



March 8, 2019

Mr. David Albright, Manager
 United States Environmental Protection Agency – Region IX
 75 Hawthorne Street
 San Francisco, CA 93105-3901

Dear Mr. Albright:

ARROYO GRANDE AQUIFER EXEMPTION PROPOSAL

Between June 2018 and January 2019, the United States Environmental Protection Agency (US EPA) submitted questions, via Email and in telephone conversations, to the Division of Oil, Gas and Geothermal Resources (DOGGR) regarding the updated Arroyo Grande Aquifer Exemption (AGAE) proposal package. Please find below the submitted questions, in bold, along with a DOGGR response to each.

June 29, 2018

General Project and Aquifer Information

1. **Areal Extent of the Aquifer Proposed for Exemption**
 - a. **Is information available to complete the following table (which EPA will need for the final decision document)?**

AE Boundary Vertex Point Number	Township	Range	Section	Latitude	Longitude	Top Dollie sands, Subsea Depth (feet)

DOGGR's Response:

The table of data points requested is in Attachment 1a.

- b. **Please provide an AE location map with identifying features (e.g., T/R/S, field administrative boundary, and expansion boundary with bounding vertices) for the Dollie sands.**

DOGGR's Response:

The map can be found in Attachment 1b.

- c. Please provide polygons (in shapefiles) of: (1) the existing exempt areas in the field; and (2) the proposed areas in the field so that we can calculate the acreage of the existing and proposed exempt areas.**

DOGGR's Response:

The shapefiles for the existing exempt areas in the field and the proposed area are contained within Attachment 1c1 "Existing AG AE Boundary" and Attachment 1c2 "Proposed AG AE Boundary" and can be seen in the map in Attachment 1c3.

2. General Project Information

- a. Based on Appendix E-1 of the 2015 application, it is shown that there are approximately 207 active or new Class II enhanced oil recovery wells and 16 active or new water disposal wells in the Arroyo Grande oil field. There should be no operating injection wells in the area proposed for exemption. Please confirm.**

DOGGR's Response:

Since February of 2015, DOGGR has not permitted any new injection wells into the area proposed for exemption for the Arroyo Grande oil field. All wells currently injecting outside of the currently approved aquifer exemption boundary are doing so on the basis of injection approvals issued prior to February 2015. Consistent with the policy articulated in the joint letter from DOGGR and the California State Water Resources Control Board to US EPA Region IX, dated January 17, 2017, and in the reply letter from US EPA Region IX, dated January 25, 2017, DOGGR and the California State Water Resources Control Board have allowed previously-approved injection into these wells to continue while the aquifer exemption proposal proceeds towards anticipated approval. Subsequent interagency correspondence has continued to keep US EPA Region IX apprised of these and other details regarding injection activity in areas that are the subject of an aquifer exemption proposal currently under review.

3. Depth and Thickness of the Aquifer Proposed for Exemption

- a. Please provide the depth to the top of the Dollie sands member in feet MSL, including a range and average depth.**

DOGGR's Response:

The depth to the top of the Dollie sands for the Boundary Vertex Points are listed in the table found in Attachment 1a. Depth of the top of the Dollie sands ranges from +365 ft to -173 ft mean seal level (MSL) with an average depth of +53 ft MSL.

40 CFR 146.4(a) Criteria Support

4. Permeability and Porosity

- a. Based on information in Appendix B-3 of the 2015 application, it appears that the porosity of the Dollie sands ranges from 11 to 57%. Please confirm that this range is accurate.**

DOGGR's Response:

Appendix B-3 of the 2015 application has been included as Attachment 4a. An additional column for Zone has been added to represent the zone location of each core. The table represents core data from the Arroyo Grande oil field. The data for Zone 1 is from the Dollie sands in their respective wells. The porosity of the Dollie sands ranges from 11 to 47%. Higher porosity values (up to 57%) are associated with diatomaceous silts that have very low permeabilities in the Miguelito (Zone 2). High porosity values reported in the Monterey (Zone 3) are also associated with very low permeabilities.

- b. The 2015 application states on page 7 that the permeability of the Dollie sands ranges from 300 millidarcies (mD) to 2 Darcies. However, the permeability values in Appendix B-3 of the 2015 application range from 4 to 8521 mD. Please clarify. Is all of the data in Appendix B-3 from the Dollie sands?**

DOGGR's Response:

Appendix B-3 of the 2015 application has been included in this response as Attachment 4a. An additional column for Zone has been added to represent the zone location of each core. The table represents core data from the Arroyo Grande oil field. Not all of the data is from the Dollie sands. The data for Zone 1 is core from the Dollie sands in their respective wells. Core data labeled as Zone 2 is for the Miguelito and Zone 3 is for the Monterey formation that underlies the Miguelito. The permeability range is from 1 to 8,521 mD for the Dollie sands. The Dollie sands do contain zones of very low and high permeabilities, the common producing permeabilities are in the 300 mD to 2 Darcies range.

5. Vertical Confinement

- a. What is the permeability of the tar sands that provide confinement above the Dollie sands? Please provide information on the source of this data, e.g., from sidewall cores, logs, etc.**

DOGGR's Response:

The impermeable tar sands that overlie the producing Dollie sands provide the confinement of the producing reservoir at the Arroyo Grande oil field (formerly Edna oil field). These tar sands were formed when the shallow oil lost their volatile constituents by evaporation creating an asphaltic residue or tar sand.

The oil that impregnates the sandstone in the Pismo formation probably originated in the shale and siltstone of both the Monterey and Pismo formations. As it migrated upward it followed the sandy members in which few cementation barriers occurred, taking advantage also of any open fractures, and concentrating in the coarser and more pervious material. As it reached shallower levels, the oil nearest the surface gradually lost its volatile constituents by evaporation, and an asphaltic residue accumulated, which in turn prevented the further escape of oil. The fact that the oil in the sandstones is fluid at depths of several hundred feet below the surface is borne out by the records of wells in the Edna field. Most of these wells produce oil of 14° Baumé gravity from depths of 500 to 1,500 feet beneath the surface.

(USGS 1944).

The long-chain hydrocarbons of bitumen/asphalt remaining near surface are the impermeable barrier that traps the lower viscosity oil currently being produced at the Arroyo Grande oil field.

friable, with streaks of gray siltstone. Accumulation of oil in the zone is due to gradational updip tar seals and a facies change from sand to siltstone.

(Lawrence, 1958).

Open hole logging and sidewall cores were not done at the shallow depths where the surface tar resides, but the Sentry Well Groundwater Monitoring Installation and Initial Sampling (Appendix I 2 of the 2015 application) notes viscous oil (asphalt) in the site lithology confirming tar sands are present above the producing Dollie sands.

References:

1944 USGS, "Geology of the Bituminous Sandstone Deposits Near Edna, San Luis Obispo County, California."

Lawrence, E. D., 1958, Arroyo Grande (Edna) Oil Field, Summary of Operations California Oil Fields, v. 44, no. 1, p. 41-46

Entrix 2006 Sentry Well Groundwater Monitoring Installation and Initial Sampling.

b. What is the source of the 1.7 mD permeability measurement cited in the 2015 application (page 7) for the Miguelito Member?

DOGGR's Response:

The 1.7 mD cited in the 2015 application is from the Miguelito member from well Guidetti A-1 (API 04079205440000). Core data is located in the 2015 application under Appendix B-3 and can also be found in Attachment 4a of this document.

6. Lateral Confinement

a. Please provide a copy of the following documents for inclusion in the Administrative Record:

- The complete 1944 USGS study "Geology of the bituminous sandstone deposits near Edna, San Luis County, California."
- California's 1999 Drinking Water Source Assessment and Protection Program Guidance.

DOGGR's Response:

The documents are included in Attachment 6a1 and 6a2 respectively.

7. Information on Drinking Water Wells

- a. Please provide a table summarizing the 13 wells located within the quarter-mile study area for inclusion in EPA's final decision document. The table should include: owner information (if not confidential), location, purpose, depth, name of aquifer, well completion, age, and data source**

DOGGR's Response:

The table for the 10 wells located within the quarter-mile study area and supporting documentation has been included in Attachment 7a.

- b. Where is the nearest public drinking water system well to the boundary of the proposed exempt area?**

DOGGR's Response:

The nearest public water system is 0.89 miles NW of the nearest point of the proposed aquifer exemption boundary, north of the Arroyo Grande fault. A map and information pertaining to the mutual water system belonging to well "Maxwellton Mutual" has been included in Attachment 7b.

- c. Are the four wells to the southeast of the AE, located on the north flank of the Oak Park Structural Basin domestic drinking water wells?**

DOGGR's Response:

It appears that all 4 wells located southeast of the AE, located on the north flank of the Oak Park Structural Basin, are domestic wells. Well logs for wells 51, 52, and 54 all indicate they were drilled for potable purposes. The well logs can be found in Attachment 7c. In communications with the property owner and property renter for well 50, both indicated that the well is used for domestic purposes.

40 CFR 146.4(b)(1) Criteria Support

8. Production Data

- a. Based on Appendix L of the 2017 supplement, 3,026,838 barrels of oil and 5,732,660 million cubic feet of gas have been produced from the Arroyo Grande oil field between 2010 and 2016. Does all of this represent production specifically from the Dollie sands?**

DOGGR's Response:

Yes. The Dollie sands are currently the only productive reservoir in the Arroyo Grande oil field.

- b. Based on information in Appendix B-3 of the 2015 application, it appears that oil saturations range from zero to over 80%. Can DOGGR confirm that these values are from the Dollie Sand, and are representative of the area proposed for exemption?**

DOGGR's Response:

An additional column has been added to the Appendix B-3 table from the 2015 application to represent the zone for each core and can be found in Attachment 4a of this document. The oil saturations from the Dollie sands do range from zero to 87%. The average oil saturation from the core data is 34%.

- c. Please provide a clearer or more higher resolution version of the bubble map included in Appendix A-10, from the 2015 version of the AE application.**

DOGGR's Response:

A clearer bubble map has been included showing the administrative boundary and the proposed aquifer exemption boundary in Attachment 8c.

October 18, 2018

- 1. Please provide polygon files. The polygons for the area proposed should be exclusive of the area that was previously exempted (i.e., with "donut holes" representing the areas exempted at primacy).**

DOGGR's Response:

The shapefiles for the proposed area have been updated and are within Attachment 1c2 "Proposed AG AE Boundary" and can be seen in the map in Attachment 1c3.

Depth and thickness

Depths mean sea level (MSL) were provided in the vertex table. These depths only represent the perimeter of the area proposed for exemption, and do not capture any deeper or shallower points on the interior of the AE.

- 2. Please provide ranges of depths MSL accounting for all points on the interior of the AE.**

DOGGR's Response:

The range in depths from MSL throughout the area proposed for exemption is from +365 ft to -173 ft MSL.

- 3. Please provide ranges of depths below ground surface – these should account for all points of the areas proposed for exemption, including the interior.**

DOGGR's Response:

The Dollie sands of the Pismo formation outcrops at the surface in places throughout the area proposed for exemption. As stated in the original aquifer exemption proposal, the State is asking for exemption starting at 250 feet below ground surface (bgs) to the bottom of the Dollie sands. The average depth to the top of the Dollie sands is 250 bgs.

Vertical confinement

The permeabilities of the Miguelito Member provided in attachment 4a range from 1 to 105 md, with an average of 28.7 md.

- 4. Would this be a more accurate characterization to include in EPA's ROD than a single data point of 1.7 md?**

DOGGR's Response:

Yes, the range of 1 to 105 mD, with an average of 28.7 mD is a more accurate characterization of the Miguelito member.

Water Wells

Per question 7a (from June 29, 2018), to provide a consistent accounting of the 13 wells within a ¼ mile radius, EPA compared Attachment 7a to the December 2017 application supplement. *(Please note, as of December 21, 2018, the total number of wells within a ¼ mile radius was corrected to 10; and a revised table was provided to EPA [and is attached])*

- 5. A few discrepancies are noted. Please clarify:**
 - a. The application supplement states that well #40 is not a well, but Attachment 7a shows it as abandoned.**

DOGGR's Response:

Attachment 7a should have indicated the well does not exist, as indicated by the property owner in Appendix O of the application supplement. This well has been removed from the table.

- b. The application supplement states that wells #46 and #47 are storage tanks, but Attachment 7a states that well 46 is an abandoned well and well 47 is a domestic well.**

DOGGR's Response:

The structures originally identified as well #46 and #47 were indeed water tanks. Discussions with the property owner did indicate other locations on the same property where there were two wells, indicated in Appendix N of the application supplement as wells #44 and #45, but listed in Attachment 7a as #46 and #47. Both of these wells are outside the ¼ mile boundary, so they should be excluded entirely from the water capture analysis and have been removed from the Attachment 7a well table.

- c. Based on the map in Figure 9 of the application supplement, wells #84 and #86 are domestic water wells, but attachment 7a indicates they are irrigation wells.**

DOGGR's Response:

It was initially not determined whether these wells were for domestic purposes or irrigation, so the water capture analysis was performed as if they were domestic wells. Subsequent investigations that included obtaining Well Completion Reports for these two wells confirmed that they are in fact domestic wells.

- 6. Can DOGGR note on the table that the purpose of well #48 was an agricultural well, as noted in the application supplement?**

DOGGR's Response:

Attachment 7a has been updated with the correct purpose for well #48.

- 7. Please provide a version of the water well table without the "owner name" column.**

DOGGR's Response:

Attachment 7a has been updated to remove the "Owner Name" from the table.

- 8. Is the well at 1564 Vista Grande Ln, Arroyo Grande, CA included in the water well survey? If so, which well in Appendix G of the application is this well, and is there a map in the application that would show the location of the well relative to the AE boundaries?**

DOGGR's Response:

This well was not included in the water well survey as it is outside the ¼ mile radius, and outside the 1-mile radius initially reviewed, being approximately 1.45 miles from the closest point of the proposed aquifer exemption boundary. A map showing the location of the well relative to the proposed aquifer exemption boundary is included in Attachment 8o.

November 29, 2018

- DOGGR provided line files (rather than polygons) for the previously and proposed exemption areas. EPA will need to have polygons for inclusion in the Headquarters aquifer exemptions tracking system. Please provide polygon files. The polygons for the area proposed for exemption should be exclusive of the area that was previously exempted (i.e., contain "donut holes" representing the areas exempted at primacy).
- As discussed [in a telephone conversation], the numbers will be verified and double check when all the GIS files are sorted but I need something now for the text as a placeholder.
 - "The areal extent of the existing AE and the proposed expansion in the Arroyo Grande oil field is approximately xx acres. This acreage includes xx acres of productive boundaries (approved at primacy in 1983), and approximately xx acres comprising the current oil producing area outside the boundaries of the currently exempted area and planned future commercially producible areas."
- [For clarity purposes] need original source files for the Appendix A7 and Appendix A10 figures from the [original] application.

DOGGR's Response:

The geographic information system (GIS) shapefiles originally provided were line files that created a shape but were not actual polygons. The GIS shapefiles for the currently exempt area, and proposed area, have been updated and are contained within Attachments 1c1 and 1c2.

The acreage of the currently approved aquifer exemption for the Dollie sands in the Arroyo Grande oil field, within the area proposed for exemption, is 340 acres. The acreage of the Dollie sands proposed for exemption is 575 acres. The total of the two areas is 915 acres. In telephone discussions with representatives from the US EPA and DOGGR, it was determined that there was an older version of the currently approved exemption area GIS shapefiles that gave an acreage of 339 acres currently exempt and that the more accurate, updated GIS shapefiles, gives the acreage of 340 acres. The updated GIS shapefiles were a result of an intense and more precise digitization of the original maps used during the 1983 delegation of primacy authority from the US EPA to DOGGR for Class II injection in the State of California.

The cross-sections (Appendixes A7a1 through A7a6) provided in the original AGAE had text boxes and font sizes that do not print out clearly on the average sized piece of paper. The text boxes with extraneous information were removed and the text of the elevation scales were increased to aid in the clarity of interpreting the cross-sections and have been provided. The original index map for the cross-sections in the original AGAE (Appendix A7a) has also been provided.

December 7, 2018

- **Wells 38 and 43 [in the Water Well Table] are listed as domestic. Wouldn't that be the same for these two [wells 84 and 86]?**

DOGGR's Response:

The well log for the drilling of water wells 84 and 86, has their use as irrigation. To remain consistent with the other data points within the water well table and subsequent investigations, DOGGR updated the "Purpose" for these two wells to "Domestic". The "Aquifer" column in the water well table was also updated to better clarify the "Unknown" data points. Because no well log is available for wells 38, 41, and 43, the physical characteristics of aquifer of the water wells could not be determined.

December 11, 2018

- **We had asked the other day [telephone conversation] about the size of the "cut out" that had been removed from the original AE request. Can you please find that number and send?**
- **Also, looking for more details on the public water supply well north of the fault – exact location, population served, completion formation, anything else.**

DOGGR's Response:

The acreage for the area "cut out" for water wells 38 and 41 is 6.4 acres.

The Maxwellton water well is the nearest municipal water well to the AGAE. It is designated as a "State Small" water well and as such, it can not serve more than 24 people. The well is screened from 35 feet to its total depth of 115 feet. It is owned by the Maxwellton Mutual Water Company at 1545 Maxwellton St, San Luis Obispo, CA.

In a telephone conversation between US EPA and DOGGR representatives, it was discussed that Figure 9 from the December 2017 supplemental to the AGAE needed to be updated for clarity purposes. The water well capture analysis for water wells 43, 84, and 86 should be removed because they do not influence the proposed aquifer exemption boundary. Water well 43 is to the north of the sealing Arroyo Grande fault zone and water wells 84 and 86 are completed in the alluvium and not in connection with the Dollie sands of the Pismo formation.

December 13, 2018

1. **The aquifer proposed for exemption underlies Township 31 South Range 12 East, Sections 25 and 36; Township 31 South Range 13 East, Sections 30, 31, and 32; and Township 32 South Range 13 East, Section 6. However, this doesn't match with TRS depicted on the boundary map provided in Attachment 1 c 3 from your September 20 submittal (we think this is due to a**

difference in the projections used in the creation of this map and the shape files). Since we will include this map in our record of decision, can you please provide an updated version of this map that shows the proposed AE area using the NAD83 projection?

DOGGR's Response:

The map provided in Attachment 1c3 is correct. The map was created using the North American Datum of 1983 (NAD 83). If NAD 27 is used for the projection of the data, the proposed aquifer exemption boundary shifts into Section 25 of Township 31 South and Range 12 East and into Section 30 of Township 31 South and Range 13 East.

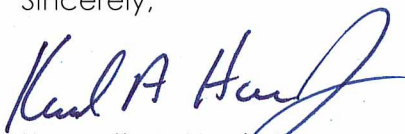
- 2. Our contractor calculated that the size of the existing AE is 340 acres, which is off by 1 acre from what you told us the other day. Please clarify this discrepancy.**

DOGGR's Response:

The discrepancy of 1 acre comes from a rounding error. The shapefile maintained by DOGGR for the current aquifer exemption in the Arroyo Grande oil field combines all four shapes into one number. In the process of determining the acreage of the shape over the current active oil field, DOGGR came up with a similar number to your contractor.

If you have any questions or wish to discuss this matter further, please contact me or the Coastal District at (805) 937-7246 or by email at DOGGRcoastal@conservation.ca.gov.

Sincerely,



Kenneth A. Harris Jr.
State Oil and Gas Supervisor

Enclosures:

- Attachment 1a: Aquifer Exemption Boundary Vertex Points Tables
- Attachment 1b: Aquifer Exemption Boundary Vertex Maps
- Attachment 1c1: Existing Arroyo Grande Aquifer Exemption Boundary Shapefile
- Attachment 1c2: Proposed Arroyo Grande Aquifer Exemption Boundary Shapefile
- Attachment 1c3: Arroyo Grande Aquifer Exemption Boundaries Map
- Attachment 4a: Arroyo Grande Core Data Spreadsheet
- Attachment 6a1: 1944 USGS study "Geology of the bituminous sandstone deposits near Edna, San Luis Obispo County, California."
- Attachment 6a2: California's 1999 Drinking Water Source Assessment and Protection Program Guidance
- Attachment 7a: Water Well Table
- Attachment 7b: Nearest Municipal Water Well

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Attachment 7c: Oak Park Area Water Well Data
Attachment 8c: Arroyo Grande Cumulative Oil Bubble Map
Attachment 8o: 1564 Vista Grande Ln Map
Appendix A7a: Index Map updated
Appendix A7a1: Cross-Section A-A' updated
Appendix A7a2: Cross-Section B-B' updated
Appendix A7a3: Cross-Section C-C' updated
Appendix A7a4: Cross-Section D-D' updated
Appendix A7a5: Cross-Section E-E' updated
Appendix A7a6: Cross-Section F-F' updated
Figure 9: Water Capture Analysis

cc: Michele Dermer – US EPA
Jonathan Bishop – SWRCB
John Borkovich – SWRCB
Eric Gillman – SWRCB
Janice Zinky – SWRCB
John Robertson – CCRWQCB
Matt Keeling – CCRWQCB
AE File
Chrono