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

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: Approval of Aquifer Exemption 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 portions of the Upper Chanac 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. 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 the following federal exemption criteria:

- The portions of the formation proposed for exemption in the field do not currently serve as a source of drinking water; and
- The portions of the formation proposed for exemption in the field cannot now and will not in the future serve as a source of drinking water because they are commercially hydrocarbon-producing.

If you have any questions, please contact David Albright, Manager of our Drinking Water Protection Section, at (415) 972-3971.

Sincerely,

Tomás Torres August 30, 2018
Director, Water Division

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

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

US Environmental Protection Agency 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 portions of the Upper Chanac Formation in the Kern Front Oil Field, background information concerning the AE request, and the basis for the AE decision. For reference, on August 30, 2017, EPA approved an aquifer exemption of the Vedder Formation, which is approximately 3,000 feet below the Chanac Formation in the Kern Front Oil Field.

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

Date of Aquifer Exemption Request: June 21, 2018

Exemption Criteria: DOGGR requests this exemption because it has determined that it meets the criteria at 40 CFR § 146.4(a) and § 146.4(b)(1).

Substantial or Non-Substantial Program Revision: Non-Substantial

Although the EPA must approve all revisions to 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 that 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 of whether a program revision is substantial or non-substantial is made on a case-by-case basis.

Operator: Hathaway, LLC.

Well/Project Name: The Upper Chanac Formation in the Kern Front Oil Field.

Well/Project Permit Number: There are approximately 42 active Class II enhanced oil recovery (EOR) wells and water disposal wells in the Kern Front Oil Field within the portion of the aquifer proposed for exemption.

Well/Project Location: The aquifer proposed for exemption underlies portions of Sections 34 and 35 of Township 27S Range 27E, and Sections 2, 3, and 10 of Township 28S Range 27E, Mount Diablo Base and Meridian (MDB&M). Refer to Figures 1 and 2.

County: Kern **State:** California

Well Class/Type: Class II EOR and produced water disposal.

DESCRIPTION OF PROPOSED AQUIFER EXEMPTION

Aquifer to be Exempted: Portions of the Upper Chanac Formation within the Kern Front Oil Field.

Areal Extent of Aquifer Exemption: The areal extent of the existing Upper Chanac exemption and the proposed expansion in the Kern Front Oil Field is approximately 6,699 acres. This acreage includes 6,100 acres of productive boundaries (approved at primacy in 1983), and approximately 599 acres comprising the current oil producing area outside the boundaries, and currently unutilized commercially producible areas. The lateral extent of the proposed exempt area is defined by sealing faults, a stratigraphic pinch-out, the previously exempted area of the Upper Chanac Formation, and the oil-water contact within the formation. See Figure 2 for a depiction of the proposed exempt formation.

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

Aquifer	Upper Chanac Formation.
Lithology	Fine to coarse grained, poorly sorted sands with interbedded siltstones, mudstones, and occasional conglomerates.
TDS (mg/L)	333 mg/L (average of 3 samples ranging from 320 mg/L to 350 mg/L).
Depth to Top	1,400 feet to approximately 2,000 feet below ground surface, or 696 feet to 882 feet below sea level.
Thickness (feet)	0 to 70 feet (averaging 40 feet).
Porosity and Permeability	Porosity ranges from 19 to 42%. Permeability ranges between 20 and 13,580 millidarcies (mD), with an average of 2,174 mD.

Confining Zone(s): In the Kern Front Oil Field, the Upper Chanac Formation is confined above and below by shales of low permeability. The proposed AE is divided into a western and eastern section. The western section of the proposed AE is bounded to the east by a sealing fault, to the west by the boundary where oil is present (this is known as the "oil-water contact"), and to the south by the previously exempted portion of the Upper Chanac Formation. The eastern section of the proposed AE is bounded to the north by a fault, to the east by a fault and a stratigraphic pinch-out, to the west by the oil-water contact, and to the south by the previously exempted portion of the Upper Chanac Formation. See Figures 3.1 through 3.4.

BACKGROUND

On June 21, 2018, the EPA received a request from DOGGR for approval to exempt portions of the Upper Chanac Formation of the Kern Front Oil Field, in Kern County, California. DOGGR reviewed the operator's request and proposed this AE based on the criteria at 40 CFR §146.4(a): it does not currently serve as a source of drinking water; and at 40 CFR §146.4(b)(1): it cannot now and will not in the future serve as a source of drinking water because it is mineral, hydrocarbon, or geothermal energy-producing, or can be demonstrated by a permit applicant as

part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible. After 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 DOGGR would be authorized, subject to state regulatory requirements, to approve Class II injection into the identified formation.

The Upper Chanac Formation that is proposed for exemption is limited to the upper oil-saturated layers of the Chanac Sand. Portions of the Upper Chanac Formation within the Kern Front Oil Field have been productive since 1912. Cyclic steam injection (steaming) was initiated in 1964, and steam flooding began in 1978. Injection of produced water for disposal began in the 1990s.

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 request, the State Water Resources Control Board (State Water Board) determined that the Upper Chanac Formation does not currently serve as a source of drinking water, and it is not hydraulically connected to any domestic or public water supply wells. This is based on an evaluation of information about water supply wells in the area, groundwater flow patterns, and confinement of groundwater flow. These reviews demonstrate that the aquifer proposed 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 Upper Chanac Formation. In addition, the formation is vertically and laterally confined (i.e., separated) from other USDWs, and no aquifers that serve as sources of drinking water are hydraulically connected to the formation. Further, within the State's water well search area (described more fully below), the Upper Chanac Formation is not currently a source of drinking water.

Water Supply Wells: DOGGR's AE request included information about water supply wells in and around the area proposed for exemption to establish that no drinking water wells draw from the aquifer proposed for exemption. The applicant searched well records to identify wells within a water supply well search area ("study area") that includes a quarter mile buffer around the boundary of the proposed AE area. This study area was selected because it accounts for all water wells within the areas of review for potential future Class II injection projects in the AE expansion area.

Well record searches of public databases maintained by the Department of Water Resources and the Kern County Environmental Health Services Department were conducted. The locations of these wells were physically verified in the field; aerial reconnaissance survey data and photographs were also reviewed. In addition, DOGGR contacted the Cawelo Water District, the Kern-Tulare Water District, and the Kern County Water Agency to verify that they do not have any wells which draw from the Upper Chanac Formation. The nearest local communities are Oildale and Rosedale, which are located approximately five miles south of the Kern Front Oil Field.

The water well survey included records for 36 water wells. These include: 27 domestic drinking water wells, 3 irrigation wells, and 6 industrial/oil & gas wells. (See Table 1). All the wells are completed in the Alluvium or the Kern River Formation, at depths of between 60 to 1,770 feet. There is at least 250 feet of vertical separation between the deepest drinking water wells and the top of the Upper Chanac Formation proposed for exemption.

Groundwater Flow Patterns: To estimate groundwater flow patterns, DOGGR evaluated available hydrogeologic information on the Upper Chanac Formation, including fluid levels in idle wells within the proposed exemption area, calculated hydrostatic pressures, and information about injection and production activities in the region. Fluid flow in the Upper Chanac Formation is to the east and inward, toward the producing wells (i.e., from high to low pressure) and away from the boundaries of the area proposed for exemption.

Confinement of the Formation to Groundwater Flow: Vertical confinement is provided by formations of lower permeability that are present above and below the Upper Chanac Formation. These sand/clayey siltstone/shale layers above the Upper Chanac Formation range from approximately 2 to 40 feet thick in the proposed exempt area (averaging 7 feet thick). The average permeability of these layers is 25 mD (ranging from 0.7 to 51 mD); these values are based on the analyses of samples from wells throughout the project area. Other evidence for the confining nature of this formation is its ability to trap hydrocarbons. Additional confinement is provided by a small fault that juxtaposes the Etchegoin wet sands against the upper confining shale. This fault is identified based on the interpretation of well logs and is depicted in one cross section in the AE request (See Figure 3.3).

Below the Upper Chanac Formation, a laterally continuous shale acts as a confining layer between the oil-bearing and water-bearing portions of the Chanac Formation. This shale averages 17 feet in thickness, and ranges from 2 to 72 feet thick in the project area. It has an average permeability of 27 mD (ranging from 6.4 to 85 mD), based on analyses of the fluid content of samples taken from well bores.

Lateral confinement on the western limb of the area proposed for exemption is provided by faulting to the east, an inward pressure gradient (i.e., a "pressure sink" caused by the withdrawal of fluids) to the west, and the previously exempted portions of the Upper Chanac Formation to the south. See Figures 3.1 through 3.3.

- *To the east*, a fault provides confinement. Evidence for the confining nature of this fault is provided by the presence of producible quantities of oil in wells on the west side of the fault, and the absence of oil in wells immediately east of the fault.
- *To the west*, the proposed AE boundary is defined by the oil-water contact in the Upper Chanac Formation, as illustrated in cross sections in the application that are based on electric logs and core samples, well reports, and historic production data. Containment along the oil-water contact is the result of an inward pressure gradient caused by the withdrawal of fluids from the Upper Chanac Formation. Between 1977 and 2017 in the area proposed for exemption, approximately 188 million barrels (bbl) of oil and water have been produced, and approximately 31.4 million bbl of steam and water have been injected, which indicates a net withdrawal of approximately 156.5 million bbl of fluids

over the last 40 years from the Upper Chanac Formation. This extraction causes movement of fluids within the proposed AE area toward the producing wells.

- *To the south*, confinement is provided by the Upper Chanac Formation that was exempted at primacy.

On the eastern side of the area proposed for exemption, lateral confinement is provided by: sealing faults to the north; a combination of faulting, and a stratigraphic pinch-out to the east; an inward pressure gradient to the west; and the previously exempted portions of the Upper Chanac Formation to the south. See Figures 3.1, 3.2, and 3.4.

- *To the north*, confinement is provided by the Poso Creek Fault. Evidence for the sealing nature of this fault is the absence of hydrocarbons in wells on the north side of the fault.
- *To the east*, a combination of a seal against the Kern Front Fault and a stratigraphic pinch-out of the Upper Chanac Formation that traps hydrocarbons serves as the confining mechanism. The Kern Front Fault displaces the entire Upper Chanac Formation against impermeable rock layers to provide trapping of hydrocarbons. Beyond the stratigraphic pinch-out, the Upper Chanac Formation is no longer present. Evidence for the existence of these confining features is based on the presence of hydrocarbons in wells west of the fault and the absence of hydrocarbons in wells immediately east of the fault.
- *To the west*, the proposed AE boundary is defined by the oil-water contact in the Upper Chanac Formation as defined by an inward pressure gradient within the area proposed for exemption.
- *To the south*, the Upper Chanac Formation is confined by the previously exempted portions of the formation.

After reviewing information regarding the location and depth of the existing drinking water supply wells, groundwater flow within the Upper Chanac Formation, and the lateral and vertical confinement of the formation as described in the AE request, the EPA concludes that the Upper Chanac Formation is not currently a source of drinking water and 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(b)(1) *It cannot now and will not in the future serve as a source of drinking water because it is mineral, hydrocarbon, or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible.*

DOGGR provided information on hydrocarbon production in the area proposed for exemption along with supporting documentation such as historic production data, the locations of current and historic producing wells, and well logs and sidewall core sample data to demonstrate the presence of commercially producible quantities of oil in the Upper Chanac Formation within the Kern Front Oil Field.

Between 1977 and 2017, the wells within the area of the Kern Front Oil Field proposed for exemption have cumulatively produced 5,071,648 bbl of oil and 43,501,000 cubic feet of gas. DOGGR's request documents several wells throughout the eastern section of the area proposed

for exemption that have produced more than 90,000 bbl of oil. (See Figure 4.) Hydrocarbons are distributed vertically and laterally throughout the oil field in the currently exempted portions of the Upper Chanac Formation and the portion that is proposed for exemption. Evidence for the presence of commercially productive quantities of oil in the Upper Chanac Formation is based on evaluations of sidewall cores and well records that show the presence and percentage of oil in the rock samples. The Upper Chanac Formation has an estimated oil saturation ranging from 15% to 70%; this oil saturation information is based on core samples from wells within the oil field.

Based on a review of information (for both the western and eastern sections of the area proposed for exemption), such as well logs, production data, oil saturation, the history of oil production, and the implementation of enhanced recovery techniques such as steaming that have the potential to increase the productivity of the Upper Chanac Formation, the EPA has determined that the aquifer proposed for exemption meets the criteria at 40 CFR § 146.4 (b)(1).

PUBLIC NOTICE AND COMMENT

DOGGR provided public notice of this proposed Aquifer Exemption on March 15, 2018, and held a public hearing on April 16, 2018 in Bakersfield, CA. The public comment period closed on April 16, 2018. 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 the information submitted by the State, including all the written and oral comments submitted to the State during its public comment process. Most of the issues raised in the comments are addressed by this decision document on the proposed exemption; specific responses not addressed by DOGGR are provided below.

One commenter (The Center for Biological Diversity) wrote to DOGGR and commented that the EPA should reject the aquifer exemption request before an environmental review has occurred under the National Environmental Policy Act (NEPA). The EPA believes that the public comment and hearing process afforded by DOGGR, the 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 NEPA environmental review for this decision.

The same 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 groundwater that is over a thousand 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.

Additionally, the commenter questioned whether the current aquifer exemption criteria reflect changing climate conditions and modern water treatment technologies. In considering whether the aquifer proposed for exemption cannot now and will not in the future serve as a source of drinking water because it is hydrocarbon producing, the EPA reviewed data about hydrocarbon production and the potential for hydrocarbon production in the portion of the Upper Chanac Formation proposed for exemption. Based on a review of historic production data, well logs and

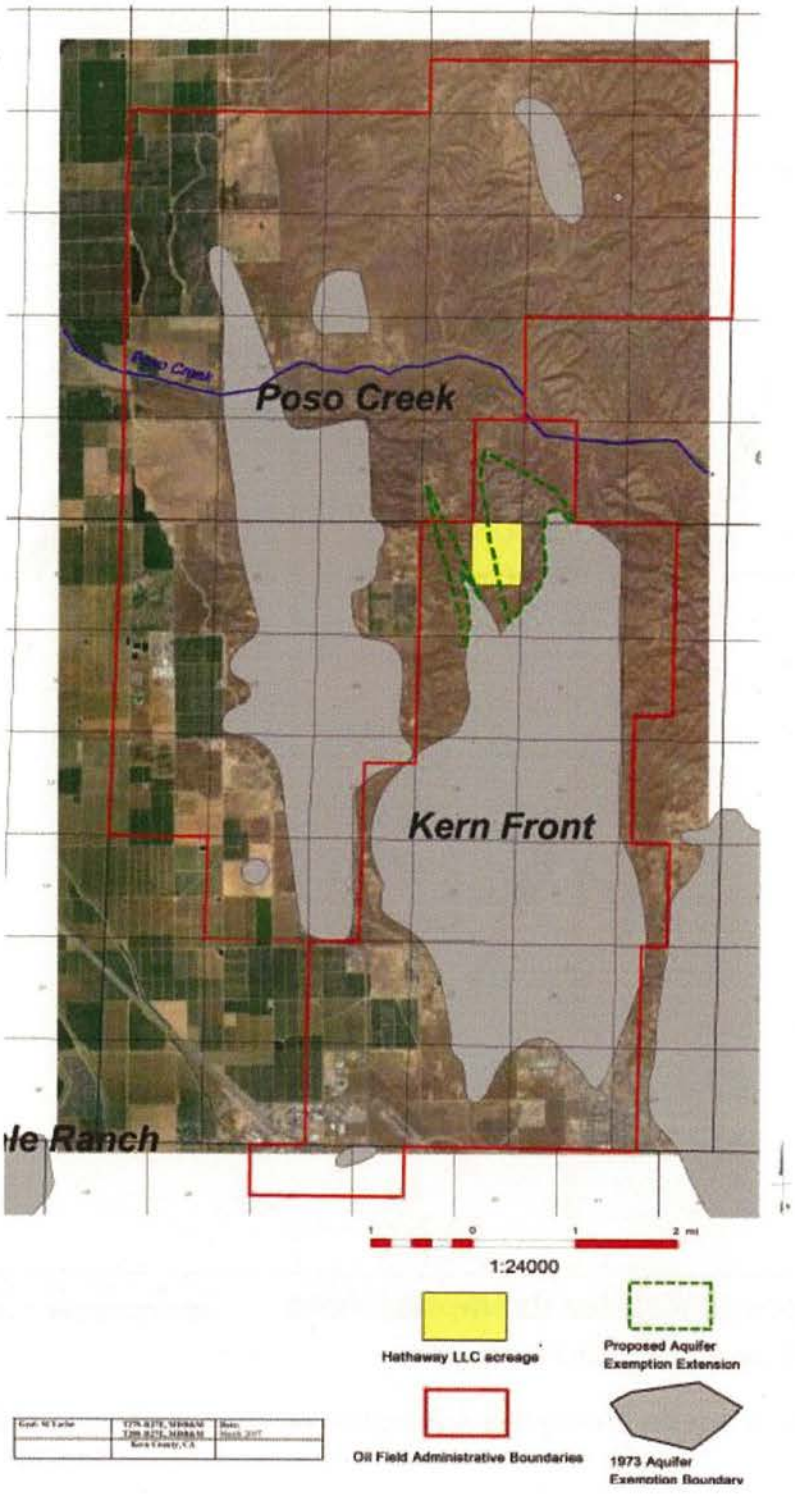
core data, and the locations of current and historical hydrocarbon producing wells, the EPA believes it is reasonable to conclude that the formation will continue to be commercially producible into the foreseeable future and meets the requirements at 40 CFR § 146.4(b)(1).

CONCLUSION AND DECISION

Based on a review of the entire record, including all 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(b)(1) have been met, and the EPA approves the aquifer exemption request as a non-substantial program revision.

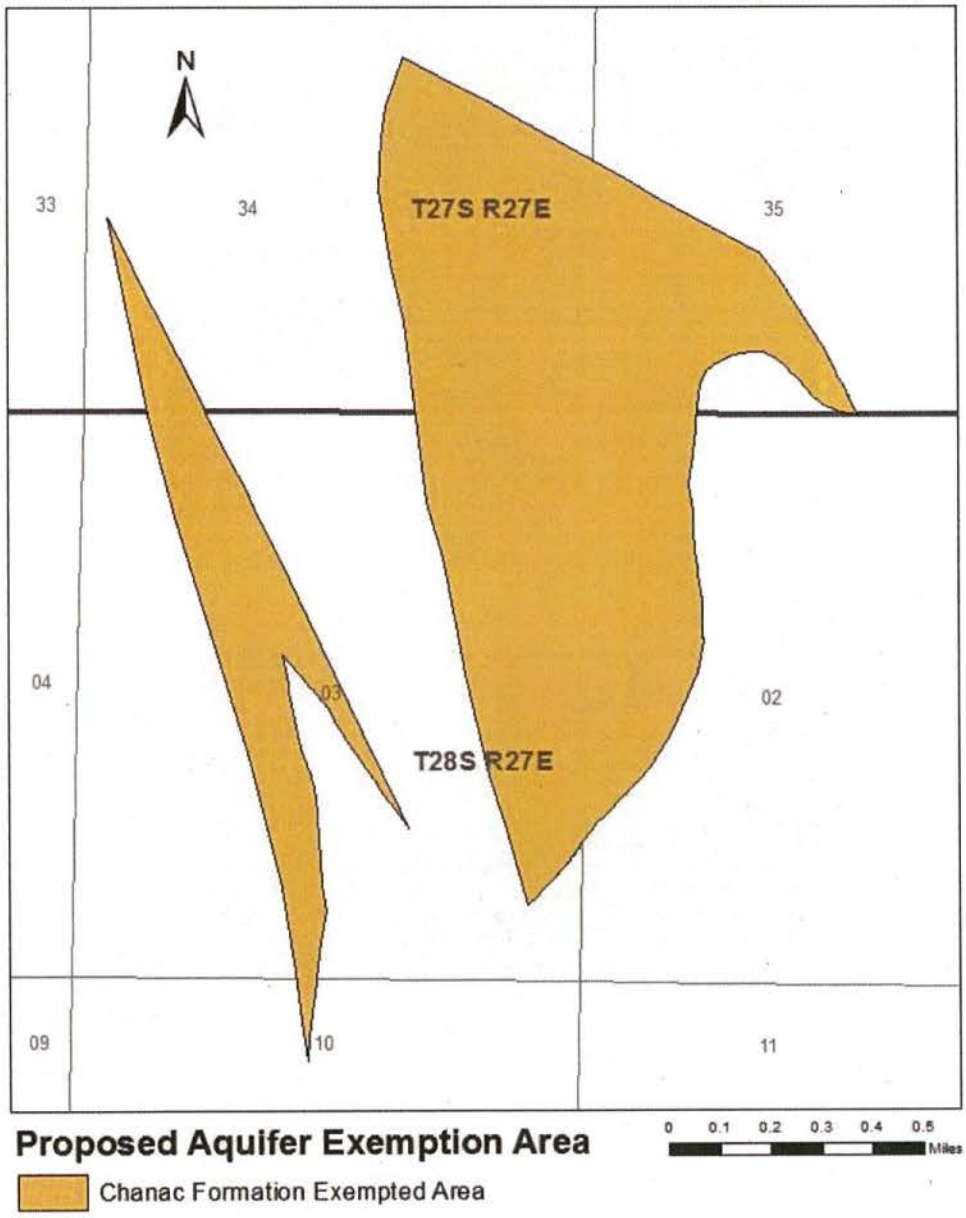
Effective Date: August 30, 2018

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

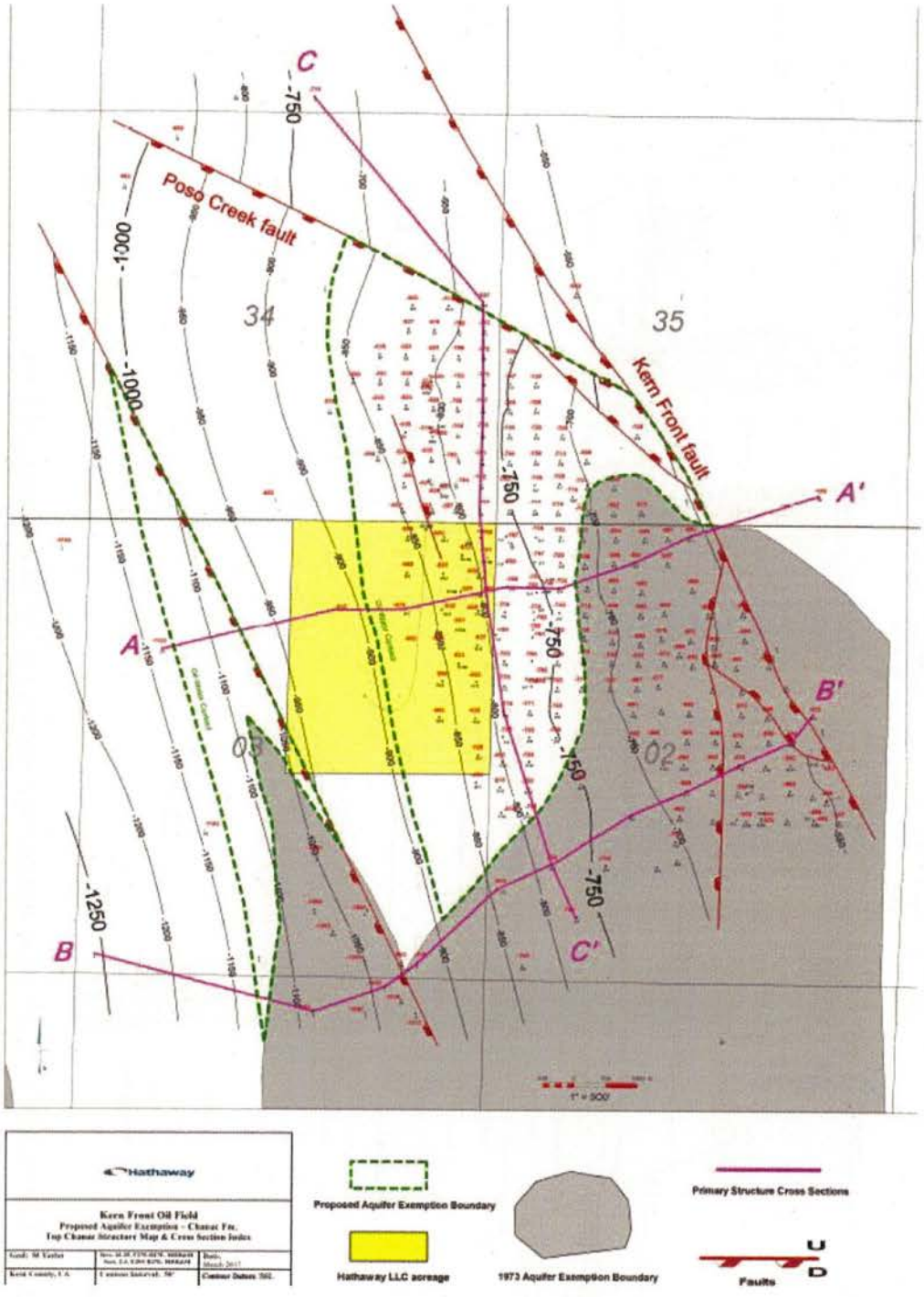
Figure 2: Upper Chanac Formation Aquifer Exemption Location Map, Kern Front Oil Field, Kern County, California



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

Figure 3.1: Cross Section Index Map, Upper Chanac Formation Aquifer Exemption Area

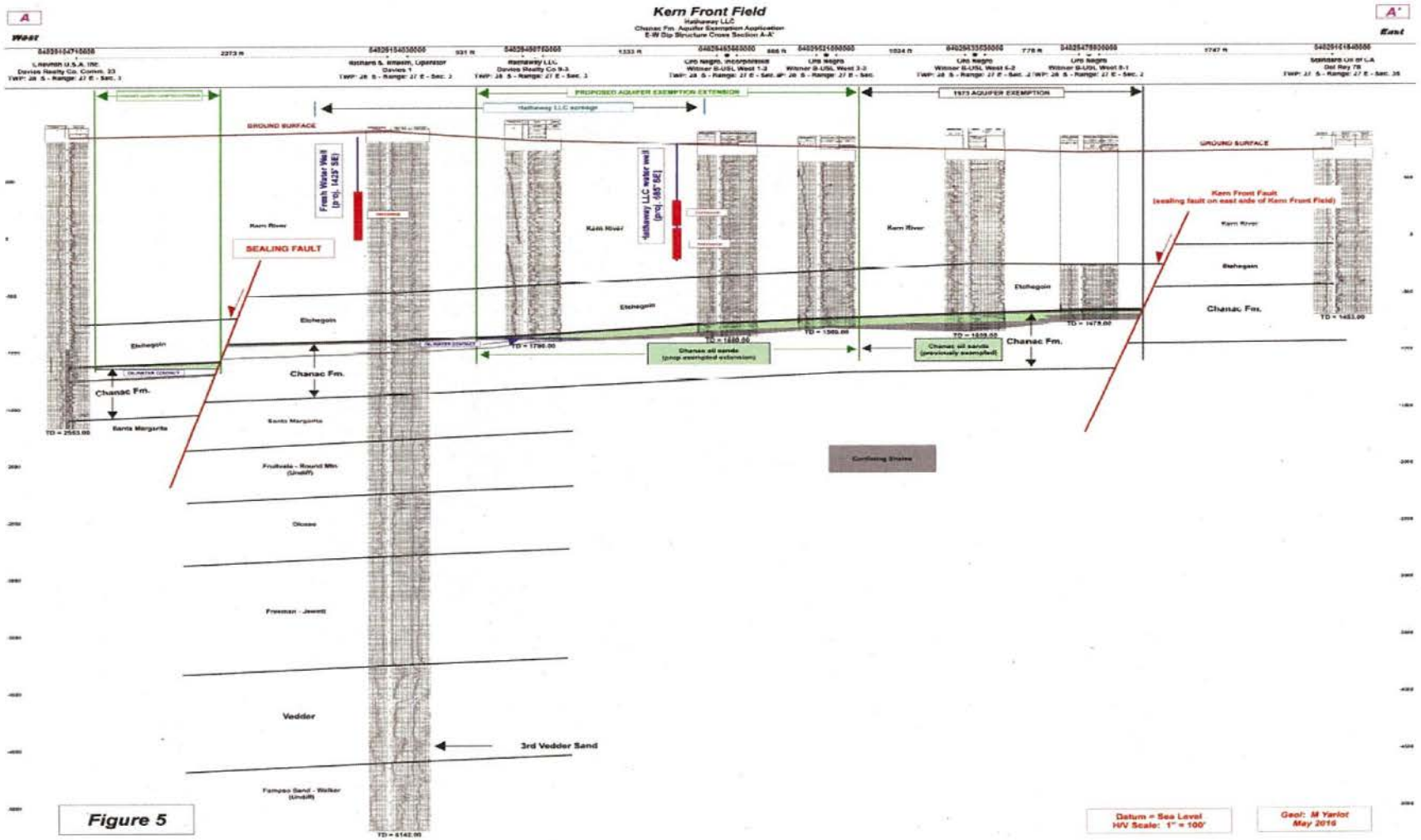
Kern Front Oil Field, Kern County, California



Source: Exhibit 4, DOGGR's Aquifer Exemption Application for the Kern Front Oil Field

Figure 3.2: Cross Section A-A' across the Upper Chanac Formation Aquifer Exemption Area

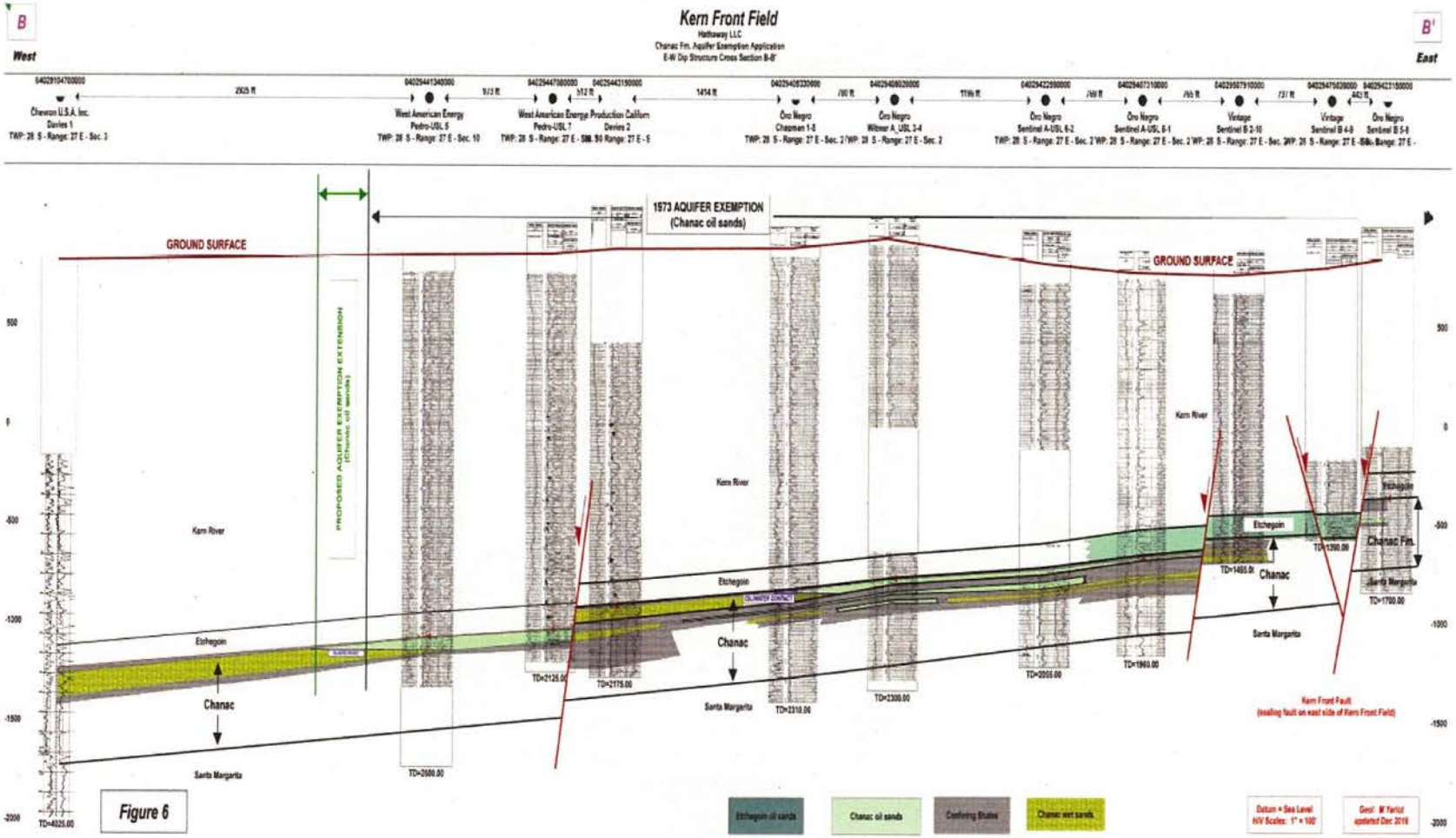
Kern Front Oil Field, Kern County, California



Source: Exhibit 5, DOGGR's Aquifer Exemption Application for the Kern Front Oil Field

Figure 3.3: Cross Section B-B' across the Upper Chanac Formation Aquifer Exemption Area

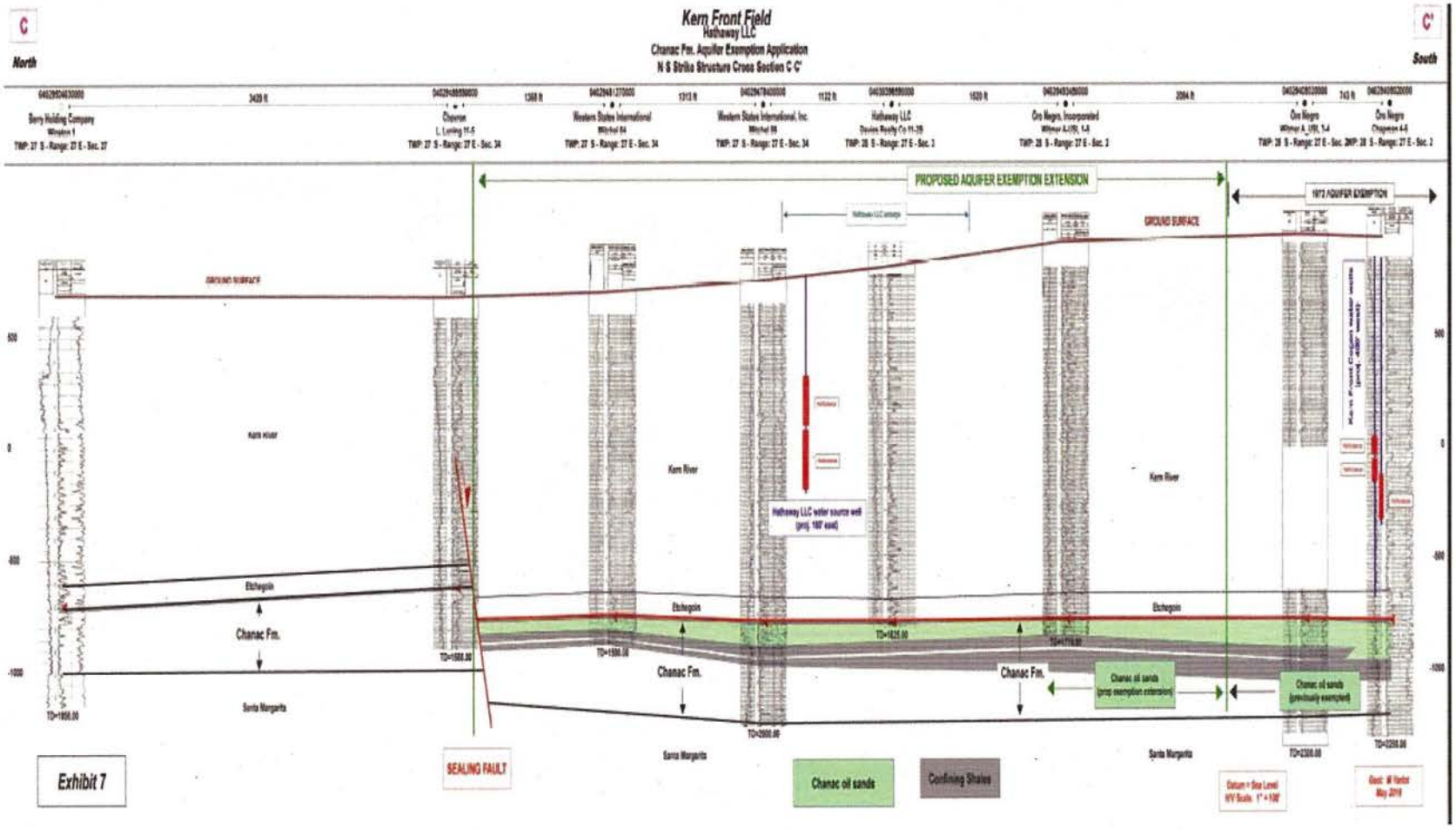
Kern Front Oil Field, Kern County, California



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

Figure 3.4: Cross Section C-C' across the Upper Chanac Formation Aquifer Exemption Area

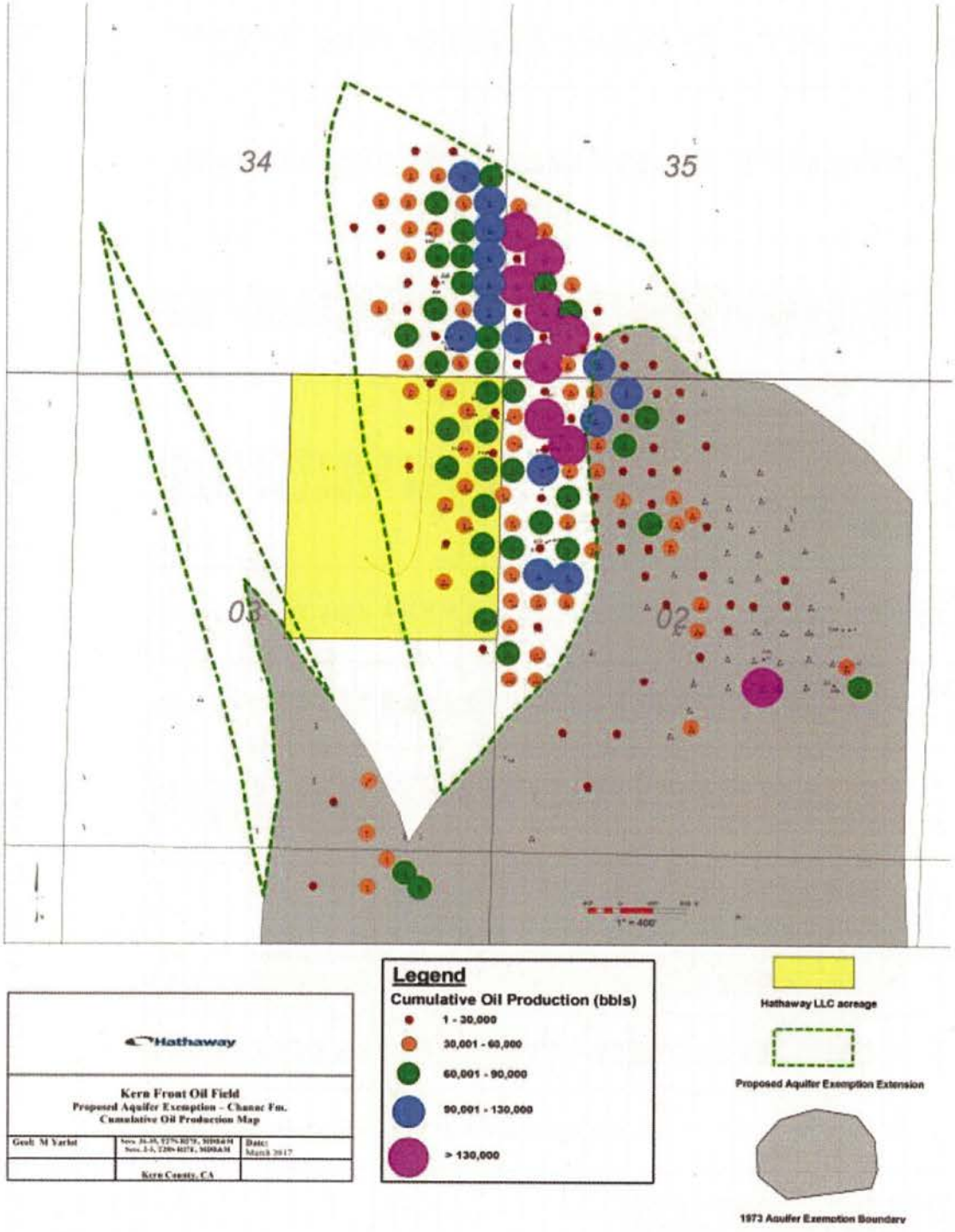
Kern Front Oil Field, Kern County, California



Source: Exhibit 7, DOGGR's Aquifer Exemption Application for the Kern Front Oil Field

Figure 4: Oil Well Production Map, Upper Chanac Formation Aquifer Exemption Area

Kern Front Oil Field, Kern County, California



Source: Exhibit 13, DOGGR's Aquifer Exemption Application for the Kern Front Oil Field

Table 1: List of Water Supply Wells

Reference Number to Map in Application	Well Completion Report Number	Section	Township	Range	Date Constructed	Well Type	Total Depth (ft bgs)	Total Depth (ft below MSL)	Screen Interval(s) (ft bgs)	Top of Chanac Top of Etchegoin (feet below MSL)	Vertical Separation (ft) from: Top of Chanac Top of Etchegoin	Completion Formation	Ground Elev. (ft)
1	278659	34	27S	27E	12/2/1992	Domestic	750	0	600' - 750'	-900.00	900	KR/A	750
2	458518	34	27S	27E	12/8/1993	Domestic	760	10	620' - 640', 660' - 740'	-900.00	890	KR/A	750
3	499693	34	27S	27E	10/3/1999	Domestic	800	50	600' - 800'	-900.00	850	KR/A	750
4	780445	34	27S	27E	8/29/2003	Domestic	710	-40	500' - 700'	-900.00	940	KR/A	750
5	26448	34	27S	27E	3/29/1968	Irrigation	911	161	481' - 911'	-1000.00	839	KR/A	750
6	e0171649	2	28S	27E	3/22/2012	Industrial	1520	770	1030' - 1350'	-550.00	220	KR/A	750
7	723805	2	28S	27E	8/22/2000	Domestic	1200	450	970' - 1170'	-700.00	250	KR/A	750
8	780422	4	28S	27E	10/4/2002	Domestic	820	70	500' - 800'	-1400.00	1330	KR/A	750
9	900035	4	28S	27E	2/12/2004	Domestic	1020	270	512' - 1000'	-1400.00	1130	KR/A	750
10	e033607	4	28S	27E	9/7/2005	Domestic	1020	270	50' - 1000'	-1300.00	1030	KR/A	750
11	275222	11	28S	27E	1/22/1989	Domestic	1228	478	562' - 1206'	-850.00	372	KR/A	750
12	275235	11	28S	27E	10/30/1990	Industrial	1508	758	832.8' - 1502'	-850.00	92	KR/A	750
13	174288	11	28S	27E	9/20/1985	For Oil & Gas	1163	413	520' - 641'	-850.00	437	KR/A	750
14	723803	11	28S	27E	6/30/2000	Domestic	1000	250	390' - 940'	-850.00	600	KR/A	750
108	--	35	27S	27E	--	Domestic	680	80	510-680	-500.00	420	KR/A	600
109	--	35	27S	27E	--	Irrigation	700	50	500-700	-540.00	490	KR/A	650
110	--	34	27S	27E	--	Domestic	1000	310	660-800	-675.00	365	KR/A	690
111	--	34	27S	27E	--	Domestic	760	60	640-740	-675.00	615	KR/A	700
112	--	34	27S	27E	--	Domestic	800	20	600-800	-950.00	930	KR/A	780
113	--	34	27S	27E	--	Domestic	800	-1	500-800	-760.00	761	KR/A	801
114	--	34	27S	27E	--	Domestic	1000	230	800-1000	-1000.00	770	KR/A	770
115	--	34	27S	27E	--	Domestic	850	-15	650-850	-1000.00	1015	KR/A	865
116	--	34	27S	27E	--	Domestic	750	-130	550-700	-975.00	1105	KR/A	880
117	--	34	27S	27E	--	Domestic	950	120	650-900	-975.00	855	KR/A	830
118	--	4	28S	27E	--	Domestic	1000	233	700-800	-1503.00	1270	KR/A	767
119	--	4	28S	27E	--	Domestic	1000	160	800-1000	-1175.00	1015	KR/A	840
120	--	4	28S	27E	--	Domestic	1000	220	500-1000	-1512.00	1292	KR/A	780
121	--	4	28S	27E	--	Domestic	995	157	800-995	-1200.00	1043	KR/A	838
129	--	28	27S	27E	--	Industrial	1420	790	840-1420	-1696.00	906	KR/A	630
133	--	4	28S	27E	--	Domestic	1000	157	500-1000	-1200.00	1043	KR/A	843
134	--	34	27S	27E	--	Domestic	800	6	500-700	-1200.00	1194	KR/A	794
135	--	34	27S	27E	--	Domestic	750	-119	600-750	-875.00	994	KR/A	869
136	--	34	27S	27E	--	Domestic	800	62	600-800	-975.00	913	KR/A	738
137	--	3	28S	27E	--	Industrial	1000	250	470-980	-875.00	625	KR/A	750
138	--	2	28S	27E	--	Industrial	1520	683	800-1000	-825.00	142	KR/A	837
139	--	4	28S	27E	--	Irrigation	--	--	--	-720.00	--	--	811

bgs = Below Ground Surface
MSL = Mean Sea Level
ft = feet
KR/A = Kern River/Alluvium, Undifferentiated
-- = No data available

Source: Enclosure 3, DOGGR's August 22, 2018 Letter regarding the Kern Front Oil Field Aquifer Exemption Application