DOCKETED	
Docket Number:	23-AFC-02
Project Title:	Elmore North Geothermal Project (ENGP)
TN #:	256579
Document Title:	Elmore North Geothermal LLC Responses to The LV Equity Technical Advisory Group Comments on the ICAPCD PDOC
Description:	N/A
Filer:	Lindsey Xayachack
Organization:	Jacobs
Submitter Role:	Applicant Consultant
Submission Date:	5/29/2024 10:11:57 AM
Docketed Date:	5/29/2024

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

May 24, 2024

Mr. Jesus Ramirez
APC Division Manager
Imperial County Air Pollution Control District
150 South Ninth Street
El Centro, California 92243

RE: **Selected Responses to The LV Equity Technical Advisory Group Comments on Preliminary Determination of Compliance for the Elmore North Geothermal Plant**

Dear Mr. Ramirez:

Elmore North Geothermal, LLC (the Applicant) appreciates the Imperial County Air Pollution Control District's (ICAPCD) efforts in producing a comprehensive Preliminary Determination of Compliance (PDOC) for the Elmore North Geothermal Project (ENGP or Elmore North).

The Applicant welcomes this opportunity to submit selected responses to certain comments submitted by the Lithium Valley Equity Technical Advisory Group (LVETAG) Comments on the PDOC for Elmore North. LVETAG's comments on the PDOC were docketed to the California Energy Commission (CEC) docket on March 11, 2024[1]. The following responses are provided for your consideration. The Applicant remains available to provide additional information in furtherance of issuance of the Final Determination of Compliance (FDOC) for the Elmore North Project.

I. Cumulative Impacts

1. *This analysis should carefully consider not only direct and induced, but also cumulative impacts on the entire Imperial County Air Pollution Control District, which is already severely degraded. Reduced inflow to the Salton Sea would indirectly impact air quality by exposing more lakebed and releasing toxic dust into the air.[1] Any worsening air quality would significantly impact public health and likely exceed legal thresholds, which must be analyzed and mitigated. Air flow models should include those that measure pollutant transport to other areas of Imperial County, air basins, and air districts. In addition, we must also consider the broader impact on air quality caused by the buildout of this project as well as other geothermal plants and renewable energy infrastructure developments throughout Imperial County on the already receding Salton Sea.*

Response: Inflows to the Salton Sea are predominantly from agricultural return flows augmented with inflows from Mexico and other sources. Imperial Irrigation District (IID) is actively working with federal and state agencies to preserve the lake.[2] Since geothermal power plants like the ENGP are not a source of inflow, their operation will not prevent IID from continuing its preservation efforts. IID requested the Applicant

[1] The LVETAG PDOC comments for the project - https://efiling.energy.ca.gov/GetDocument.aspx?tn=254966&DocumentContentId=90653.
[2] https://www.iid.com/water/salton-sea

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

prepare an assessment of the ENGP's potential impact to the flows into the Salton Sea. A draft of this assessment is being prepared for submittal to IID and will be publicly available once finalized. Based on preliminary results, the ENGP will not have a significant impact on drain flows into the Salton Sea.

With regards to air flow models, ICAPCD Rule 207.F.1.a requires the use of U.S. Environmental Protection Agency (EPA)-recommended models when conducting an air quality impact analysis as part of a permit application. Consistent with this requirement and the modeling protocol approved both by ICAPCD and CEC Staff,[3] the Applicant's air quality impact analysis was conducted using AERMOD. AERMOD is one of three models preferred by the EPA, as described in Appendix A to Appendix W of 40 Code of Federal Regulations (CFR) Part 51, *Guideline on Air Quality Models*. AERMOD is, however, the only preferred model considered suitable for the project, based on the following:

- The Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations (CTDMPLUS) is appropriate for applications with only elevated point sources, whereas AERMOD is appropriate for applications with point, volume, and area sources. Since the project includes both point and area sources, CTDMPLUS is not appropriate for use.

- The Offshore and Coastal Dispersion (OCD) Model is appropriate for overwater emission sources, of which the project has none.

In addition, both AERMOD and CTDMPLUS are appropriate for transport distances of up to 50 kilometers (km). Nearby Riverside and San Diego counties are located within 50 km of the project site, such that either model is capable of estimating potential impacts in nearby counties, air basins, and air districts. As described in Section 5.1.9.1.2 of Attachment DRR 7-1 of the *Elmore North Geothermal Project Data Request Response Set 1 (Revised Responses to Data Requests 3, 4, 7, 10 to 13, and 69 to 73)* (Transaction Number [TN] #253081), the Applicant's modeling domain extended 10 km from the project fenceline. Extension of this modeling domain was not considered necessary both because the locations of maximum modeled impacts were nowhere near the edge of the modeling domain and the magnitude of modeled impacts diminishes as one moves farther from the source. Pollutant transport within Imperial County and the surrounding areas is also generally addressed through ICAPCD's development of the State Implementation Plan (SIP).

With regards to cumulative impacts, the Applicant's cumulative impacts analysis did include all reasonably foreseeable projects within six miles of the project. As described in Section 4.3 of the *Air Dispersion Modeling Report for Black Rock, Elmore North, and Morton Bay Geothermal Projects*,[4] renewable energy infrastructure developments were evaluated but excluded because they are not expected to emit more than five tons per year of criteria pollutants or hydrogen

[3] CEC Staff provided informal approval via electronic mail to the Applicant on December 14, 2022 and did not have any subsequent data requests associated with the modeling protocol. ICAPCD similarly did not have any comments regarding the modeling protocol during its completeness review of the permit application.
[4] Refer to Attachment DRR 12-1 of the *Elmore North Geothermal Project Data Request Response Set 1 (Revised Responses to Data Requests 3, 4, 7, 10 to 13, and 69 to 73)* (TN #253081).

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

sulfide (H_2S). As a future geothermal plant, Hell's Kitchen was similarly evaluated but excluded because it is currently in the entitlement process, which occurs before any air emissions-related permitting and licensing. As such, it is impossible to predict what its potential emissions may be or if the project will even be built in the future. Furthermore, ICAPCD's future permit evaluation of Hell's Kitchen would be expected to include the ENGP in its cumulative evaluation.

2. *In addition to dust and suppression and mitigation, plans should be outlined for pavement of roads, ideally with permeable material to mitigate climate and health risks. Despite the well-known problems related to dust pollution in this area, a dust control plan is only required 10 days prior to construction, and paving roads is not required according to the document (Imperial County Air Pollution Control District, 2024, p. 32; 38). Internal combustion engines proposed by the Applicant may be exempt from emission limits if they are emergency standby engines (Imperial County Air Pollution Control District, 2024, p. 31), but the role of electric vehicles (EVs), including trucks and off-road vehicles, in mitigating air pollution from traffic and goods transportation should be outlined in detail with performance metrics for commute trip reduction, rideshare programs, and heavy-duty charging infrastructure.*

Response: The project's dust, stationary sources, and vehicle exhaust emissions will be minimized to the extent feasible during both construction and operation through a number of means, including the following:

- As presented in Section 5.1.7.2.2 of Attachment DRR 7-1 of the *Elmore North Geothermal Project Data Request Response Set 1 (Revised Responses to Data Requests 3, 4, 7, 10 to 13, and 69 to 73)* (TN #253081), the Applicant will implement control measures during project construction to minimize fugitive dust and equipment and vehicle exhaust emissions.

- The project's construction-related emission estimates already assume the majority of construction equipment will meet Tier 4 final emission standards.

- The Applicant will comply with applicable provisions of the California Air Resources Board's (CARB) Airborne Toxic Control Measures for diesel-fueled on- and offroad vehicles, which strive to minimize equipment and vehicle exhaust emissions.

- Although the project's internal combustion engines are exempt from emission limits as standby emergency units, they will use state-of-the-art emissions controls to minimize stationary combustion emissions.

- The vehicle fleet used to support project operations will be subject to CARB's Advanced Clean Fleet Regulation, which requires a transition to electric and other zero-emission vehicles over time and will reduce vehicle exhaust emissions.

3. *In addition to measures described by the Applicant in responses to data requests, such as PPE and fugitive dust control, mitigation planning should support more robust monitoring for Valley Fever infections in the County from exposure to soil pathogens in dust. Even if Valley Fever is not considered to be endemic in Imperial Valley, as the Applicant has asserted in response to data requests, disturbing soil has been linked to outbreaks in places*

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

where the fungus was not expected to live, according to the CDC.[2]

Response: Imperial County comprises less than 1 percent of the State's total Valley Fever cases according to the California Department of Public Health's (CDPH) year-end surveillance report on suspect, probable, and confirmed Valley Fever cases in 2022.[5] Therefore, the potential exposure of construction workers and sensitive receptors to Valley Fever is expected to be very low. Furthermore, the implementation of the construction worker health and safety plans, which will include procedures for using personal protective equipment, as necessary, and training on the recognition of Valley Fever infection, and the air quality fugitive dust control measures proposed by the Applicant will reduce the already low potential impacts even further. These activities are consistent with CDPH's tips for reducing exposure to Valley Fever[6] and the requirements of Assembly Bill (AB) 203 and are expected to similarly reduce exposure to other respiratory irritants that may lead to asthma, other respiratory diseases, and heart diseases.

4. *Air quality impacts should include exposure to asbestos, lead, bird waste, and other respiratory irritants, with specific attention made in CalEnviro Screen designated areas.*

Response: The Applicant has analyzed air quality and public health impacts for all pollutants known or expected to be emitted by the project, including lead and other respiratory irritants, consistent with programs and methods approved by regulatory agencies.

II. Best Available Control Technologies (BACT)

1. *According to the determination of compliance, BACT is triggered for PM10 and H2S emissions, and models show these emissions exceeding thresholds (Imperial County Air Pollution Control District, 2024, p. 24; 28; 35). Nonetheless, the Air District's proposed BACT alternatives were rejected. In some cases, tradeoffs regarding water use or other incompatibilities rendered such alternatives technically infeasible. However, in other instances proposed BACT alternatives were rejected because they were considered less cost-effective, for example regenerative thermal oxidizers and bioreactors as potential alternatives to spargers (Imperial County Air Pollution Control District, 2024, p. 25). There needs to be substantial evidence showing that these alternatives are not cost effective. Without such evidence, these alternatives should be reconsidered in relation to the significant tax and financial incentives that the Applicant has been able to access for advancing this development project.*[3]

Response: At the request of the ICAPCD, the Applicant prepared an addendum[7] to a 2017 Best Available Control Technology (BACT) analysis, which was prepared for the JJ Elmore facility and previously approved by ICAPCD. This addendum specifically considered the following additional control technologies for the project's particulate matter and hydrogen sulfide (H_2S) emissions: air-cooled condensers (ACC) with evaporative pre-cooling for particulate matter abatement; direct injection of condensate for sour condensate liquid (H_2S) abatement; and liquid

[5] https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/CocciEpiSummary2022.pdf
[6] https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/ValleyFeverPrevention.aspx
[7] Refer to Appendix 5.1E of Attachment DRR 7-1 of the *Elmore North Geothermal Project Data Request Response Set 1 (Revised Responses to Data Requests 3, 4, 7, 10 to 13, and 69 to 73)* (TN #253081).

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

redox technologies, including Stretford Process, SulFerox, and LO-CAT, for non-condensable gas (NCG) (H_2S) abatement.

The BACT analysis was performed following the EPA's top-down approach, which includes the following elements:

- Step 1: Identify potential control technologies
- Step 2: Eliminate technically infeasible options
- Step 3: Rank remaining control technologies by control effectiveness
- Step 4: Evaluate most effective controls
- Step 5: Select BACT

Per Step 2 of the above process, technically infeasible options are eligible for elimination from the BACT analysis and do not require further evaluation of control and cost effectiveness. As a result, the BACT analysis focused on technically feasible options that reduce emissions without formation of any associated secondary emissions. For example, although thermal oxidizers would reduce H_2S emissions, they require propane combustion to operate, which would lead to an increase in emissions of combustion contaminants.

ICAPCD Rule 207.B defines BACT as the most effective emission control device which has been achieved in practice or any other alternative emission control device determined to be technologically feasible and cost-effective by the Air Pollution Control Officer (APCO).[8] ICAPCD Rule 207.B further indicates that a cost-effectiveness analysis should be performed in accordance with methodology and criteria specified in the South Coast Air Quality Management District's (SCAQMD) BACT Guidelines.

Consistent with the EPA's top-down approach and the provisions of ICAPCD Rule 207.B, the cost-effectiveness of each technically feasible option was provided as part of the ENGP's administrative record, either in the 2017 BACT analysis or the Applicant's addendum. SCAQMD's BACT Guidelines indicate that a technology is considered to be cost effective if its "cost per ton of emissions reduced is less than the maximum required cost effectiveness."[9] However, no maximum required cost effectiveness is provided for H_2S. Therefore, the Applicant instead relied on a comparison of cost per ton of emissions reduced to determine which technology was the most cost-effective and recommended that technology for the project.

2. *Moreover, the Applicant needs to ensure a process for periodic review of BACTs and other emerging best practices that can be employed. This could be achieved through an annual review process linked to the Specific Plan and Programmatic Environmental Impact Report for Lithium Valley, which includes this project in its study area. Whether or not BHE Renewables plans to extract lithium from this facility, it should be subject to a public review and the ability of the public and other public agencies to weigh in on emerging impacts, BACTs, and other issues that may emerge as the industry near the Salton Sea develops. For example, the Applicant should track progress toward better drift eliminators with a greater*

[8] https://apcd.imperialcounty.org/wp-content/uploads/2020/01/1RULE207.pdf
[9] https://www.aqmd.gov/docs/default-source/bact/bact-guidelines/bact-guidelines-2024/part-c_policy-and-procedures-for-non-major-polluting-facilities.pdf

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

drift rate that can remove higher concentrations of pollutants.

Response: As stated in the response to II.1 above, the Applicant prepared a BACT analysis consistent with the EPA's top-down approach. This analysis was appropriate for the project's new emission sources, as BACT applies to new and modified stationary sources. Future modification of stationary sources at the ENGP will comply with BACT requirements at the time of modification.

3. *The Applicant should explain how mineralization buildup affects the effectiveness of drift eliminators and pollution control and their plan for maintenance and cleaning to ensure equipment operates to performance specifications.*

Response: As required under proposed Permit Condition F.5 of the PDOC, the Applicant will inspect the cooling tower drift eliminators annually. This inspection includes conducting an inventory survey of the drift eliminators to ensure the equipment is operating to its performance specifications without degradation and replacing any drift eliminators that are damaged. A report of the inspection results will be submitted to the ICAPCD in accordance with proposed Permit Condition I.2 of the PDOC.

4. *The proposed drift eliminators for the cooling towers are an "end-of-pipe" solution to air pollution emissions. The Applicant should pursue methods to remove contaminants like mercury and H2S from the raw steam before they reach the generators, as upstream abatement or separation before the turbines will result in fewer downstream emissions. This could help reduce pollution and increase the capture of pollution at the cooling tower and help avoid heavy metals and other pollution emissions.*

Response: The BACT analysis described in response to II.1 above looked at all feasible control technologies for emissions at both the cooling tower and the steam turbine, where NCGs are first separated from the steam. The proposed control technologies were those that were determined to be achieved in practice, consistent with the EPA's top-down approach and ICAPCD Rule 207.B.

III. Brine Pond Alternatives

1. *Brine ponds represent one of the potential sources of hazardous waste and emissions at geothermal facilities (Dobson et al., 2023, p. 136).[4] Based on the description of the Fluid Injection System, the brine pond at this proposed site appears to be used to temporarily store all manner of potentially hazardous waste (Imperial County Air Pollution Control District, 2024, p. 6).[5] It is worth noting that there is a track record of spill-related contamination at most of the geothermal facilities in the Salton Sea Known Geothermal Resource Area (SSKGRA) after inaccurate predictions of low spill risk in previous EIRs, and CalEnergy / BHE Renewables already agreed to pay a $910,000 penalty and conduct soil remediation as part of a 2007 consent agreement.[6] Alternatives to brine ponds should be considered for onsite waste handling and storage, such as: (a) above-ground, sealed storage containers to prevent spills and wind-blown contaminants, and secured to avoid tipping in the event of earthquakes; (b) effectively covered to minimize emissions; and/or (c) covered solar to generate further onsite renewable energy that could also serve as an alternative to diesel generation. Given the high potential likelihood of hazardous materials, these storage containers should not be treated as exempt like the tank storage contents described in the*

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

compliance decision–some of which may contain 20,000 gallons of hydrochloric acid (Imperial County Air Pollution Control District, 2024, p. 7; 23).

Response: The contents of the brine pond will largely be reinjected and otherwise managed in accordance with the requirements of the Regional Water Quality Control Board and Title 22 California Code of Regulations (CCR) Division 4.5 requirements, outside the jurisdiction of the ICAPCD. Furthermore, there is no potential for emissions from the brine pond as H_2S and other NCGs are removed from the geothermal gas streams before the depleted process stream reaches the brine pond and were included in the modeling analysis as being emitted by the upstream emission sources. Lastly, ICAPCD has included the 20,000-gallon hydrochloric acid storage tank in the PDOC, indicating that appropriate consideration was given to the project's potential emission sources when determining eligibility for exemption.

2. *It is imperative to develop and implement a comprehensive stormwater management plan that meticulously separates centralized and/or decentralized spill control mitigation facilities from stormwater runoff management infrastructure. This approach is designed to safeguard against adverse impacts during extreme hydrologic events. By delineating distinct zones for spill control and stormwater management, the potential contamination present in spill control facilities can be effectively contained, preventing its dispersion into surrounding areas via stormwater runoff that may have other knock-on effects for air quality in the broader Salton Sea region. This proactive measure not only preserves the integrity of stormwater management systems but also mitigates the environmental risks associated with the spread of contaminants, and consequent costs.*

Response: Spill control and stormwater management activities will be addressed through the appropriate water resources programs and are outside the jurisdiction of the ICAPCD. However, the Applicant expects to contain all onsite stormwater by either evaporation in the stormwater retention basin or discharge to the geothermal resource. Likewise, spills from process equipment will also be managed in a similar manner and will avoid offsite impacts.

IV. PM10 Emissions

1. *According to the compliance decision, modeling results for this project exceed the CAAQS standards for PM10 (Imperial County Air Pollution Control District, 2024, p. 28). However, this is dismissed because 24-hour and annual background PM10 concentrations already exceed the CAAQS based on data from 2019-2021 from the Niland monitoring site (Imperial County Air Pollution Control District, 2024, p. 29). This failure of compliance seems to be allowed based on the logic that Imperial Valley is a "green sacrifice zone."*[7] *While renewable energy development may appear to meet state and federal climate action goals, it must not render the area a green sacrifice zone by perpetuating unresolved environmental problems or creating new ones, especially considering the urgent need for environmental justice and ecological restoration of the Salton Sea region.*

Response: As stated in Section 5.1.10.1.1 of Attachment DRR 7-1 of the *Elmore North Geothermal Project Data Request Response Set 1 (Revised Responses to Data Requests 3, 4, 7, 10 to 13, and 69 to 73)* (TN #253081), "Although the Project is expected to have maximum impacts that exceed the 24-hour SIL for PM_{10}, its emissions are expected to be less than the

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

ICAPCD Rule 207 offset thresholds and CEQA significance thresholds for PM_{10}, as presented in Tables 5.1-1 and 5.1-17, respectively. Furthermore, the Project will implement BACT to reduce particulate matter emissions from the cooling towers and to minimize emissions from diesel combustion by using a Tier 3-certified fire pump and Tier 4-certified emergency generators." With this language, the Applicant is not dismissing the particulate matter with aerodynamic diameter of 10 microns or less (PM_{10}) exceedances but rather demonstrating both that there are other methods for demonstrating a project's significance in nonattainment areas and that BACT is being implemented to reduce PM_{10} emissions to the extent feasible.

V. Radon and Other Hazardous Non-Condensable Gases (NCGs)

1. *In response to data requests, BHER recently disclosed emissions of radon as high as 2515 pCi/L from Non-Condensable Gas Vacuum Discharge at the CalEnergy Elmore Geothermal Power Plant (Jacobs and Black Rock Geothermal LLC, p. 19).[8] Whether this gas enters the atmosphere or remains inside the facility, this is an alarmingly high level of exposure for workers and fenceline communities, considering the significant cancer risks outlined by the EPA for long- term exposures to radon above 4 pCi/L.[9] Exposure to this radioactive gas is the leading cause of death due to lung cancer among non-smokers.[10] High soil radon has been detected across geothermally active areas, and scientists have analyzed radionuclides in geothermal brine via aquifer host rocks beneath the Salton Sea.[11] OSHA offers guidelines for protecting workers in different exposure scenarios.[12] Nonetheless, in the determination of compliance, cancer risks are considered below the SCAQMD significance threshold (Imperial County Air Pollution Control District, 2024, p. 35).*

Response: According to the commentor, the project may have "emissions of radon as high as 2515 pCi/L." The value of 2,515 picocuries per liter (pCi/L) is not a measure of the project's radon emissions but the concentration of radon within the inlet stream to the sparger, as measured by source testing at other nearby geothermal facilities. This concentration was incorporated into the Applicant's estimates of radon emissions from the geothermal processes, based on the project- and process-specific steam flowrates. Worker exposure to the project's radon emissions is discussed below.

Radon (Rn-222) primarily is a hazard in occupations where workers may be exposed to Naturally Occurring Radioactive Materials (NORM) and to occupants in buildings overlying soils high in radium (Ra-226).[10] Radon workplace hazards are addressed as part of a facility occupational health and safety program; risks to the general public from radon exposure are addressed by programs administered by state and county health departments, which primarily involve education about indoor air testing and building mitigation. Selected sources of radon are managed under federal standards, including U.S. Nuclear Regulatory Commission (NRC) regulations and EPA's National Emissions Standards for Hazardous Air Pollutants (NESHAPs). For example, NRC regulations for uranium mill tailings include requirements to control the release of radon. The NESHAP for emissions of radon from U.S. Department of Energy facilities establishes a surface emission standard of 20 picocuries per square meter per second (pCi/m^2-s) from impoundments or disposal facilities. Because radon is managed as a radiation health hazard under

[10] International Commission on Radiological Protection (ICRP). 1993. *Protection Against Radon-222 at Home and at Work*. ICRP Publication 65. https://journals.sagepub.com/doi/pdf/10.1177/ANIB_23_2.

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

other programs, it has not been identified as a toxic air contaminant (TAC) in California. An outcome of not being a TAC is that there are no risk assessment methods in Office of Environmental Health Hazard Assessment (OEHHA) guidelines for assessing radon emissions to ambient air.

The risk from the project's radon emissions can be assessed based on comparison with background levels in ambient air. An authoritative estimate of a typical concentration of radon in ambient (outdoor) air is 0.4 pCi/L.[11] Studies conducted by CARB reported a statewide average outdoor air concentration of 0.49 pCi/L.[12, 13]

Radon emissions from the project's cooling tower were modeled to estimate the annual average radon concentration for the Maximum Exposed Individual Resident (MEIR). As shown in Table V.1-1, the annual average concentration at the MEIR is 0.0072 pCi/L, which is well within existing (background) levels of radon in air in California. While radon cancer risk may not have been included in the project's health risk assessment (HRA), there is sufficient basis to show that radon emissions from the proposed project do not represent an increased health risk. Other hazards associated with radon (for example workplace hazards) are addressed through existing regulatory programs.

Table V.1-1. Radon Concentration at the MEIR

Parameter	Value
Annual Maximum Modeled TAC Impact [a]	19.96 µg/m^3 per g/s
	2.00E+07 pCi/m^3 per Ci/s
Annual Radon Emissions [b]	11.4 Ci/year
	3.62E-07 Ci/s
Annual Maximum Radon Impact [c]	7.22 pCi/m^3
	7.22E-03 pCi/L

[a] The Annual Maximum Modeled TAC Impact was taken as the maximum annual impact for the cooling towers from the 1 g/s TAC AERMOD run and converted to units of pCi/m^3 per Ci/s using the following conversion factors:

1 µg = 1.00E-06 g
1 g = 1.50E+05 Ci[14]
1 Ci = 1.00E+12 pCi

[b] Annual Radon Emissions were taken from Appendix 5.1A, Table 1 of Attachment DRR 7-1 of the *Elmore North Geothermal Project Data Request Response Set 1 (Revised Responses to Data Requests 3, 4, 7, 10 to 13, and 69 to 73)* (TN #253081) and converted to units of Ci/s using the following conversion factor:

1 year = 3.15E+07 s

[c] The Annual Maximum Radon Impact was calculated by scaling the Annual Maximum Modeled TAC Impact by the Annual Radon Emissions and converted to units of pCi/L using the following conversion factor:

[11] Agency for Toxic Substances and Disease Registry (ATSDR). 2012. *Toxicological Profile for Radon*. May. https://www.atsdr.cdc.gov/ToxProfiles/tp145.pdf.
[12] Liu, K-S et al. 1990. *Survey of Residential Indoor and Outdoor Radon Concentrations in California*. https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/a6-194-53.pdf.
[13] Liu, K-S et al. 1991. *Annual Average Radon Concentrations in California Residences*. Journal of Air and Waste Management Association. 41(9):1207-1212. https://www.tandfonline.com/doi/abs/10.1080/10473289.1991.10466917.
[14] https://www.ncbi.nlm.nih.gov/books/NBK158787/table/T23/

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

1 m^3 = 1,000 L

Notes:
µg = microgram(s)
µg/m^3 = microgram(s) per cubic meter
Ci = curie(s)
Ci/s = curie(s) per second
g = gram(s)
g/s = gram(s) per second
L = liter(s)
m^3 = cubic meter(s)
pCi = picocurie(s)
pCi/m^3 = picocurie(s) per cubic meter
s = second(s)

2. *Radon is not mentioned in the Air District determination of compliance until the very end of the document as source tests needed for analysis. It is not included in estimates of emissions that focus primarily on hydrogen sulfide (p. 15-22). Given the disclosure of significant levels of radon at neighboring facilities, it is critical to consider more rigorous mitigation measures comparable to the abatement of hydrogen sulfide described in the document including: limits on emissions, continuous monitoring, notification and reporting, as well as surveying to further analyze results. These mitigation measures would help to prevent and control cumulative atmospheric emissions of all NCGs, including radon, before this proposed project and other related developments are approved. Occupational radon exposures should also be monitored to ensure that they remain below levels suggested by OHSA for worker health and safety.*[13]

Response: The Applicant did estimate radon emissions associated with the project, as disclosed throughout Attachments DRR 7-1 and DRR 7-2 of the *Elmore North Geothermal Project Data Request Response Set 1 (Revised Responses to Data Requests 3, 4, 7, 10 to 13, and 69 to 73)* (TN #253081). Consistent with the response to VI.1 above, radon emissions from the project's cooling tower were modeled to estimate an annual average radon concentration at the MEIR of 0.0072 pCi/L, which is well within existing (background) levels of radon in air in California. While radon cancer risk may not have been included in the project's HRA, based on its not being identified as a TAC in California, there is sufficient basis to show that radon emissions from the proposed project do not represent an increased health risk. Specifically, the lifetime cancer risk from the radon concentration at the MEIR location is estimated to be less than 1 in 1 million, as shown in Table V.2-1. Other hazards associated with radon (for example workplace hazards) are addressed through existing regulatory programs.

Table V.2-1 Lifetime Cancer Risk from Radon Concentration in Air at the MEIR

Parameter	Value
Radon-222 Concentration	0.0072 pCi/L
Working Level (WL) [a]	0.00003
Working Level Month (WLM) [b]	0.001
Lifetime Cancer Risk [c]	0.00000078 or 0.78 in 1 million

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

[a] The WL represents the energy of radon daughters (i.e., isotopes from rapidly decaying radon) and is calculated per the following equation:

WL = Radon-222 Concentration (pCi/L) x Equilibrium Factor x Fraction of Time Exposed to Radon Concentration in Air / 100, where:
Equilibrium Factor = 0.4 for residences[15]
Fraction of Time Exposed to Radon Concentration in Air = 1 (default)

[b] The WLM is calculated per the following equation:

WLM = WL x Exposure Time (hours) / 170 hours per month, where:
Exposure Time = 7,000 hours for residential[16]

[c] The Lifetime Cancer Risk was calculated per the following equation, based on calculations presented in NRC training:[17]

Lifetime Cancer Risk = WLM x Risk Factor per WLM, where:
Risk Factor per WLM = 0.00066, based on the mid-point of the estimated range[18]

3. *Other non-condensable gases should receive similar attention, including ammonia, arsenic, mercury, benzene, toluene, and xylene (Imperial County Air Pollution Control District, 2024, p. 47). Exposure to hydrogen sulfide emissions from geothermal plants is associated with an increase in hospitalization due to respiratory diseases, as well as nervous system disorders and cardiovascular diseases.[14] The need for a robust hydrogen sulfide reduction system in geothermal energy development is well known.[15] Yet, while hydrogen sulfide is considered a "nuisance" due in part to its odor, the air quality health standards for the other NCGs also ought to be rigorously monitored (Imperial County Air Pollution Control District, 2024, p. 32).*

Response: Ammonia, arsenic, mercury, benzene, toluene, and xylene are all identified TACs in California, were included in the Applicant's HRA per OEHHA guidance, and contribute to the project's modeled health risks. Because there are no established state or federal ambient air quality standards for these TACs, there is no need to address them outside of the HRA.

To determine the relative importance of each of the above pollutants, the per-pollutant contribution to the project's modeled health risks were estimated. Table V.3-1 presents the per-pollutant contribution to the project's estimated cancer risk of 18.7 in 1 million at the PMI. As shown, arsenic is the predominant contributor to the project's cancer risks.

Table V.3-1. Per-pollutant Contribution to Cancer Risk

Pollutant	Cancer Risk (per million) [a]	Contribution (%)
Ammonia	0	0
Arsenic	12.6	67
Mercury	0	0
Benzene	5.44	29

[15] ICRP. 1993. *Protection Against Radon-222 at Home and at Work*. ICRP Publication 65. https://journals.sagepub.com/doi/pdf/10.1177/ANIB_23_2.
[16] *Id.*
[17] https://www.nrc.gov/docs/ML1122/ML11227A237.pdf
[18] EPA. 2003. EPA Assessment of Risks from Radon in Homes. EPA 402-R-03-003. Available online at https://www.epa.gov/sites/default/files/2015-05/documents/402-r-03-003.pdf.

Elmore North Geothermal LLC
4124 NW Urbandale Drive
Urbandale, IA 50322

Jon Trujillo
General Manager, Geothermal Development

Toluene	0	0
Xylene	0	0
H_2S	0	0

[a] The per-pollutant cancer risk was extracted from the Applicant's HRA modeling file titled 'BR_8760_MEIR_CancerRisk.csv' for Receptor 75.

Similarly, Attachment V.3-1 presents the per-pollutant contributions to the project's estimated chronic and acute health risks at the PMI. As shown, the respiratory system has the highest chronic health risk, with arsenic contributing up to 79 percent of the estimated risk. Note that chronic health risks to the cardiovascular system, central nervous system, reproductive and development system, and skin are also greater than the significance threshold of 1.0, with arsenic as the only contributing pollutant. The central nervous system is the only organ with acute health risks greater than the significance threshold of 1.0, with H_2S contributing up to 99 percent of the estimated risk.

Based on the above analysis, arsenic is the only pollutant apart from H_2S that is notably driving the project's modeled health risks. Although arsenic is a predominant contributor to the project's estimated cancer and chronic risks, those risks are considered to be less than significant for the following reasons:

- Cancer risk is less than 1 in 1 million at the MEIR, Maximum Exposed Individual Worker (MEIW), and Maximum Exposed Sensitive Receptor.
- Chronic risk is less than 1.0 at the MEIR and Maximum Exposed Sensitive Receptor, with risks greater than 1.0 limited to 300-feet of the facility's eastern fenceline. Although technically not within the project property, it is not expected to be a location presenting a potential for long-term or chronic exposure because public access to this land is restricted through its ownership by BHE Renewables, LLC.

Because the arsenic-driven risks are considered to have a less-than-significant impact on public health, additional scrutiny of the project's arsenic emissions is not warranted.

The Applicant looks forward to working with the ICAPCD during the finalization of the Determination of Compliance. Please contact Anoop Sukumaran at (760) 348-4275 (email address: Anoop.Sukumaran@calenergy.com) or Jerry Salamy at (916)769-8919 (email address: Jerry.Salamy@jacobs.com) if you have any questions or if you need additional information.

Sincerely,

Jon Trujillo
General Manager, Geothermal Development

Attachment V.3-1

Per-pollutant Contribution to Chronic and Acute Health Risks

Elmore North Geothermal Project

Chronic Risks at Receptor 50

Target Organ	Cardiovascular System	Central Nervous System	Immune System	Kidney	Gastrointestinal Tract and Liver or Alimentary Tract	Reproductive and Development System	Respiratory System	Skin	Eye	Bone and Teeth	Endocrine System	Blood	Odor	General
Risk by Target Organ [a]	1.02	1.03	0.00	0.00	0.00	1.02	**1.29**	1.02	0.00	0.00	0.00	0.03	0.00	0.00
Per-pollutant Contribution to Target Organ														
Ammonia	0%	0%	0%	0%	0%	0%	9%	0%	0%	0%	0%	0%	0%	0%
Arsenic	100%	100%	0%	0%	0%	100%	79%	100%	0%	0%	0%	0%	0%	0%
Mercury	0%	0%	0%	96%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Benzene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
Toluene	0%	0%	0%	0%	0%	0%	0%	0%	62%	0%	0%	0%	0%	0%
Xylene	0%	0%	0%	0%	0%	0%	0%	0%	38%	0%	0%	0%	0%	0%
H_2S	0%	0%	0%	0%	0%	0%	8%	0%	0%	0%	0%	0%	0%	0%
Per-pollutant Risk by Target Organ [b]														
Ammonia	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	1.02E+00	1.02E+00	0.00E+00	0.00E+00	0.00E+00	1.02E+00	1.02E+00	1.02E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury	0.00E+00	9.46E-04	0.00E+00	9.46E-04	0.00E+00	9.46E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.68E-02	0.00E+00	0.00E+00
Toluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xylene	0.00E+00	7.72E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.72E-07	0.00E+00	7.72E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H_2S	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.87E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Maximum Risk

[a] The total chronic risk was extracted from the Applicant's HRA modeling file titled 'BR_8760_Chronic_NCChronicRiskSumByRec.csv' for Receptor 50.

[b] The per-pollutant chronic risk was extracted from the Applicant's HRA modeling file titled 'BR_8760_Chronic_NCChronicRisk.csv' for Receptor 50.

Attachment V.3-1
Per-pollutant Contribution to Chronic and Acute Health Risks
Elmore North Geothermal Project

Acute Risks at Receptor 75

Target Organ	Cardiovascular System	Central Nervous System	Immune System	Kidney	Gastrointestinal Tract and Liver or Alimentary Tract	Reproductive and Development System	Respiratory System	Skin	Eye	Bone and Teeth	Endocrine System	Blood	Odor	General
Risk by Target Organ [a]	0.02	**2.41**	0.31	0.00	0.00	0.33	0.76	0.00	0.76	0.00	0.00	0.31	0.00	0.00
Per-pollutant Contribution to Target Organ														
Ammonia	0%	0%	0%	0%	0%	0%	97%	0%	97%	0%	0%	0%	0%	0%
Arsenic	100%	1%	0%	0%	0%	7%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Benzene	0%	0%	100%	0%	0%	93%	0%	0%	0%	0%	0%	100%	0%	0%
Toluene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Xylene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H_2S	0%	99%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Per-pollutant Risk by Target Organ [b]														
Ammonia	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.30E-01	0.00E+00	7.30E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	2.30E-02	2.30E-02	0.00E+00	0.00E+00	0.00E+00	2.30E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury	0.00E+00	4.34E-04	0.00E+00	0.00E+00	0.00E+00	4.34E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzene	0.00E+00	0.00E+00	3.07E-01	0.00E+00	0.00E+00	3.07E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.07E-01	0.00E+00	0.00E+00
Toluene	0.00E+00	2.11E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.11E-05	0.00E+00	2.11E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xylene	0.00E+00	4.12E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.12E-06	0.00E+00	4.12E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H_2S	0.00E+00	2.38E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Maximum Risk

[a] The total acute risk was extracted from the Applicant's HRA modeling file titled 'BR_8760_Acute_NCAcuteRiskSumByRec.csv' for Receptor 75.

[b] The per-pollutant acute risk was extracted from the Applicant's HRA modeling file titled 'BR_8760_Acute_NCAcuteRisk.csv' for Receptor 75.