



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IX

75 Hawthorne Street

San Francisco, CA 94105-3901

MAR 13 2020

Uduak-Joe Ntuk
State Oil and Gas Supervisor
Geologic Energy Management Division
California Department of Conservation
801 K Street, MS 18-05
Sacramento, CA 95814-3530

Re: Approval of Aquifer Exemption for the South Belridge Oil Field, Kern County, California

Dear Mr. Ntuk:

Based on a thorough review of the supporting documents submitted by the California Department of Conservation, Geologic Energy Management Division (CalGEM) and the State Water Resources Control Board (SWRCB), the U.S. Environmental Protection Agency (EPA) hereby approves the aquifer exemption request for portions of the Tulare Formation in the South Belridge Oil Field, in Kern County, California.

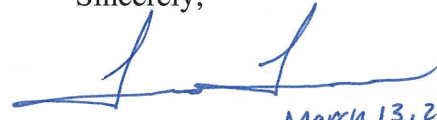
In accordance with applicable regulations at 40 C.F.R. Parts 144, 145, and 146, we find that this aquifer exemption request is a non-substantial program revision, and the requested formation meets the following federal exemption criteria:

- 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.

The approved aquifer exemption boundaries and depths, along with the EPA's analysis and rationale in support of the approval, are detailed in the enclosed Record of Decision. In addition, we are enclosing the application and other documents submitted by the CalGEM and SWRCB to the EPA that were considered in this approval decision. Due to the size of these additional enclosures, we are providing, via email, a link to an electronic folder containing all the remaining documents.

If you have any questions, or if you have any difficulty accessing the electronic folder, please contact David Albright, Manager of our Groundwater Protection Section, at (415) 972-3971.

Sincerely,



March 13, 2020

Tomás Torres
Director, Water Division

Enclosures: Aquifer Exemption Record of Decision for South Belridge Oil Field
GIS Shape Files of Approved Aquifer Exemption
Final South Belridge Exemption Application
Letter from Uduak-Joe Ntuk to David Albright dated February 24, 2020

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
SOUTH BELBRIDGE OIL FIELD – TULARE FORMATION

This Record of Decision (ROD) provides the United States Environmental Protection Agency's (EPA's) decision to approve an aquifer exemption (AE) for portions of the Tulare Formation in the South Belridge Oil Field, background information concerning the AE request, and the basis for the AE decision.

Primacy Agency: California Geologic Energy Management Division (CalGEM, formerly Division of Oil, Gas, & Geothermal Resources, or DOGGR)

Date of Aquifer Exemption Request: May 9, 2019

Exemption Criteria: CalGEM 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 Underground Injection Control (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 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.

Current Operators: Aera Energy LLC; Belridge Energy Resources; E&B Natural Resource Management; Freeport-McMoRan Oil & Gas; LINN Operating, Inc.; Vaquero Energy, Inc.; and West American Energy.

Well/Project Name: The Tulare Formation in the South Belridge Oil Field.

Well/Project Permit Number: There are currently approximately 295 Class II enhanced oil recovery (EOR) wells in the Tulare Formation within the area of the South Belridge Oil Field proposed for exemption. In the future, the State anticipates there will be additional Class II wells permitted to inject within the portions of the aquifer proposed for exemption.

Well/Project Location: The aquifer proposed for exemption underlies Township 28 South, Range 20 East, Sections 11, 12, 13, 14, 24, 25, and 36; Township 28 South, Range 21 East, Sections 27, 28, 30, 31, 32, 34, and 35; and Township 29 South, Range 21 East, Sections 1, 2, 4, 5, 6, 8, 9, 10, 11, and 12, Mount Diablo Base and Meridian (MDB&M). [Refer to Figure 1.]

County: Kern **State:** California

Current Well Class/Type: Class II EOR.

DESCRIPTION OF PROPOSED AQUIFER EXEMPTION

Aquifer to be Exempted: Portions of the Tulare Formation within the South Belridge Oil Field.

Areal Extent of Aquifer Exemption: The areal extent of the existing AE and the proposed expansion in the South Belridge Oil Field is approximately 13,275 acres. This acreage includes 9,988 oil-productive acres that EPA exempted at the time California received primacy in 1983, and approximately 3,287 acres comprising the oil producing area outside the existing exemption boundaries. CalGEM provided GIS shape files that delineate the AE boundaries, which are included in the administrative record for this ROD. See Figure 2 for a depiction of the portions of the formation that are proposed for exemption.

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, average porosity, and permeability information about the aquifer proposed for exemption.

Formation	Tulare Formation.
Lithology	High-permeability sands.
TDS (mg/L)	3,498 mg/L.
Depth to Top	70 to 390 feet below ground surface (bgs), or 530 to 175 feet above mean sea level (msl).
Thickness	400 to 3,000 feet.
Porosity and Permeability	Porosity ranges from 30% to 40%. Permeability ranges from 35 millidarcies (mD) to approximately 4,000 mD.

Confining Zone(s): In the South Belridge Oil Field, vertical confinement of the Tulare Formation is provided by low-permeability formations, including the Corcoran Clay Equivalent above and the Upper Diatomite Zone below. Lateral confinement in the area proposed for exemption is provided by geologic structural controls. In addition, there is an inward pressure gradient (i.e., a “pressure sink” caused by the withdrawal of fluids). See Figures 3.1 through 3.4.

BACKGROUND

On May 9, 2019, the EPA received a request from CalGEM to exempt portions of the Tulare Formation of the South Belridge Oil Field, in Kern County, California. CalGEM reviewed the operator’s request and proposed this AE based on the criteria at 40 CFR §146.4(a) (the portion of the aquifer proposed for exemption does not currently serve as a source of drinking water) and at 40 CFR §146.4(b)(1) (the portion of the aquifer proposed for exemption 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 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 CalGEM would be authorized, subject to state regulatory requirements, to approve additional Class II injection into the identified formation.

As noted above, approximately 295 Class II EOR wells are currently permitted for injection into the portions of the formation proposed for exemption. Upon EPA's approval of the AE, injection through these wells will be into an exempt aquifer.

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.

State Water Resources Control Board (State Water Board) Concurrence:

In their concurrence on this AE request, the State Water Board determined that the portions of the Tulare Formation that are proposed for exemption do not currently serve as a source of drinking water and are not hydraulically connected to any domestic or public water supply wells. The State Water Board's determination was 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 portions of the aquifer proposed for exemption do 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 portions of the Tulare Formation proposed for exemption. 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 portions of the Tulare Formation that are proposed for exemption are not currently a source of drinking water.

Water Supply Wells: CalGEM's AE request included information about the state's efforts to identify wells in the area proposed for exemption to establish that no drinking water wells draw water from the portions of the aquifer proposed for exemption. The applicant searched for wells within a water supply well search area ("study area") that extended 1 mile beyond the boundary of the area proposed for exemption. This area was selected to expand upon the one-quarter mile review area recommended in the EPA's Guidance 34 to ensure performance of a complete review of all water wells.

The water supply well search involved reviewing water well data from the Kern County Environmental Health Department (KCEH). CalGEM and the operators reviewed the KCEH data and CalGEM staff conducted field surveys to verify the information about water supply wells within the study area.

The water well study identified two wells that were located within the study area but outside of the area proposed for exemption (see Table 1). The first was a domestic drinking water well that was screened in the Alluvium and hydraulically isolated from the Tulare Formation by the Corcoran Clay Equivalent. This water well has been filled with gravel and cement (i.e., "destroyed"), so that it cannot be used as a drinking water source. The second well is an idle irrigation well, which will not serve as a source of drinking water.

The nearest municipal water supply wells are the Spicer City Water System's wells, which are approximately 5.2 miles east of the South Belridge Oil Field. The Spicer City Water System has two active wells that are completed in the Tulare Formation, below the Corcoran Clay Equivalent (CCE), at depths of approximately 535 to 650 feet bgs. CalGEM determined that,

based on the geologic conditions (i.e., a structural dome with air sands within the Tulare Formation, creating a low-pressure area in the crest of the field) and a pressure sink created by oil production in the Tulare Formation (described below), the wells are not hydraulically connected to the portions of the Tulare Formation that are proposed for exemption. Therefore, any injected fluids will not affect the Spicer City wells. According to CalGEM, the Spicer City wells are operated by Aera Energy, which has been consulted on, and is involved with, the AE.

Finally, CalGEM contacted the local water districts (Lost Hills and Belridge Water Storage Districts) and met with the nearby Buttonwillow County Water District regarding the South Belridge proposed AE (the Buttonwillow County Water District wells are approximately 9.6 miles southeast of the South Belridge Oil Field). The districts confirmed that neither the districts, nor any individual growers, operate wells within the study area.

Groundwater Flow Patterns: Fluid flow in the portions of the Tulare Formation proposed for exemption is toward the crest of the anticline (as described in the next section), the producing wells (i.e., from high to low pressure), and toward the area exempted at primacy, which is in the center of the oil field. This occurs because, in the South Belridge Oil Field, more fluid is withdrawn from the aquifer than is injected, as shown by injection and production data provided by CalGEM in the AE request. This conclusion is supported by three-dimensional groundwater modeling that was performed by the operators and reviewed by CalGEM and the State Water Board, as well as CalGEM's evaluation of field-wide pressure monitoring data.

Confinement of the Formation to Groundwater Flow: Confinement above the portions of the Tulare Formation that are proposed for exemption is provided by a regional clay aquitard layer, locally referred to as the CCE. The CCE, which ranges in thickness from 15 to 45 feet, is shown on cross sections provided in the AE request and is extensive throughout the area proposed for exemption. Core samples demonstrate that the CCE has a permeability of 0.196 mD. The presence of this low-permeability clay is also represented on well logs provided by CalGEM. Multiple clay layers within the Upper Tulare Formation, which are 2 to 15 feet thick and have permeabilities that range from 0.006 to 0.272 mD, provide additional upward confinement.

Below the Tulare Formation, confinement is provided by the Upper Diatomite Zone, with additional confinement by the San Joaquin and Etchegoin Formations. The Upper Diatomite Zone, which ranges from approximately 2,000 to 4,400 feet thick in the area of the formation that is proposed for exemption, has a permeability of less than 1 mD, as documented in numerous core samples collected throughout the field. Cross sections provided by CalGEM in the AE request show the Upper Diatomite Zone is present throughout the area proposed for exemption.

A combination of structural controls (described below) and an inward pressure gradient (i.e., a "pressure sink" caused by the withdrawal of fluids) provide lateral confinement. See Figures 3.1 through 3.4.

Geologically, the South Belridge Oil Field is on the eastern side of a series of folded rock layers that form a dome (known as an anticline) that has trapped the oil within the field over geologic time. Within the steeply dipping structure of the dome, an inward pressure gradient created by the withdrawal of fluids from the Tulare Formation provides confinement. Fluid balance data provided by CalGEM in the AE package indicates that more fluid has been withdrawn from the

formation than has been injected. Between 1977 and 2018, a total of 9,364,507,098 bbls of oil and water have been produced from the Tulare Formation in the South Belridge Oil Field and 5,744,184,486 bbls of water and steam have been injected, for a net withdrawal of 3,620,322,612 bbls of fluid. This withdrawal causes the fluids within the proposed AE area to move toward the producing wells and away from the boundary of the area proposed for exemption. Measured and calculated pressures in wells within the oil field and the results of modeling performed by the operator provide additional evidence of the pressure sink.

After reviewing information regarding the location of existing drinking water supply wells, groundwater flow within the Tulare Formation, and the lateral and vertical confinement of the formation as described above, the EPA concludes that the portions of the Tulare Formation that are proposed for exemption are not currently a source of drinking water and are not hydraulically connected to any domestic or public drinking water supply wells. Therefore, the EPA has determined that the portions of the aquifer proposed for exemption meet 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.*

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

The South Belridge Oil Field is the fourth largest oil field in California. Oil production in the South Belridge Oil Field began in 1911 from the Tulare Formation and Diatomite zones. EOR operations in the Tulare Formation using steam injection (i.e. steaming) began in the 1960s. This practice has continued as the primary means of oil production from the Tulare Formation within the South Belridge Oil Field. It is estimated that 1,090,742,469 bbls of oil have been produced from the Tulare Formation in the South Belridge Oil Field, including 925,242,469 bbl from 1977 through 2018, for which detailed data are available, as well as an estimated additional 165,500,000 bbls of oil before 1977. The South Belridge Oil Field has also produced 25,717,355 million cubic feet of gas between 1977 and 2018. Figure 4 shows the location of the 211 wells that currently produce from the Tulare Formation in the area of the South Belridge Oil Field that is proposed for exemption.

The Tulare Formation is the shallowest oil-producing zone in the South Belridge Oil Field. The presence of hydrocarbons in the Tulare Formation is demonstrated through evaluation of historic production data, well logs, and the physical properties (including the presence of oil) in samples that were collected when wells in the area of the oil field that is proposed for exemption were drilled. Oil saturations within the Tulare Formation in the vicinity of the South Belridge Oil Field range from 31% to 48%.

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

PUBLIC NOTICE AND COMMENT

CalGEM provided public notice of this proposed AE on November 19, 2018 and held a public hearing on December 19, 2018 in Bakersfield, CA. The public comment period closed on December 19, 2018. CalGEM provided the EPA a summary of the single written public comment it received, a copy of the written public comment, a transcript of the public hearing (at which no comments were made), and CalGEM's written response to the written comment.

In making this decision, the EPA considered all the information submitted by the State, including the written comment submitted to the State during its public comment process. Specific responses not addressed by CalGEM are provided below.

One commenter (The Center for Biological Diversity) wrote to CalGEM and commented that the EPA should reject the 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 CalGEM, 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 environmental review for this decision.

The same commenter also raised concerns regarding protection of listed species and critical habitat under the federal Endangered Species Act (ESA). After consideration of this issue, the EPA has determined that ESA consultation is not required because the AE approval has no effect on any listed threatened or endangered species or the designated critical habitat of such species. The EPA's conclusion is based on a number of considerations. First, the AE approval under the SDWA changes the jurisdictional status of a confined, underground aquifer. No species of concern are known to be present in the subsurface portions of the aquifer considered in the EPA's approval action. Further, the EPA's approval of the AE is only one preliminary step in the process leading to potential fluid injection into the aquifer, with many additional steps (including State decisions and actions by third party operators) that must occur prior to injection and prior to any potential effects to protected species or critical habitat that may occur at the surface. Thus, EPA approval of the aquifer exemption would not be the cause of potential effects to listed species or designated critical habitat, if any.

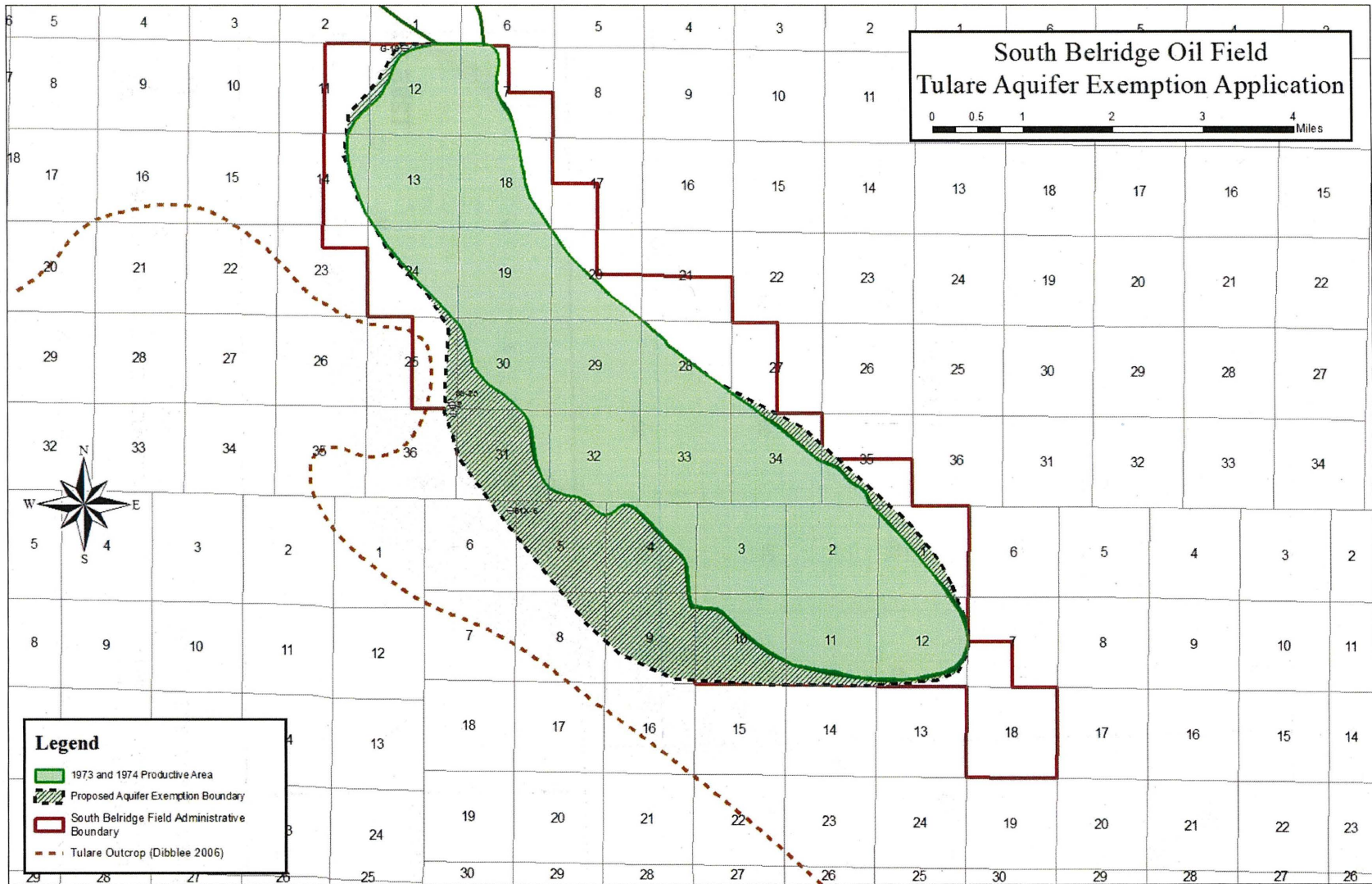
Additionally, the commenter questioned whether the current AE criteria reflect changing climate conditions and modern water treatment technologies. In considering whether the portions of the aquifer proposed for exemption cannot now and will not in the future serve as a source of drinking water because it is hydrocarbon producing, the EPA reviewed data about hydrocarbon production in the portions of the Tulare Formation that are proposed for exemption. Based on a review of historic production data, well logs, and core data, the EPA concludes that the formation will continue to be commercially producible into the foreseeable future and meets the existing requirements at 40 CFR § 146.4(b)(1).

CONCLUSION AND DECISION

Based on a review of the entire record, including all written comments submitted to CalGEM 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.

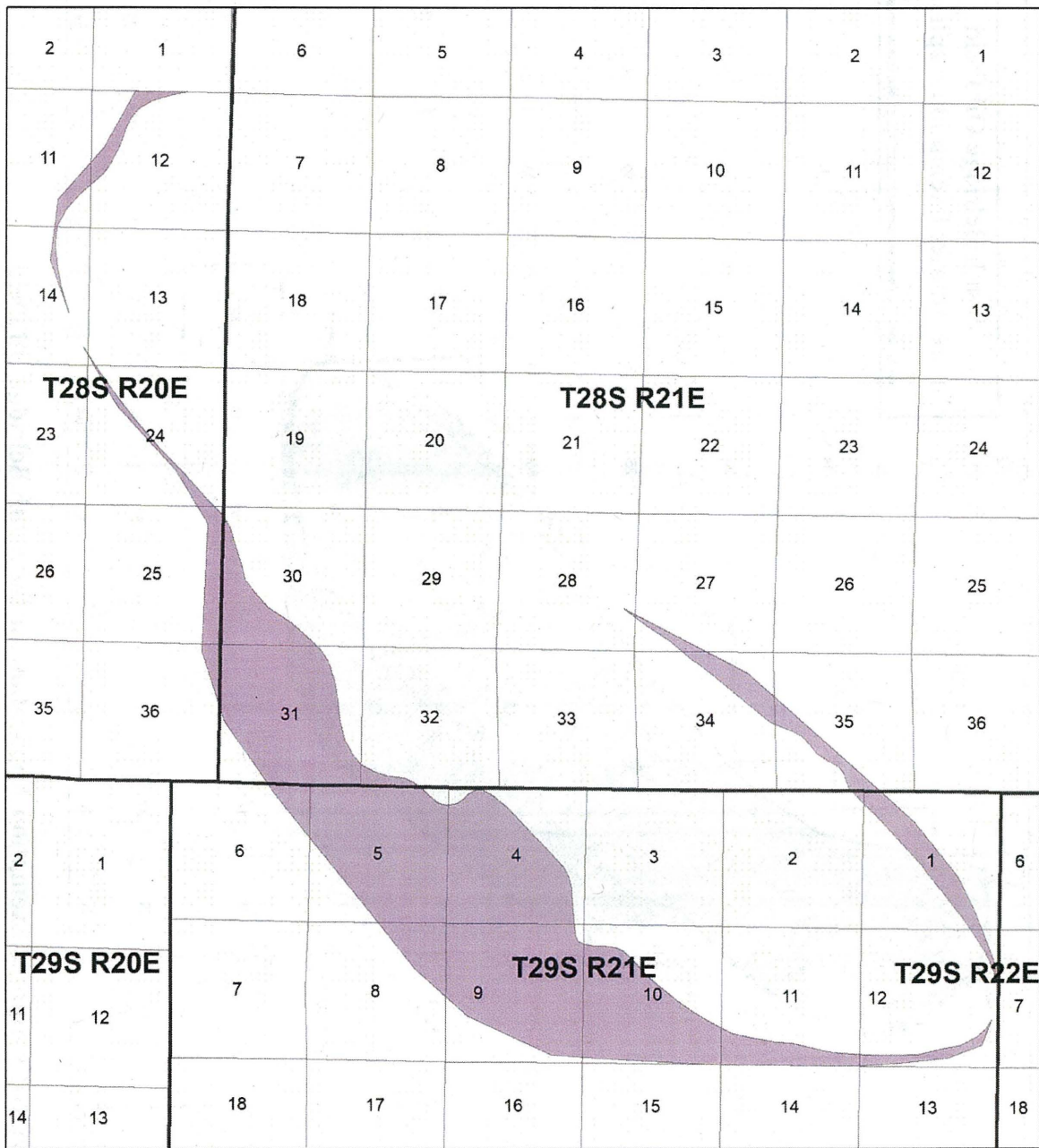
Effective Date: March 13, 2020

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




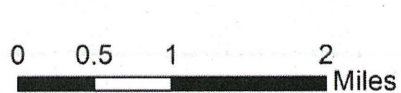
Source: Figure 14a, DOGGR's Aquifer Exemption Application for the South Belridge Oil Field

Figure 2: Tulare Formation Aquifer Exemption Location Map, South Belridge Oil Field, Kern County, California



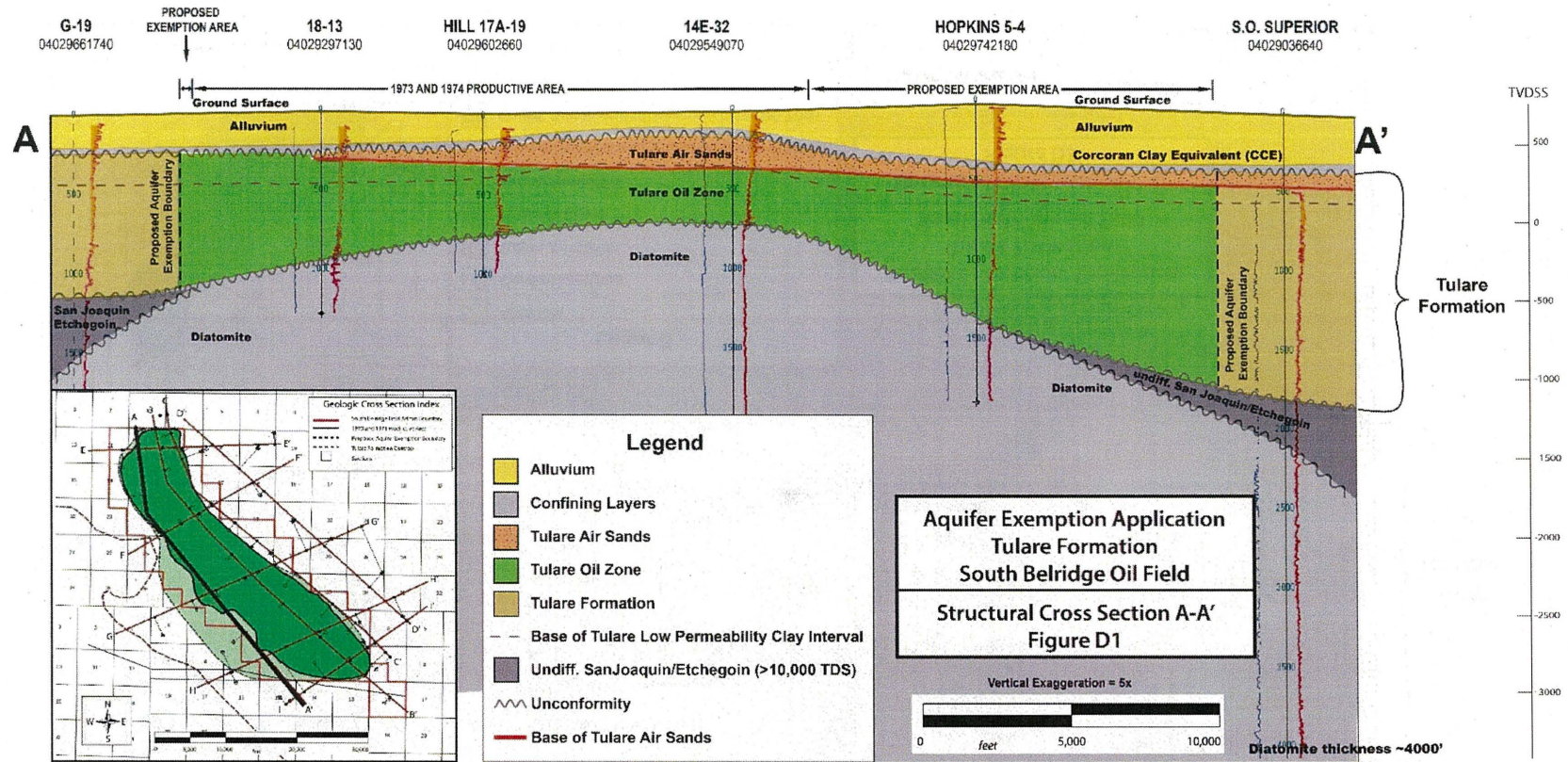
Proposed Exemption Area

 Tulare Formation - South Belridge Field
 Proposed Exemption Area



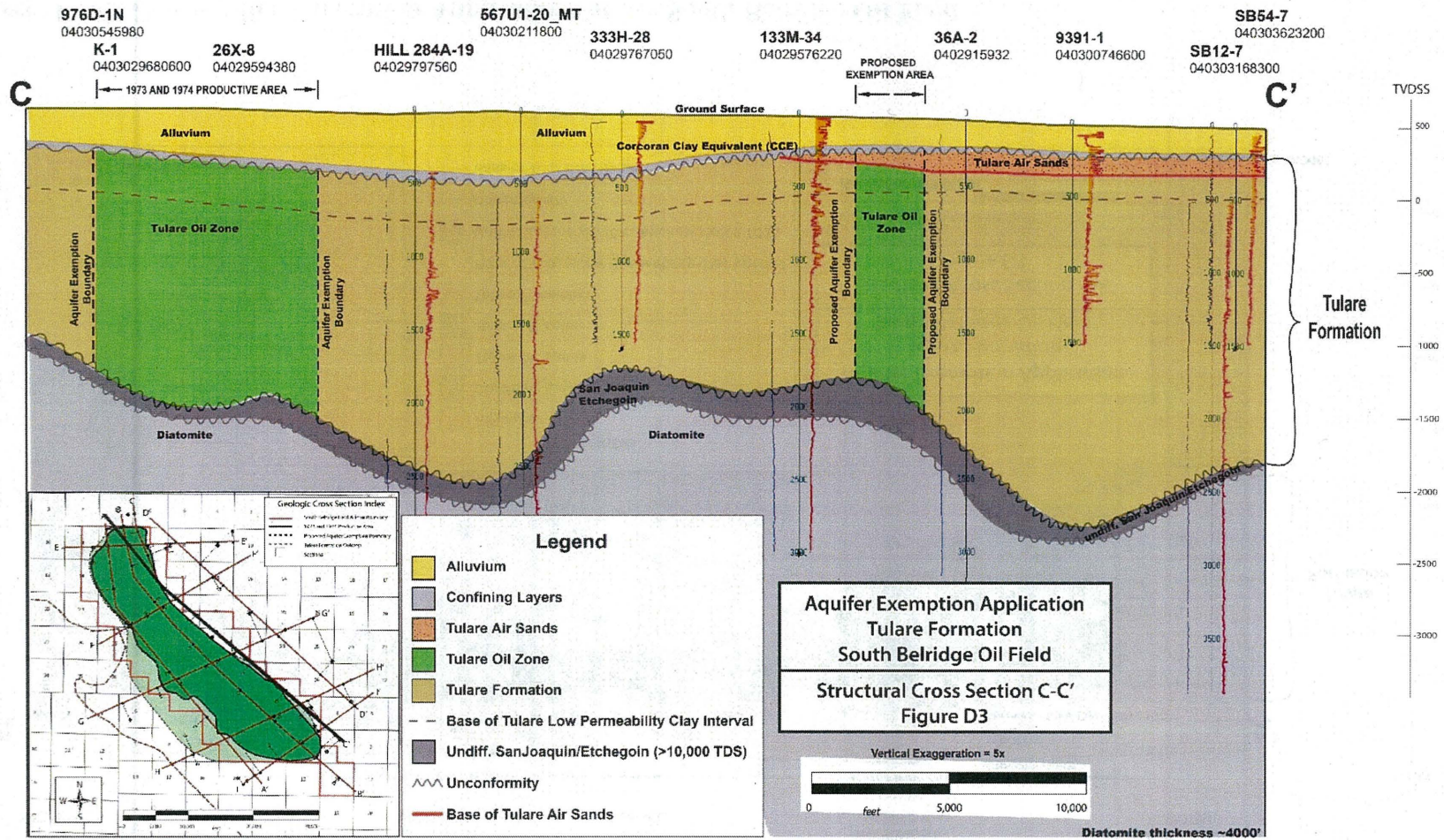
Source: DOGGR's Aquifer Exemption Application for the South Belridge Oil Field

Figure 3.1: Cross Section A-A' across the Tulare Formation Aquifer Exemption Area
 South Belridge Oil Field, Kern County, California



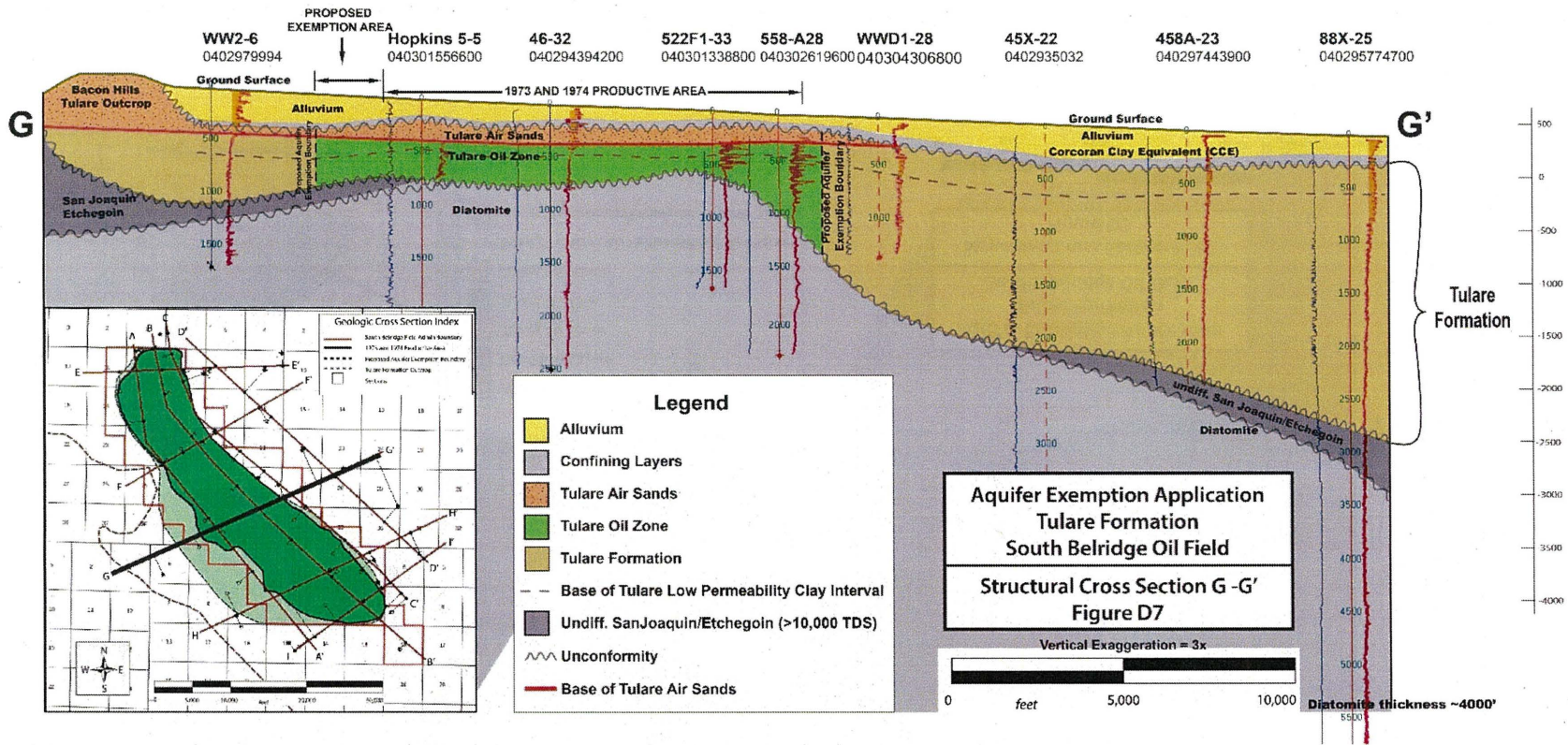
Source: DOGGR's Aquifer Exemption Application for the South Belridge Oil Field

Figure 3.2: Cross Section C-C' across the Tulare Formation Aquifer Exemption Area
 South Belridge Oil Field, Kern County, California



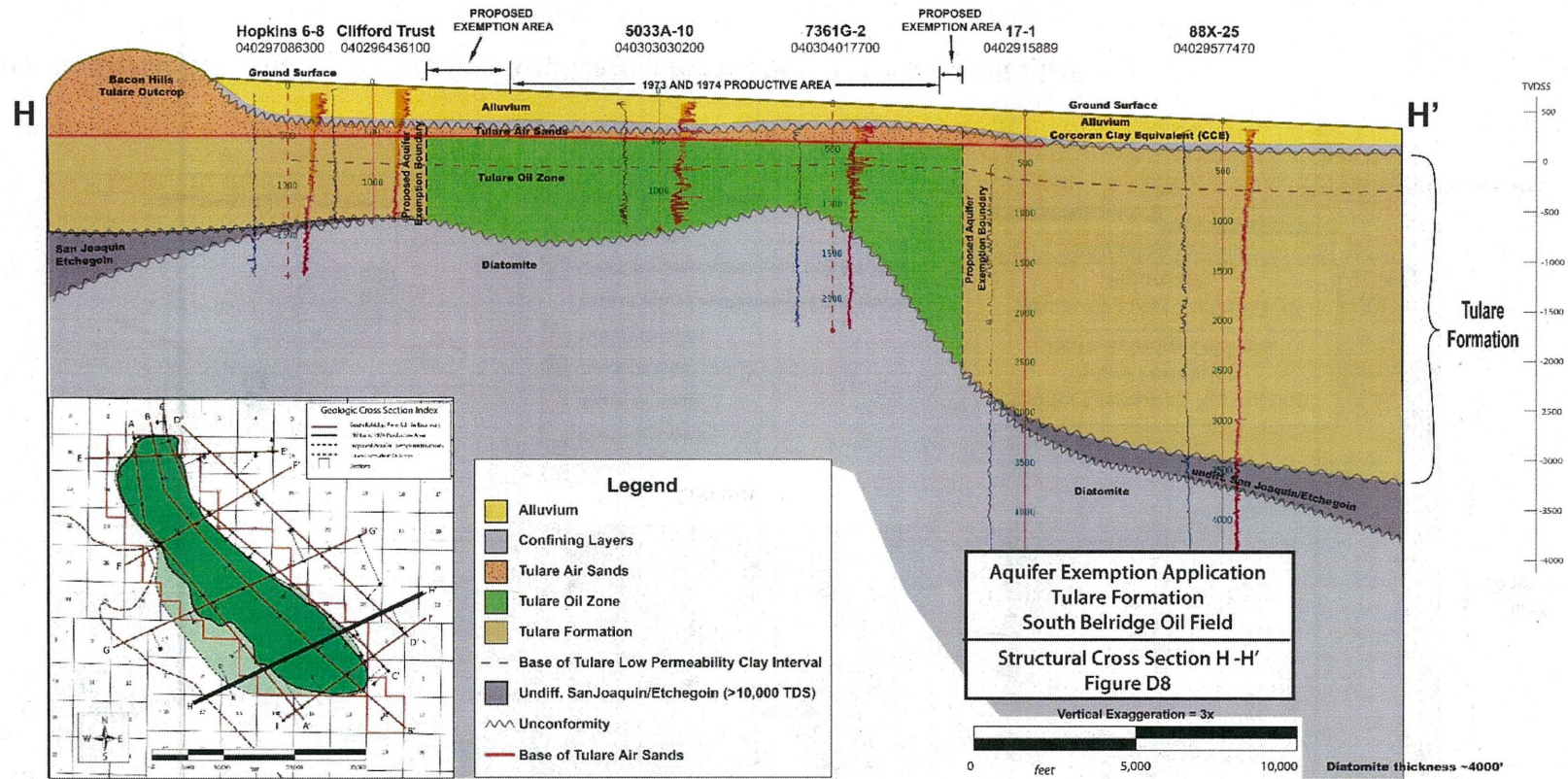
Source: DOGGR's Aquifer Exemption Application for the South Belridge Oil Field

Figure 3.3: Cross Section G-G' across the Tulare Formation Aquifer Exemption Area
 South Belridge Oil Field, Kern County, California



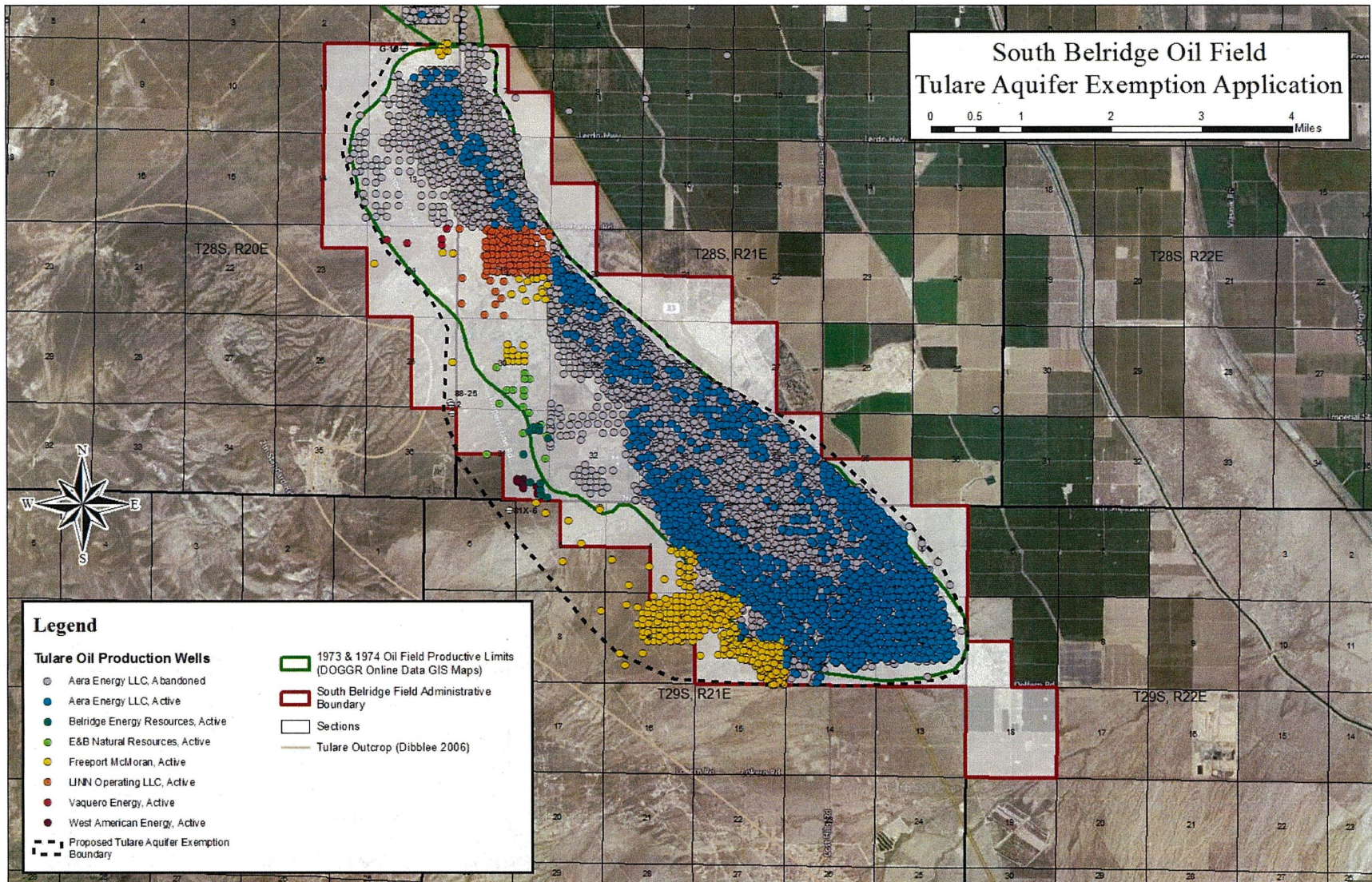
Source: DOGGR's Aquifer Exemption Application for the South Belridge Oil Field

Figure 3.4: Cross Section H-H' across the Tulare Formation Aquifer Exemption Area
 South Belridge Oil Field, Kern County, California



Source: DOGGR's Aquifer Exemption Application for the South Belridge Oil Field

Figure 4: Tulare Formation Producing Wells, South Belridge Oil Field, Kern County, California



Source: Figure 5a, DOGGR's Aquifer Exemption Application for the South Belridge Oil Field

Table 1: List of Water Supply Wells

Well ID		Well Type	Distance from Aquifer Exemption Boundary (ft)	TD	Perf Depth (ft)		SECT	TSHP	RNG	Latitude (NAD 83)	Longitude (NAD83)	Well Address / Information	Probable Completed Formation	Source
#	Identifier				Top	Base								
1	29S/21E-17	Domestic - Destroyed	3,300	496	356		17	29S	21E	35.409250	-119.73491	Norris Road	Alluvium	KCEH Records
2	WW-3	Irrigation - Idle	4,750	580	245	542	18	29S	22E	35.405213	-119.65	Starrh Ave	Tulare and Alluvium	KCEH Records

Source: DOGGR's Aquifer Exemption Application for the South Belridge Oil Field