUIFER EXEMPTION

Aquifer to be Exempted: A portion of the Vedder Formation within the Kern Front Oil Field.

Areal Extent of Aquifer Exemption: The areal extent of the AE is approximately 8,706 acres, which represents the entire extent of the Vedder Formation that lies within the Kern Front Oil Field’s administrative boundary, excluding the northeastern area. DOGGR has provided a GIS shape file that delineates the AE boundary, which is incorporated in the administrative record of this ROD. Refer to Figure 3 for a depiction of the proposed exemption.

Lithology, Total Dissolved Solids (TDS), Depth, Thickness, Porosity, and Permeability of the Aquifer: The following table presents the lithology, TDS levels, depth, thickness, and average porosity and permeability information about the aquifer proposed for exemption.

<i>Aquifer</i>	Vedder Formation.
<i>Lithology</i>	Gray to light brown, well-sorted very fine to medium-grained silty sandstone with shaley laminations, locally cemented with silica.
<i>TDS (mg/L)</i>	3,500 mg/L to over 10,000 mg/L (calculated, based on well log data for the First, Second, and Third Vedder Formations).
<i>Depth to Top (feet bsl)</i>	3,900 - 5,700 feet.
<i>Thickness (feet)</i>	At least 450 feet in the Kern Front Oil Field where it overlies the granitic basement; 800-1,000 feet in other areas.
<i>Average Porosity and Permeability</i>	Porosity averages 30%. Average permeability values in the Young Fee WD4 and Badger Creek WD1 wells are 247.1 millidarcies (mD) and 496.7 mD, respectively.

The Vedder Formation consists of three subunits: the First, Second, and Third Vedder Formations, which vary in their salinity, as well as their porosity and permeability. Each of these subunits is 150 to 250 feet thick. However, pressure data indicate that they are hydraulically connected; therefore, for the purposes of evaluating the proposed AE, and consistent with EPA’s regulatory definition of an aquifer at 40 CFR § 146.3, the combined First, Second, and Third Vedder Formations are considered as a single aquifer.

Confining Zone(s): The Vedder Formation is a deep stratigraphic interval in the Kern Front Oil Field and is separated from shallow water supply wells by 2,330 to 6,540 vertical feet of claystone, siltstone and sandstone. Updip, to the east, in the Kern River Oil Field, the Vedder Formation is an exempt aquifer. To the west and downdip, the formation waters of the Vedder Formation exceed 10,000 mg/L TDS. The Vedder Formation is confined by a clay layer that averages 125 feet thick and separates the Vedder Formation from the underlying Famoso Sand except where the Vedder is underlain by granite bedrock, and there is no Famoso Sand present. [Refer to Figures 4.1, 4.2, and 4.3.]

BACKGROUND

On July 21, 2017, DOGGR submitted a request for EPA Region 9's approval to exempt a portion of the Vedder Formation beneath the Kern Front Oil Field in the City of Bakersfield, Kern County, California. DOGGR reviewed the operator's request and proposed this AE based on the criteria at 40 CFR § 146.4(a): that it does not currently serve as a source of drinking water; and at 40 CFR § 146.4(c): that the TDS content of the ground water is more than 3,000 milligrams per liter (mg/L) and less than 10,000 mg/L and it is not reasonably expected to supply a public water system. Subsequent to the EPA's approval of the AE, the exempt formation would not be protected as an "underground source of drinking water" (USDW) under the Safe Drinking Water Act (SDWA) and therefore, would allow DOGGR, subject to state regulatory requirements, to approve Class II injection into the identified formation.

The Kern Front Oil Field was discovered in 1912. Early wells in the field recovered several hundred barrels of oil per day until reservoir pressure declined significantly. Steam cycling was initiated in February 1964, and steam flooding began in 1978. The Vedder Formation is not productive in the Kern Front Oil Field, but does produce oil in several nearby fields. Oil is produced from the overlying Etchegoin and Chanac Formations. These formations, within the Kern Front Field, were exempted at the time California was granted primacy to allow Class II steam injection for EOR. In 2015, a total of 5.01 million barrels of oil were produced from the Kern Front Oil Field.

BASIS FOR DECISION

Regulatory Criteria under which the AE is Requested and Approved

40 CFR § 146.4(a) *It does not currently serve as a source of drinking water.*

In their concurrence on this AE package, the State Water Resources Control Board (State Board) determined that the portion of the Vedder Formation to be exempted is not currently a source of drinking water, and it is not hydraulically connected to domestic or public water supply wells. This is based on the evaluation of information about water supply wells in the area, ground water flow patterns, and confinement of the formation to ground water flow. These reviews demonstrate that the aquifer identified for exemption does not currently serve as a source of drinking water because: there are no existing drinking water supply wells, public or private, that currently or in the future would draw water from the portion of the Vedder Formation proposed for exemption; the formation is vertically and laterally confined (separated) from other USDWs; and no aquifers that serve as sources of drinking water are hydraulically connected to the aquifer. Further, within the state's water well search area (described more fully below), the Vedder Formation is not currently a source of drinking water. All drinking water supply wells in the vicinity of the Kern Front Oil Field draw from the shallow alluvium/Kern River Formation.

Water Supply Wells: DOGGR's AE proposal included information about water wells in the area proposed for exemption in order to establish that no drinking water wells or other water supply wells draw from the aquifer proposed for exemption. The State Board reviewed this well data from the Kern County Water Agency (KCWA), the Department of Water Resources (DWR)

Water Data Library, the DWR California Statewide Groundwater Elevation Monitoring Program, the Kern County Environmental Health Services Department, and the USGS National Water Information System, in order to evaluate and confirm this information.

The water supply well search area (study area) included the entire surface of the area proposed for exemption and all adjacent one square mile sections within a one-quarter mile area around the area proposed for exemption. This expanded study area allowed the reviewers to identify wells in the databases that had limited location details (e.g., wells that were identified by section only, such that there was uncertainty whether they are within the AE area). This yielded information about a significant number of wells that are representative of ground water resources in the area.

A total of 139 water wells were identified within the study area. All of these wells draw water from the overlying shallow alluvium/Kern River Formation. Of the 139 wells identified in the search area, three are public drinking water supply or municipal drinking water wells. These wells are located 0.5 to 1 mile west of the administrative boundary of the Kern Front Oil Field, and are completed at least 4,340 feet above the Vedder Formation.

No public drinking water supplies or private wells within the study area currently use the Vedder Formation as a source of drinking water. The nearest community, Oildale, lies 1.5 miles to the south-southwest of the Kern Front Oil Field, and is served by the Oildale Mutual Water Company (OMWC).

DOGGR's well search investigation confirmed there are no water supply wells, drinking water or other type of well, that draw from the Vedder Formation, and that the formation proposed for exemption is not currently a source of drinking water, and is not hydraulically connected to domestic or public water supply wells.

Ground Water Flow Patterns: To estimate ground water flow patterns, DOGGR evaluated available hydrogeologic information on the Vedder Formation, including porosity and permeability data, isochore maps, and information about injection and production activities in the region.

The Vedder Formation in the area proposed for exemption is hydrogeologically isolated from its surroundings, as it is stratigraphically confined above and below, and is surrounded laterally by formations above 10,000 mg/L TDS (downdip) or exempted aquifers (updip). The formation is not in contact with surface recharge. Therefore, the fluid gradients within the formation in the area proposed for exemption are primarily controlled by hydrocarbon production activities and injection activities in the surrounding oil fields.

Because the Vedder Formation is not an active source of ground water, flow in the Vedder Formation within the Kern Front Oil Field is minimal (i.e., on the order of one foot per year toward the east due to Vedder oil production in nearby oil fields). According to DOGGR, over the remaining 35-year projected lifetime of the Kern Front Oil Field, the total amount of fluid migration would be on the order of 40 to 60 feet to the east, which would be within the aquifer

exemption boundary. Therefore, DOGGR concluded in their evaluation that any injected fluids would remain within the formation in the area proposed for exemption.

Regional ground water flow in the shallow alluvium/Kern River Formation (the source for drinking water supply wells in the area) is toward the northwest. The depth to the water in wells within these formations is between 500 and 650 feet, based on data provided by KCWA.

Confinement of the Formation to Ground Water Flow: Within the Kern Front Oil Field, the Vedder Formation is confined above by the Freeman-Jewett Silt, a low-permeability silt and clay that is more than 900 feet thick throughout most of the Kern Front Oil Field and is present throughout much of the San Joaquin Basin (it thins northward in the Kern Front Oil Field, but is at least 700 feet thick throughout the field). The existence of a barrier to vertical flow from the Vedder Formation is demonstrated by permeability data for the Freeman-Jewett Silt (which ranges from 0.2 mD to 5 mD in the Young Fee WD4 well and 0.1 mD to 3.8 mD in the Badger Creek WD1 well, as measured in percussion sidewall cores) and pressure measurements in the Young Fee WD4 well. The Vedder Formation is separated from shallow water source wells by 2,330 to 6,540 vertical feet of claystone, siltstone and sandstone.

Lower confinement is provided by a clay layer that averages 125 feet thick and separates the Vedder Formation from the underlying Famoso Sand. This clay zone is present across the Kern Front Oil Field area except where the granitic basement is relatively shallow (refer to Figures 4.1, 4.2, and 4.3). Evidence for this vertical confinement to flow is provided by the difference in salinity between the Third Vedder Formation above the clay layer (9,600 mg/L) and the Famoso Sand below it (1,800 mg/L).

Several faults, including the Pond-Poso Fault, the Premier Fault, and the Kern Front Fault, are present at the margins of the Kern Front Oil Field. Based on pressure measurements, the Vedder Formation is approximately 400 pounds per square inch (psi) below hydrostatic pressure relative to the overlying formations, and pressures applied during injection are not anticipated to increase above this level during the operational life of the Kern Front Oil Field. At the volumes anticipated to be injected (approximately 50,000 barrels of water per day), the pressure increase on the Freeman-Jewett Silt at the Kern Front Fault is anticipated to be only 372 psi. Therefore, vertical fluid movement along the faults is not anticipated to occur during injection operations.

The lateral boundaries of the area proposed for exemption coincide with DOGGR's administrative boundaries of the Kern Front Oil Field, except for the northeastern portion. There are no physical structures that provide lateral confinement in the Kern Front Oil Field; however, the Vedder Formation dips regionally to the west-southwest and EPA evaluated the characteristics of the neighboring updip and downdip formations that contribute to confinement.

To the west (downdip), salinity increases as the Vedder Formation gets deeper within the Kern Front Oil Field, and salinity exceeds the 10,000 mg/L salinity-based definition of a USDW (e.g., as measured in a well in the southern Kern River Oil Field).

To the east (updip), the Vedder Formation is an exempt aquifer within the adjacent Kern River Oil Field. The Vedder Formation is also exempted within the nearby Round Mountain and

Mount Poso Oil Fields (the EPA approved aquifer exemptions for the Vedder Formation in these fields in February and April 2017, respectively). Updip of these fields, physical confinement in the Vedder Formation occurs at faults such as those that create the Main Area pools at the Mount Poso and Round Mountain Oil Fields.

After reviewing information regarding the location and screened intervals of the existing drinking water supply wells, the minimal ground water flow within the Vedder Formation, and the lateral and vertical confinement of the formation as described in the AE application the EPA concludes that the Vedder Formation is not a current source of drinking water and it is not hydraulically connected to any domestic or public drinking water supply wells. Therefore, the EPA has determined that the aquifer proposed for exemption meets the criteria at 40 CFR § 146.4(a).

40 CFR § 146.4(c) The total dissolved solids content of the ground water is more than 3,000 and less than 10,000 mg/L and it is not reasonably expected to supply a public water system.

DOGGR provided information on the TDS content of the Vedder Formation, along with supporting information such as logs, log-derived salinity data, and analysis of a single sample performed by certified laboratories that support a demonstration that the TDS of the Vedder Formation is between 3,000 and 10,000 mg/L in the portion of the aquifer proposed for exemption.

Calculated TDS values based on well log results support a determination that TDS levels in the Vedder Formation in the area proposed for exemption exceed 3,000 mg/L. The salinity of the Vedder Formation ranges from 3,500 mg/L to 5,400 mg/L in the shallower First Vedder Formation—to 5,800 mg/L to 8,250 mg/L in the Second Vedder Formation—to 4,200 to over 10,000 mg/L in the deeper Third Vedder Formation. The salinity of the Vedder Formation was calculated based on resistivity and density porosity log data using the Archie equation following EPA guidelines. These logs were collected in four wells: the Young Fee WD4, Section 22 104, and Pedro U.S.L. 10-1 wells (located west of the Kern Front Fault) and the Badger Creek WD1 well (located on the east side of the fault).

These calculated salinity values are consistent with a single measured salinity value of 9,600 mg/L in water sampled from the Third Vedder Formation in the Young Fee WD4 well. Because the Vedder Formation has not been used for hydrocarbon production or disposal, the salinity as measured in the Young Fee WD4 well should be representative of native ground water throughout the area proposed for exemption. An additional direct salinity measurement of 9,400 mg/L was recorded in the Badger Creek WD1 well. However, this sample represents commingled water from the First and Third Vedder Formations and it is not possible to estimate to what extent salinity of water from each subunit of the Vedder Formation contributed to the total sample salinity.

Regionally, TDS values increase to the south and southwest, where the Vedder Formation becomes deeper, reaching 16,174 mg/L in the southwest section of the nearby Kern River Oil Field. In general, salinity in the vicinity of the Kern Front Oil Field increases with depth

down dip to the southwest, and the calculated salinity values are consistent with regional trends that are based on sampling and analysis of the Vedder Formation in nearby fields.

Analysis presented in the AE package indicates that the aquifer is not reasonably expected to supply a public water system. Chemical analysis of ground water sampled from the Vedder Formation in the area proposed for exemption indicates chemicals of concern are present within the aquifer. Based on a sample collected in the Young Fee WD4 well, several of these constituents exceed federal primary or secondary maximum contaminant levels (MCLs). These include: radionuclides (such as gross alpha, radium 226, and radium 228), volatile organic compounds (such as benzene), chloride, manganese, selenium, turbidity, and TDS. The presence of these constituents render the ground water in the Vedder Formation unsuitable for domestic drinking water use.

DOGGR and the applicant compared water treatment costs to local utility data to demonstrate that treating the water to remove these contaminants would be economically infeasible. DOGGR estimated the cost of treating Vedder Formation ground water so that it would meet the standards for drinking water use. DOGGR evaluated the cost of treating ground water that contains high levels of TDS and that exceeds regulatory thresholds for other elements such as manganese, selenium, radionuclides and VOCs, based on the concentrations reported in samples taken from the Young Fee WD4 well.

The AE application includes information on cost estimates for two different sized water systems (representing Oildale and Kern County) to pump ground water from 4,000 to 5,000 feet below the surface, treat the water with reverse osmosis and mechanical vapor compression, deliver the water, and properly manage treatment residuals. The cost of treated water was estimated to be between \$3,980 and \$7,270 per acre-foot, depending on water system size; this is approximately 8 to 15 times the current cost of regional potable water, of \$500/acre-feet. These cost estimates were based on pilot- and bench-scale testing performed by the operator.

The cost to treat the water to meet federal standards could result in an annual water charge per household of \$5,009, which is 8% of the average household annual income in Kern County, and 11% of the average household annual income in the Oildale community. This would also result in a four-fold increase in the current water rates for residents in Oildale.

DOGGR evaluated existing drinking water sources in vicinity of the Kern Front Oil Field and, based on current water supplies, DOGGR determined that current sources can meet local growth demands. Based on a review of an Integrated Regional Water Management Plan that includes three districts: OMWC, the California Water Service Bakersfield District (Cal Water), and the City of Bakersfield, DOGGR concluded that municipal water districts in the vicinity of the Kern Front Oil Field have adequate supplies of currently developed ground water-bearing zones to meet expected population growth, including demand under drought conditions.

The OMWC service area covers about 10 square miles north of the City of Bakersfield. Based on OMWC's 2011 water management plan, the population within the Oildale Service Area has increased gradually over the last 20 years and is expected to continue to increase gradually through 2030. Improvement District No. 4, which serves a large portion of the City of

Bakersfield, can access and deliver 100% of its total annual water demands under all single and multiple dry-year scenarios considered in its 2011 water management plan and relies on ground water banking projects in dry years.

The Cal Water service area covers about 50 square miles in central, northwest, and northeast Bakersfield. Future water supply plans will decrease reliance on ground water and increase the use of treated surface water. Ground water will remain a reliable supply of water during drought, but long-term ground water overdraft will be reduced by area ground water recharge projects.

The City of Bakersfield's 2010 Urban Water Management Plan concludes that planned management practices, which include increased recharge of the shallow alluvium/Kern River Formation and anticipated future ground water reserves and water conservation practices, should allow the City to rely on the Kern County sub-basin to supply customer needs over the next 20 years under single year and multiple year droughts. The City has not experienced long-term water supply deficiencies and historically has been able to meet consumer demands.

All drinking water wells in the area draw from the shallow alluvium/Kern River Formation (where the salinity averages 216 mg/L), and the majority of these wells only penetrate the upper 50% of the Kern River Formation. This under-utilization of the aquifer demonstrates that current water resources are adequate for the area, and the much deeper Vedder Formation is not expected to be necessary to meet drinking water needs.

Based on a review of this information, the EPA concludes that the Vedder Formation in the Kern Front Oil Field contains between 3,000 mg/L and 10,000 mg/L TDS and it is not reasonably expected to supply a public water system. As such, the EPA has determined that the aquifer proposed for exemption meets the criteria at 40 CFR § 146.4(c).

PUBLIC NOTICE AND COMMENT

DOGGR provided public notice of this proposed AE on March 20, 2017 and held a public hearing on April 19, 2017 in Bakersfield, CA. The written comment period closed on April 19, 2017. DOGGR provided the EPA a summary of the public comments, copies of the public comments submitted, a transcript of the public hearing, and their responses to the written and oral comments.

In making this decision, the EPA considered all of the information submitted by the State, including all of the written and oral comments submitted to the State during its public comment process. One commenter who wrote to DOGGR requested that the EPA reject the exemption request before environmental review has occurred under the National Environmental Policy Act (NEPA). The EPA believes that the public comment and hearing procedures afforded by DOGGR and the in-depth technical analysis to protect USDWs required in the aquifer exemption proposal process under the EPA's UIC regulations and the enabling legislation in the SDWA provide a functionally equivalent environmental review for this action.

The commenter also raised concerns regarding protection of species under the federal Endangered Species Act. This issue is outside the scope of EPA's AE decision, as this action

does not authorize future injection activities at the surface. Approval of this aquifer exemption concerns ground water that is thousands of feet below the surface, and a review of materials submitted by the commenter indicates that there are no subsurface listed threatened or endangered species that would be affected by the EPA's approval.

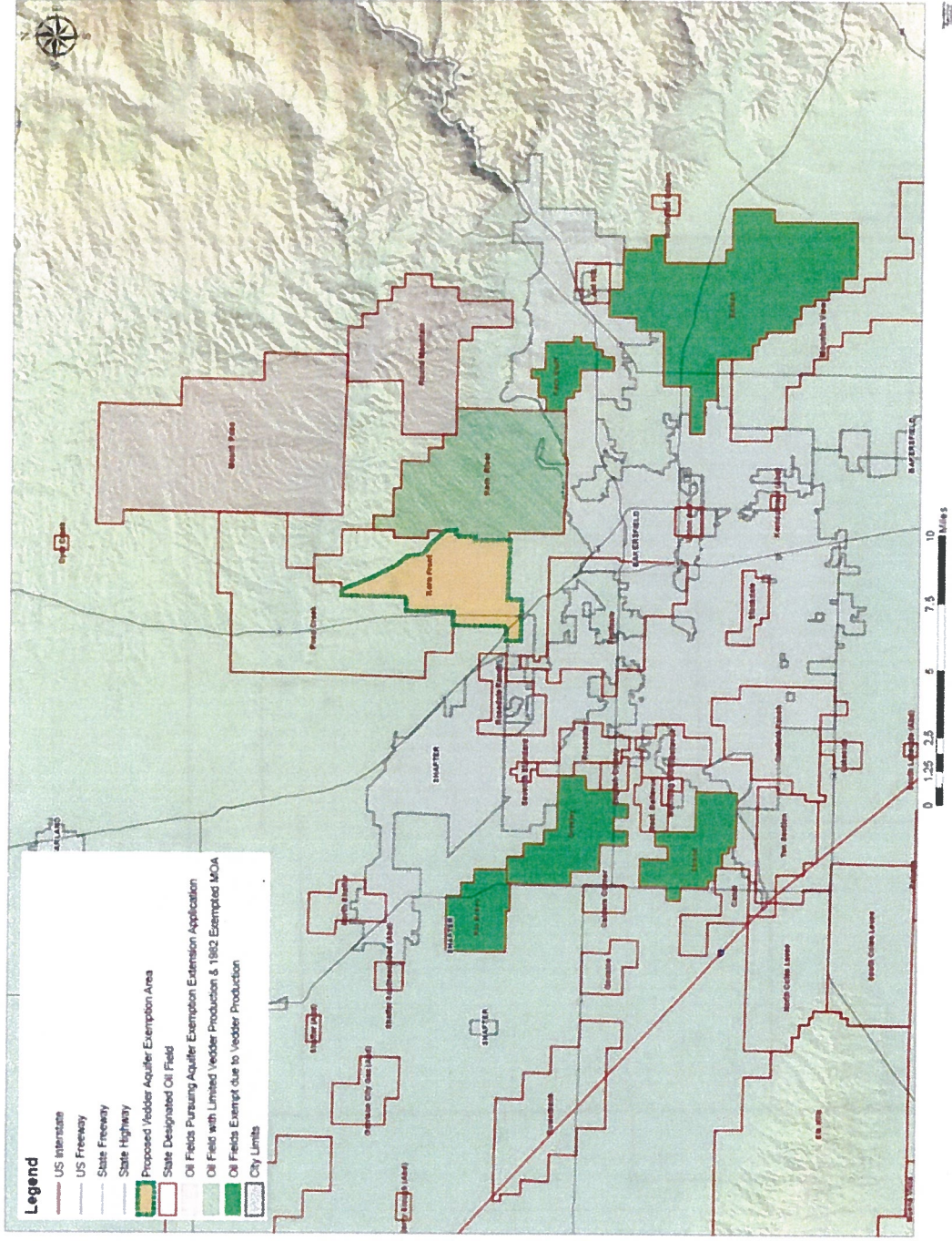
The commenter also questioned whether the current technical criteria to consider future drinking water uses is adequate given changing climate conditions and new technology available for water treatment. In considering whether the area proposed for exemption cannot now and will not in the future serve as a source of drinking water, the EPA reviewed data regarding the level of contaminants in the ground water and information on the economic feasibility of treatment of this water for human consumption. Even with the potential for improved treatment technology and higher demand for drinking water due to drought or scarcity, shallower aquifers than the Vedder Formation would continue to provide an adequate supply of higher quality water for public water systems. As a result, the EPA concluded this aquifer is not reasonably expected to supply a public water system.

CONCLUSION AND DECISION

Based on a review of the entire record, including all the written and oral comments submitted to DOGGR during its public comment process, the EPA finds that the exemption criteria at 40 CFR § 146.4(a) and § 146.4(c) have been met and the EPA approves the aquifer exemption request as a non-substantial program revision.

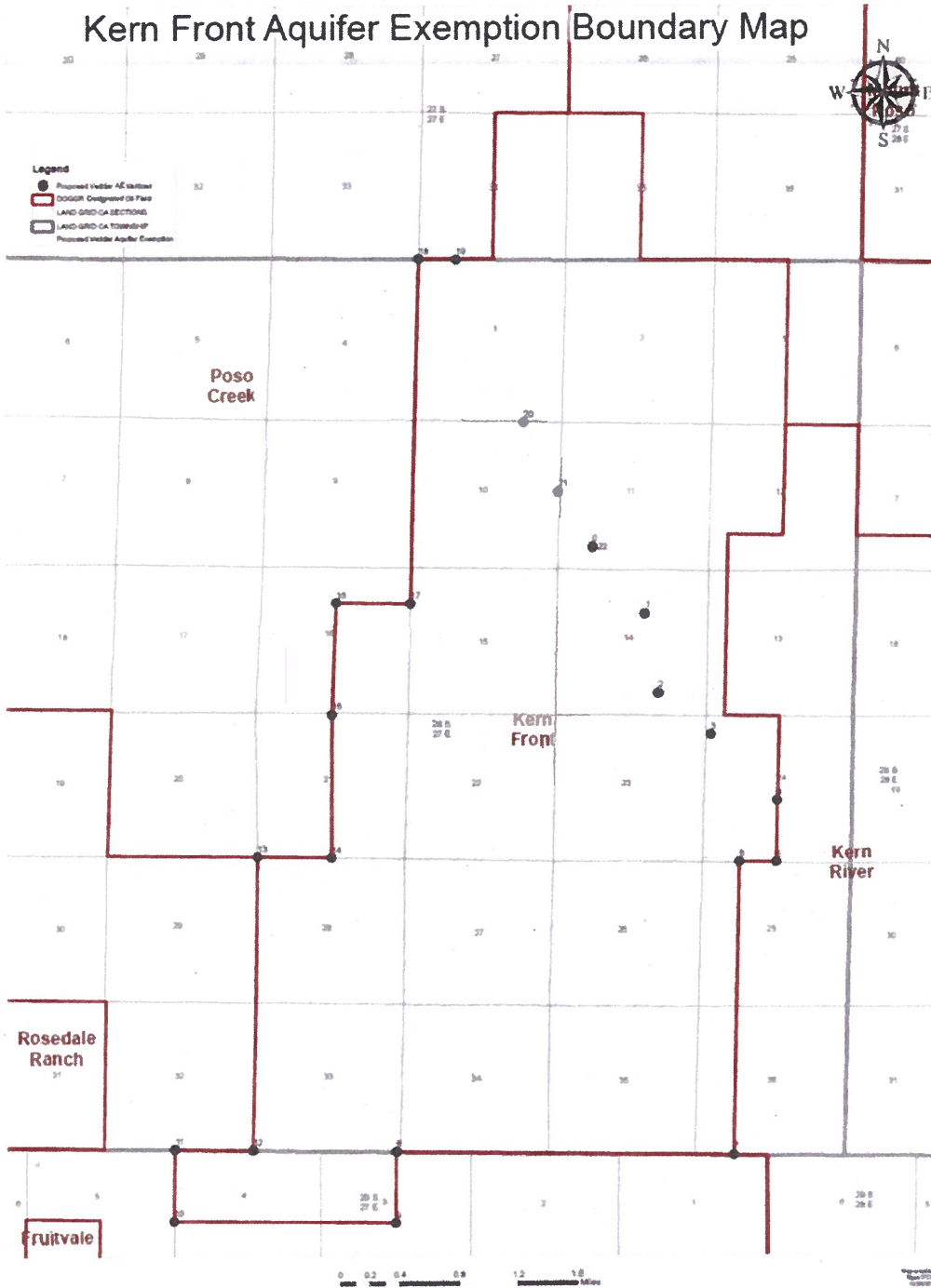
Effective Date: August 30, 2017

Figure 1: Location of the Kern Front Oil Field, Kern County, California



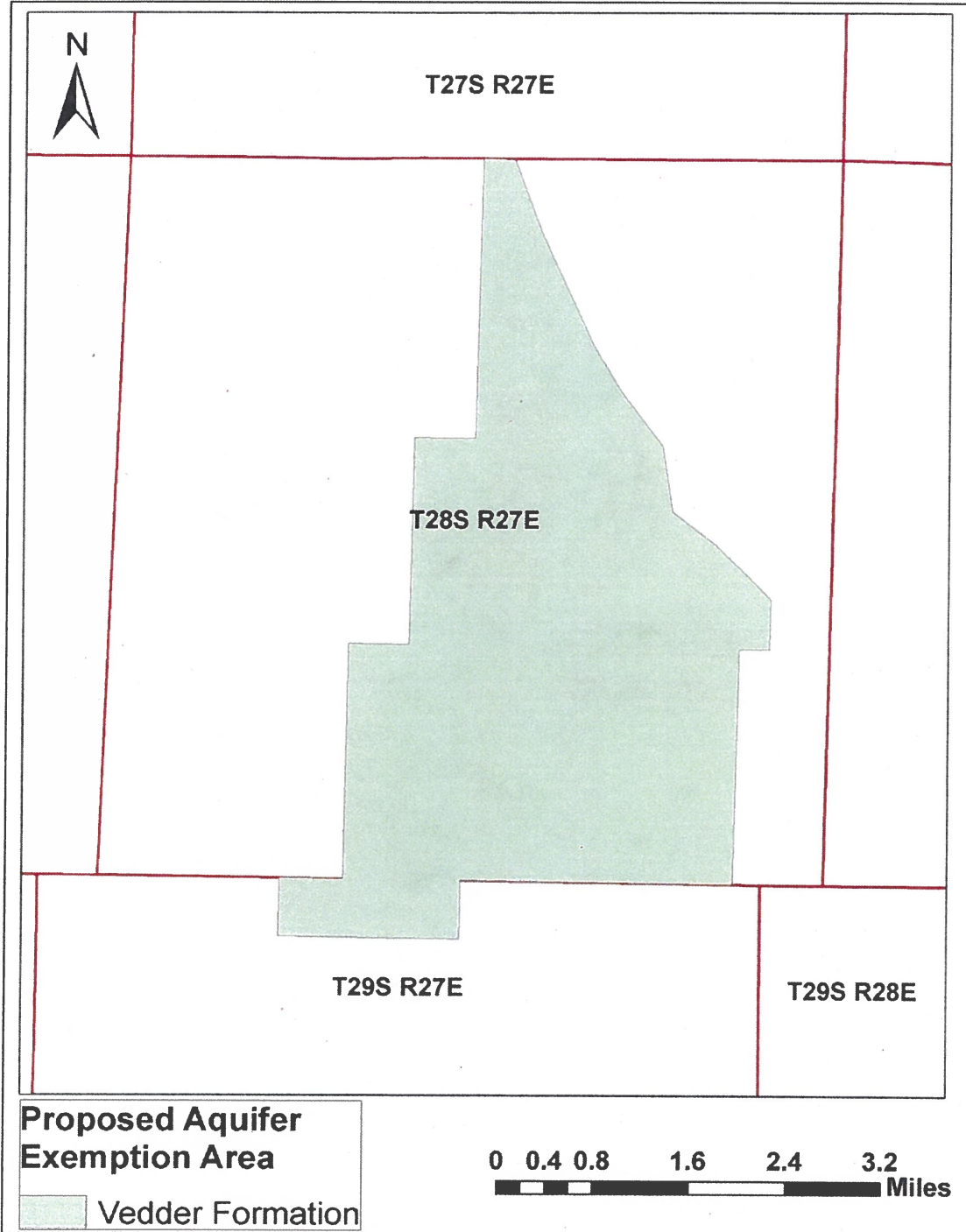
Source: Exhibit 1, DOGGR's Aquifer Exemption Application for the Kern Front Oil Field

Figure 2: Vedder Formation Aquifer Exemption Location Map with Identifying Features, Kern Front Oil Field, Kern County, California



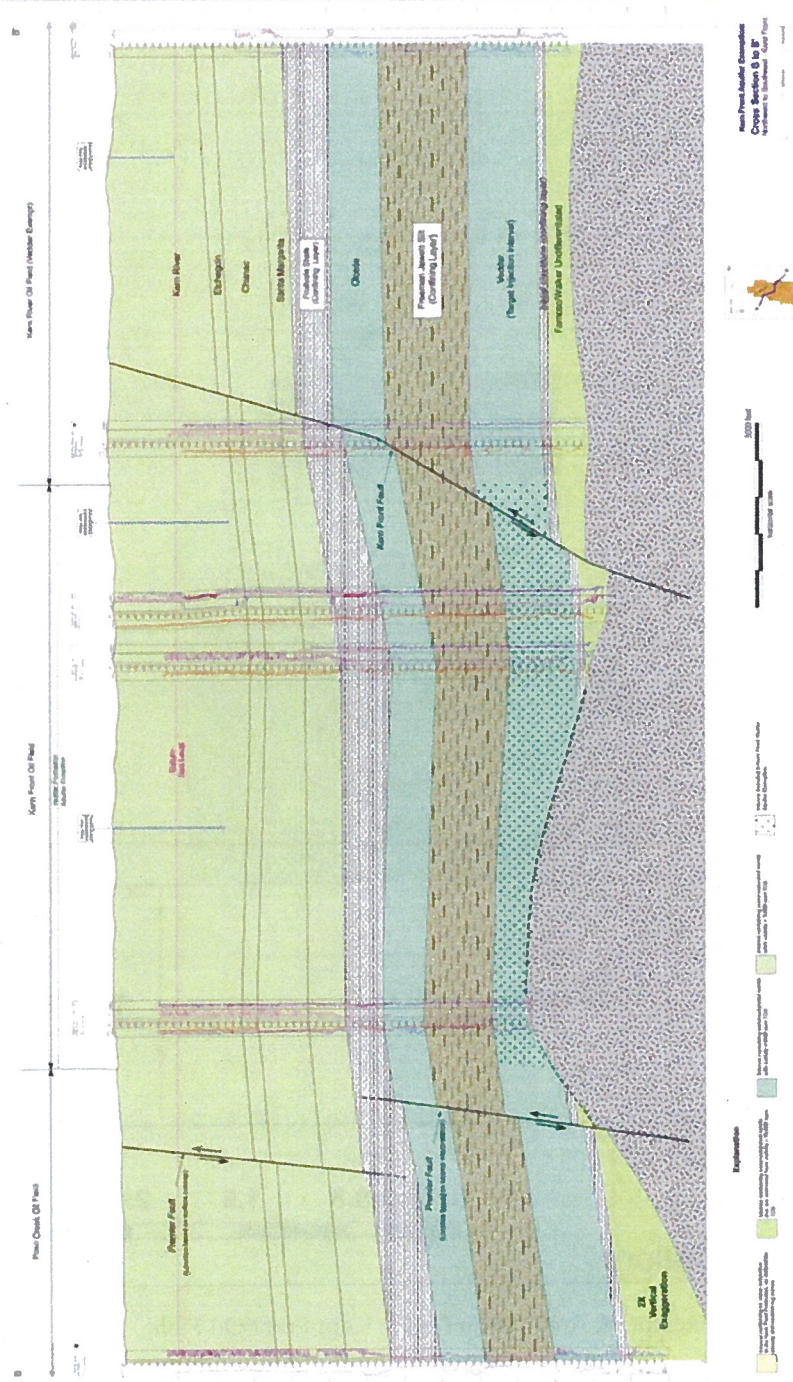
Source: DOGGR's Aquifer Exemption Application for the Kern Front Oil Field

Figure 3: Vedder Formation Aquifer Exemption Location Map, Kern Front Oil Field, Kern County, California



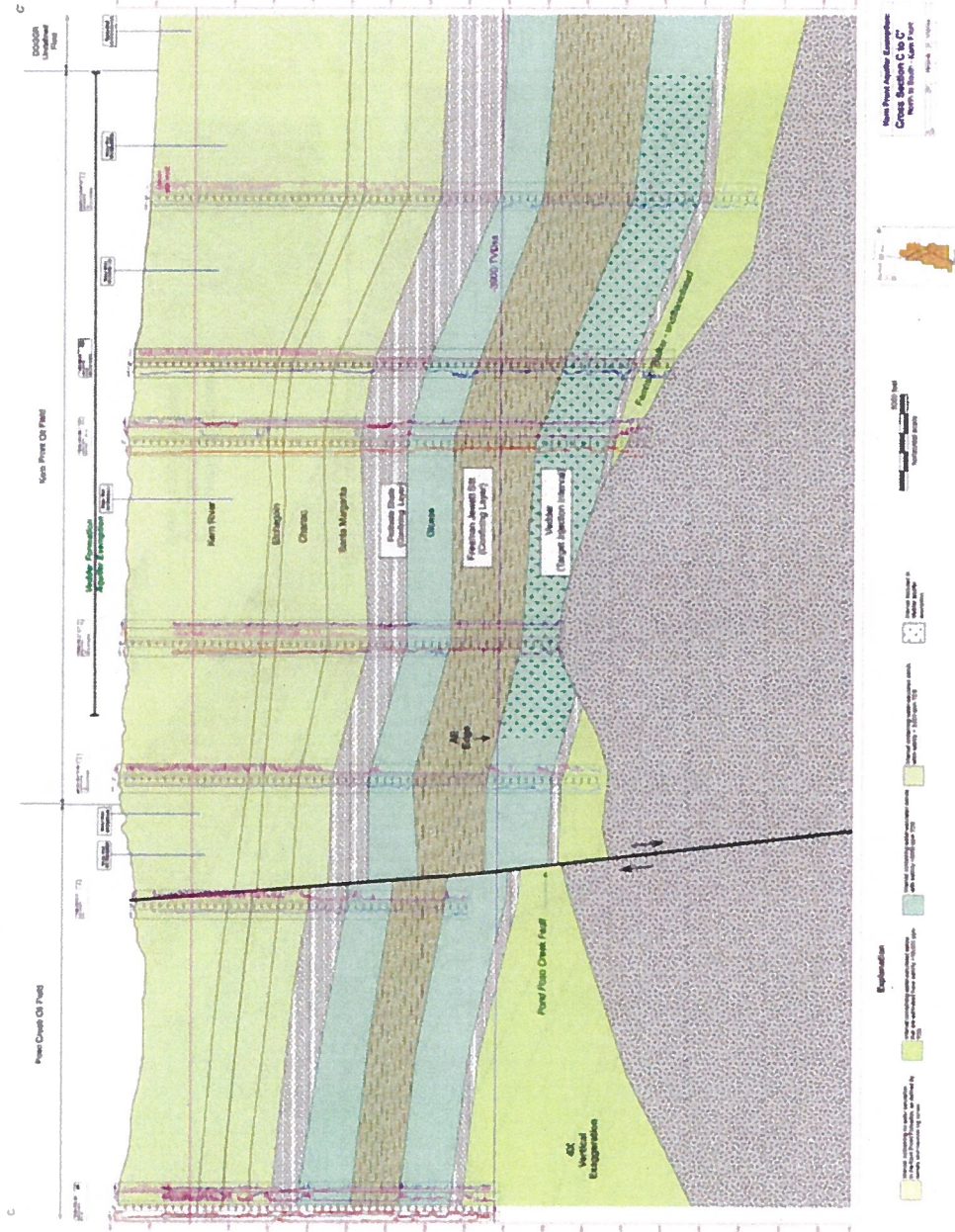
Source: DOGGR's Aquifer Exemption Application for the Kern Front Oil Field

**Figure 4.1: Cross Section B-B' across the Vedder Formation Aquifer Exemption Area
Kern Front Oil Field, Kern County, California**



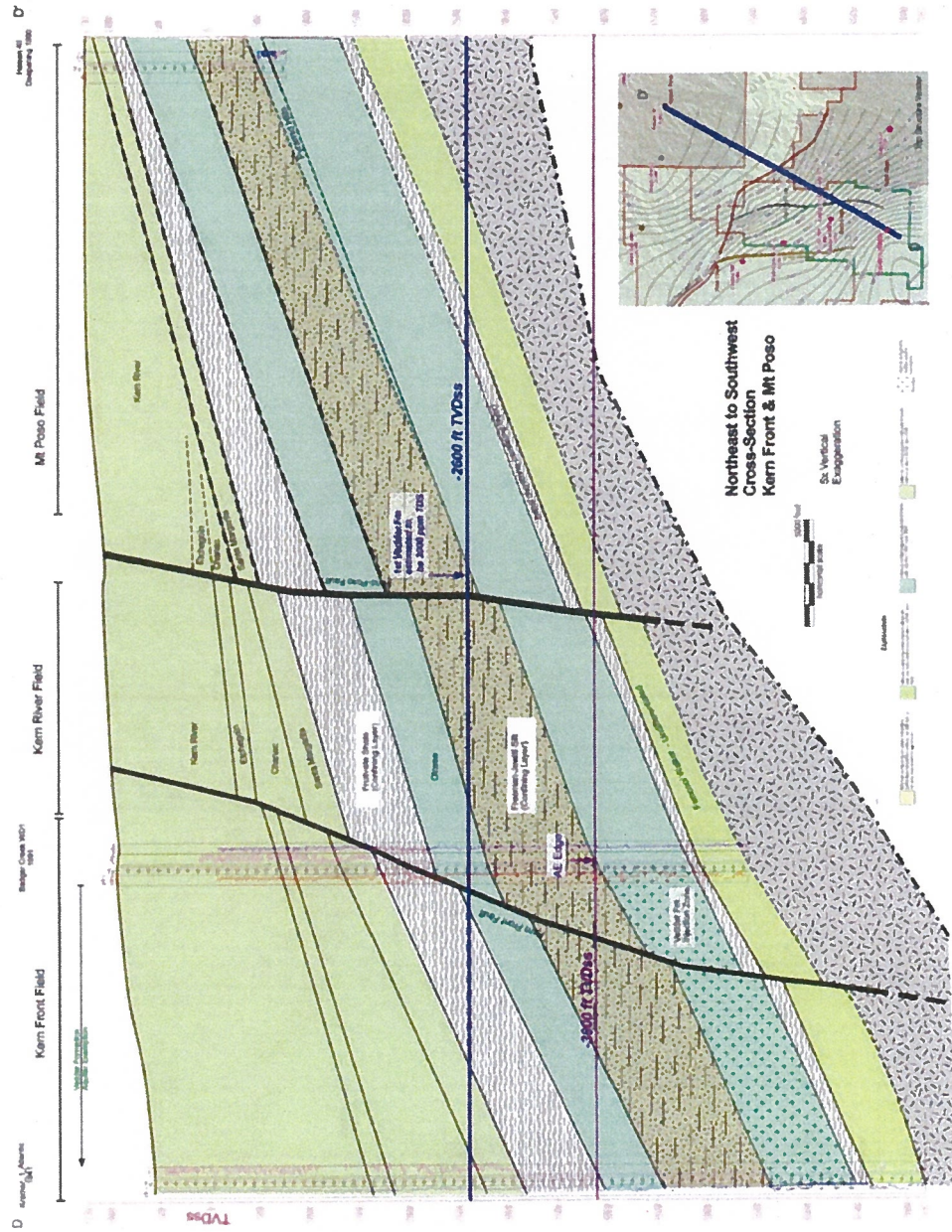
Source: Exhibit 6-2, DOGGR's Aquifer Exemption Application for the Kern Front Oil Field

Figure 4.2: Cross Section C-C' across the Vedder Formation Aquifer Exemption Area
 Kern Front Oil Field, Kern County, California



Source: Exhibit 6-1, DOGGR's Aquifer Exemption Application for the Kern Front Oil Field

**Figure 4.3: Cross Section D-D' across the Vedder Formation Aquifer Exemption Area
Kern Front Oil Field, Kern County, California**



Source: Exhibit 6-3, DOGGR's Aquifer Exemption Application for the Kern Front Oil Field