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VIA CEC E-FILING SYSTEM

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Re: Comment on Preliminary Staff Assessment for Morton Bay Geothermal Project (Docket No. 23-AFC-01)

Dear Chair Hochschild, Vice Chair Gunda, Honorable California Energy Commissioners, and Mr. Veerkamp:

This comment is submitted on behalf of Supporters Alliance for Environmental Responsibility ("SAFER") and its members living and working in and around Imperial County regarding the California Energy Commission's ("CEC") Preliminary Staff Assessment ("PSA") prepared for Berkshire Hathaway Energy ("BHE") Renewables' (the "Applicant") Morton Bay Geothermal Project ("MBGP" or "Project").

As discussed below, the PSA inadequately analyzes numerous environmental impacts and lacks substantial evidence to support the PSA's conclusions that the Project will not have a significant air quality, human health, hazards and hazardous materials, water quality, water quantity, and cumulative impacts. Additionally, the PSA violates CEQA because it improperly piecemeals the project by failing to disclose and analyze impacts of the project's reasonably foreseeable future direct lithium extraction operations, which will also have significant air quality, hazards and hazardous materials, water quantity, and water quality impacts. Accordingly, SAFER requests that CEC refrain from finalizing the staff assessment until the deficiencies of the PSA are remedied in a revised PSA and the revised PSA is recirculated for public review and comment.

These comments are supported by the expert comments of air quality and power plant expert Dr. Ranajit Sahu, Ph.D., and water quality, hazards, and hazardous materials expert Dr. Joseph E. Odencrantz, Ph.D., P.E., BCEE, PH. The written comments of Dr. Sahu and Dr.

Odencrantz are attached hereto as Exhibit A and Exhibit B, respectively.

PROJECT DESCRIPTION AND ENVIRONMENTAL SETTING

The Project is proposed for 51-acres of a 160-acre parcel in the Salton Sea Known Geothermal Resource Area (KGRA) in Imperial County, southeast of the Salton Sea. The town of Niland is six miles northeast and the town of Calipatria is six miles southeast of the Project site. The Sonny Bono National Wildlife Refuge headquarters is 0.5 miles southwest of the Project.

The Project includes a 157 megawatts (MW) gross (140 MW net) geothermal electricity generating facility powered by steam sourced from super-heated geothermal brine. Electricity generated from the Project would be delivered via a new half-mile transmission line to the new Imperial Irrigation District switching station that would be built adjacent to the Project site.

More specifically, the MBGP would utilize geothermal fluid from the production wells near the power generating facility. The fluid will flow, without pumping, to and through above ground pipelines to the steam handling system where the fluid will be separated from the steam phase to produce high-pressure steam. Successive flashing ultimately produces low pressure steam to be used in the steam turbine to produce electricity.

The main components of the Project include a steam turbine generator system, geothermal fluid processing system, a single 14-cell cooling tower, 20 wells (including production and injection wells) and 12 well pads, and a 3.2-mile-long aboveground interconnection to an Imperial Irrigation District switching station to be constructed as part of the project. The project also includes geothermal production wells, pipelines, fluid and steam handling facilities, a solids handling system, a Class II surface impoundment (brine pond), a service water pond, a stormwater retention basin, process fluid injection pumps, a power distribution center, borrow pits, and injection wells.

The proposed Project site is within a bowl-shaped area that was likely previously used as freshwater pond for hunting purposes, but the ponds are currently dry.[1] The surrounding area consists of similar pond basins to the north, south, and west as well as other geothermal power plants,[2] including the Hudson Ranch Power l geothermal-fired electrical generating plant immediately east of the Project site across Davis Road.[3] According to the PSA, "[s]everal carbon dioxide (CO2) gas driven mud volcanoes, approximately 5-10 feet high, are sited at the vacant parcel southeast of the MBGP site." The PSA states that "[a]ncillary facilities are all on

[1] PSA, p. 3-2.
[2] See, *infra*, DISCUSSION, Section II. p. 18, for a list of existing thermal power plants and newly proposed geothermal developments.
[3] PSA, p. 3-2.

relatively flat, plowed, agricultural land, vacant property, equipment staging areas, or industrial (geothermal powerplant) areas."[4]

LEGAL BACKGROUND

I. CEQA AND CERTIFIED REGULATORY PROGRAMS

CEQA was enacted to effectuate the policy of the Legislature that "public agencies should not approve projects as proposed if there are feasible alternatives or feasible mitigation measures available which would substantially lessen the significant environmental effects of such projects."[5] The primary means of achieving this is the requirement that agencies prepare an environmental impact report ("EIR"), which serves as an "environmental alarm bell. . . to alert the public and its responsible officials to environmental changes before they have reached ecological points of no return."[6]

CEQA recognizes that certain regulatory programs may serve similar functions as CEQA and authorizes the Secretary of the Resources Agency to certify regulatory programs that meet specified requirements.[7] Certified regulatory programs are exempt from certain procedural requirements of CEQA, including the requirement to prepare an EIR.[8] The regulation of power plants greater than 50 MW under the CEC's Power Plant Site Certification program is a certified regulatory program. As such, the Power Plant Certification process is considered the "functional equivalent" of the EIR process.[9] Under the CEC's certified regulatory program, a preliminary staff assessment and final staff assessment are prepared, rather than a draft and final environmental impact report, and the CEC serves as the lead agency.[10]

While the Staff Assessment need not comply with CEQA's procedural requirements, it is not exempt from compliance with its substantive requirements. In approving a Staff Assessment, the CEC must conform not only to the CEC's regulatory provisions and process but also those provisions of CEQA from which it has not been specifically exempted.

Thus, a Staff Assessment, like an EIR, must disclose baseline environmental conditions, analyze the individual and cumulative environmental impacts of a proposed project, determine whether those impacts are significant, and adopt feasible mitigation measures or project

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[4] *Id*.
[5] Pub. Res Code § 21002.
[6] *Laurel Heights Improvement Assn. v. Regents of the University of California* (1988) 47 Cal.3d 376, 392 (quotations omitted).
[7] *Id.* § 21080.5.
[8] *Id.* § 21080.5(c).
[9] PRC § 21080.5; 14 CCR § 15251(j); *City of Morgan Hill v. Bay Area Air Quality* (2004) 118 Cal.App.4th 861, 867, 877.
[10] 20 CCR § 1742(b).

alternatives if significant impacts would occur.[11] The Staff Assessment must contain sufficient information to enable informed decision-making and must provide an opportunity for public review and comment before the lead agency makes a final decision.[12]

In addition, the Staff Assessment, like an EIR, must analyze the entire project being proposed for approval. A "project" is defined under CEQA as "the whole of an action" that may result in either a direct physical environmental change or a reasonably foreseeable indirect change.[13] Although a project may go through several approval stages, the environmental review accompanying the first discretionary approval must evaluate the impacts of the ultimate development authorized by that approval. This prevents agencies from chopping a large project into little ones, each with a minimal impact on the environment, to avoid full environmental disclosure.[14]

II. THE CEC POWER PLANT SITE CERTIFICATION PROGRAM AND STAFF ASSESSMENT PROCESS.

The CEC has the exclusive authority to certify the construction, modification, and operation of thermal electric power plants 50 MW or larger in California. The CEC certification is in lieu of any permit required by state, regional, or local agencies, and federal agencies to the extent permitted by federal law, for use of the site and related facilities, and supersedes any applicable statute, ordinance, or regulation of any state, local, or regional agency, or federal agency to the extent permitted by federal law.[15] The CEC must review power plant applications for certification to assess potential environmental, public health and safety impacts, engineering assessment related to facility efficiency, health and safety and potential measures to mitigate those impacts and ensure compliance with applicable governmental laws or standards.[16]

The CEC's siting regulations require staff to review proposed projects, assess whether potential environmental impacts have been properly identified, and whether the applicant's proposed mitigation or other, more effective, mitigation measures are necessary, feasible, and available.[17] Additionally, staff is required to assess the adequacy of the measures proposed by the

[11] PRC, § 21080.5(d)(3)(i)-(ii).
[12] See, *Sierra Club*, 7 Cal.4th at 1230-31; *Schoen v. Dept. of Forestry & Fire Protection* (1997) 58 Cal.App.4th 556, 573-74; *City of Morgan Hill*, 118 Cal.App.4th at 877.
[13] 14 Cal Code Regs §15378; see, *Habitat & Watershed Caretakers v. City of Santa Cruz* (2013) 213 Cal.4th 1277, 1297; *Banning Ranch Conservancy v. City of Newport Beach* (2012) 211 Cal.4th 1209, 1220.
[14] See, 14 CCR § 15003(h); *Bozung v. LAFCO* (1975) 13 Cal.3d 263, 283; see also *California Unions for Reliable Energy v Mojave Desert Air Quality Mgmt. Dist.* (2009) 178 Cal.4th 1225, 1249.
[15] Pub. Res. Code, § 25500.
[16] Pub. Res. Code, §§ 25519; 25523(d).
[17] 20 CCR § 1742.

applicant to ensure the assessment evaluates the safety and reliability of the project.[18] Staff is required to develop a compliance plan (coordinated with other agencies) to ensure that applicable laws, ordinances, regulations, and standards ("LORS") are met and adhered to.[19]

Under CEC's power plant site certification program, staff must "prepare a preliminary and final environmental assessment of the proposed site and related facilities."[20] "CEC staff prepares a preliminary staff assessment ["PSA"] that presents staff's initial analyses, conclusions, and recommendations to the applicant, intervenors, agencies, California Native American tribes, interested parties, and members of the public."[21] "[T]he PSA incorporates comments received from agencies, the public, parties to the siting case, and comments made at public meetings."[22] The final staff assessment "is the staff's independent report that describes and analyzes the significant environmental effects of a project, the completeness of the applicant's proposed mitigation measures, and the need for, and feasibility of, additional or alternative mitigation measures."[23] The main purpose of the staff assessment is to inform interested persons and the CEC of the environmental consequences of the Project.[24]

CEQA requires public agencies to avoid or reduce environmental damage when "feasible" by requiring "environmentally superior" alternatives and all feasible mitigation measures.[25] The EIR or the CEC's staff assessments serve to provide agencies and the public with information about the environmental impacts of a proposed project and to "identify ways that environmental damage can be avoided or significantly reduced."[26] If the project will have a significant effect on the environment, the agency may approve the project only if it finds that it has "eliminated or substantially lessened all significant effects on the environment where feasible" and that any unavoidable significant effects on the environment are "acceptable due to overriding concerns."[27] The lead agency may deem a particular impact to be insignificant only if it produces rigorous analysis and concrete substantial evidence justifying the finding.[28]

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[18] 20 CCR § 1742(b).
[19] 20 CCR § 1744(b).
[20] 20 CCR § 1742(b).
[21] PSA, p. 2-2.
[22] *Id.*; see, 20 CCR § 1742(c) ("After close of the comment period staff shall publish a final staff assessment, which shall include responses to comments on significant environmental issues received during the comment period.").
[23] 20 CCR § 1742(b).
[24] 20 CCR § 1742(b).
[25] CEQA Guidelines § 15002(a)(2) and (3); *see also*, *Berkeley Jets*, 91 Cal.App.4th 1344, 1354; *Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553, 564.
[26] CEQA Guidelines §15002(a)(2).
[27] PRC § 21081; CEQA Guidelines § 15092(b)(2)(A) & (B).
[28] *Kings County Farm Bureau v. City of Hanford* (1990) 221 Cal.App.3d 692, 732.

DISCUSSION

I. THE PSA FAILS TO ADEQUATELY ANALYZE AND MITIGATE THE PROJECT'S SIGNIFICANT ENVIRONMENTAL IMPACTS.

A. The PSA's Project Description is Incomplete.

The PSA omits key information about the Project that is necessary to analyze its environmental impacts. For example, the PSA does not disclose the manufacturer of the steam turbine, its year of manufacture, or model. Each of these specifications is important in assessing emissions from the turbine.[29]

B. The PSA Fails to Adequately Analyze and Mitigate the Project's Significant Air Quality Impacts.

1. The PSA's Project-Emissions Estimates are Unsupported.

The PSA states that emission estimates were derived from analytical data from other geothermal power plants in the area and vendor-provided data. Yet neither of these sources of information is provided. As noted above, the manufacturer of key pieces of equipment like the steam turbine is never disclosed. Similarly, the PSA does not disclose which other geothermal power plants were relied on, nor does it explain why emissions from the Project would be similar. Without disclosing this data, the PSA's emissions estimates are nothing more than mere conclusions, unsupported by substantial evidence.

Similarly unsupported is the PSA's assumption that "drift" of PM from the cooling tower will be 0.0005%.[30] This assumption drives the entire analysis of the Project's PM emissions, yet there is no discussion of why this number is used, how it will be achieved over the life of the cooling tower, and no testing is proposed to verify the assumption.[31] Numerous other assumptions are made about the cooling towers, without providing evidence to support those assumptions.[32]

Equipment and vehicle emissions estimates are based on emission factors from CalEEMod and EMFAC2021. Dr. Sahu explains that it is difficult, if not impossible, to discern how these emission factors were reached.[33] The models rely on a generic set of emission factors, equipment models and years, and activity levels for various types of projects. However, there is

[29] Ex. A, p. 2.
[30] PSA, p. 3-11.
[31] Ex. A, p. 10.
[32] See Ex. A, pp. 11-12.
[33] Ex. A, p. 11.

no evidence that the same assumptions used in the models are relevant to the Project.[34] "It is illogical to assume that the emissions of any pollutant from unknown pieces of equipment can be properly characterized by generic and non-transparent emission factors that may apply, at best, to generic classes of equipment and that are hard-wired into CalEEMod and EMPAC2021. The PSA surely cannot claim that every front-loader, for example, has the same emissions – as depicted in CalEEMod or EMFAC2021."[35]

The PSA also relies on unsupported assumptions about the Project's H_2S emissions. The PSA assumes that "H_2S emissions from the NCG stream are assumed to split between the gas phase and the condensate/liquid phase prior to reaching the cooling tower at a ratio of 60 to 40%, respectively (based on average source test results from Elmore). Thus, 60% of the total mass flow of H_2S in the steam is incorporated into the gas phase emissions calculations described above, while the other 40% is incorporated into the liquid/condensate calculations."[36] The basis for this 60:40 split, however, is not provided anywhere in the record.

Evidence must be provided to support each of these assumptions.

2. The PSA Fails to Adequately Analyze the Project's Significant PM_{10} Emissions.

The PSA improperly concludes the Project's operational PM_{10} emissions will be less-than-significant. Even without the Project or Morton Bay and Black Rock, the Project area is classified as a non-attainment area for O_3 and PM_{10} under state standards.[37]

TABLE 5.1-12 MAXIMUM AMBIENT AIR QUALITY IMPACTS DURING OPERATION (µg/m³)

Pollutant	Averaging Time	Project Impact	Background	Total Impact	Limiting Standard	Percent of Standard
PM10	24-hour	7.2	**474.7**	**481.9**	50	**964%**
	Annual	0.7	**48.6**	**49.3**	20	**247%**
PM2.5 [a]	24-hour	4.4	24.5	28.9	35	83%
	Annual	0.4	9.4	9.8	12	82%
	1-hour	1,326.6	5,726	7,053	23,000	31%

The Project's 24-hour and PM10 emissions would exceed the U.S. EPA PM_{10} SIL of 5 µg/m^3.[38] When the Project's emissions are added to the existing background levels, 24-hour PM_{10} levels will be 964% greater than the ambient air quality standard, and annual PM_{10}

[34] *Id*. at 11.
[35] *Id*.
[36] Imperial County Air Pollution Control District ("ICAPCD"), MBGP Preliminary Determination of Compliance ("PDOC"), p. 12.
[37] PSA, 5.1-3 to 4; Ex. A, p. 8. Since background measurements were taken at the Nihland monitoring station, further from the PM-generating Salton Sea than the project, the baseline conditions are be much higher at the Project site than the Nihland station. (Ex. A, p. 8.)
[38] PSA, p. 5.1-28.

emissions will be 247% higher than the standard.[39] The PSA improperly dismisses this impact as significant without providing and adequate justification.

Focusing only on residential sensitive receptors beyond the fence line[40] ignores impacts to onsite workers and nearby workers at farms and other facilities. These impacts must be accounted for. Moreover, there is justification as to why additional the Project's PM10 should be allowed into the local airshed that is significantly impacted with adequate analysis and mitigation.

3. The PSA Fails to Adequately Analyze the Project's Operational $PM_{2.5}$ Emissions.

The PSA improperly concludes the Project's $PM_{2.5}$ emissions will be less-than-significant. The Project's operational emissions of $PM_{2.5}$ will exceed the 2024 national ambient air quality standard (NAAQS) of 9 $\mu g/m^3$.[41] Dr. Sahu finds that operational emissions in excess of this standard constitutes a significant air quality impact.[42]

The PSA dismisses this potential impact because the 2012 NAAQS of 12.0 $\mu g/m^3$ was the applicable standard when the Project application was deemed complete. But compliance with a law or standard is not sufficient to support a finding of no significant impact, nor does it obviate the need for further analysis of environmental impacts. [43]

The PSA's finding that the Project's operational $PM_{2.5}$ emissions will be less than significant because it is below the outdated 2012 NAAQS is insufficient. The fact that the standard was lowered just months after the application was deemed complete is itself evidence that the 12.0 $\mu g/m^3$ was not sufficient to avoid environmental harm. Moreover, Dr. Sahu concludes that emissions exceeding the now-relevant standard of 9 $\mu g/m^3$ will significantly impact air quality both on a project-level, and cumulatively, when evaluated with other related projects.[44]

Without substantial evidence that exceedance of the 2024 NAAQS does not result in a significant impact on the environmental the PSA's less-than-significant finding is unsupported.

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[39] PSA, p. 5.1-27.
[40] See, PSA, p. 5.1-28.
[41] Ex. A, pp. 8-9; PSA, p. 5.1-3.
[42] Ex. A, p. 6.
[43] *Kings Cty. Farm Bureau v. City of Hanford* (1990) 221 Cal.App.3d 692, 712-18 (agency erred by "wrongly assuming that, simply because the smokestack emissions would comply with applicable regulations . . . the overall project would not cause significant effects"); *Californians for Alternatives to Toxics v. Dept. of Food and Agriculture* (2005) 136 Cal.App.4th 1, 17.
[44] Ex. A, p. 5.

4. The PSA Fails to Analyze and Mitigate Cumulative PM_{10} and $PM_{2.5}$ Emissions Resulting from a Shrinking Salton Sea.

The Project and its sister projects are located directly east of the Salton Sea.[45]

According to Dr. Sahu, the Salton see is drying-out and shrinking as a result of climate change.[46] As the Salton Sea shrinks, it exposes new dry playas to the wind, which increases fugitive dusts, and can amount to a substantial source of emissions of PM 2.5 and PM10.[47] Numerous studies corroborate Dr. Sahu's comments, finding the consequence of the drying Salton Sea "an environmental catastrophe."[48]

The PSA fails to evaluate the cumulative impacts to air quality as a result of the drying-out and shrinking of the Salton Sea. The PSA must consider the cumulative air quality impact caused by the Project, cumulative projects, and the reasonably foreseeable increased PM emissions and human health impacts resulting from the shrinking Salton Sea.

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[45] PSA, Figure 1-1, p. 1; see also, Ex. A, pp. 2, 4-5
[46] Ex. A, p. 4.
[47] *Id.* at 4-5.
[48] Jules Bernstein, *Why the Salton Sea is turning into toxic dust: Study identifies cause of lake's water loss* (Oct. 6, 2022), UC Riverside, available at https://news.ucr.edu/articles/2022/10/06/why-salton-sea-turning-toxic-dust; Emily C. Dooley, *A Drying Salton Sea Pollutes Neighboring Communities: Research Finds Higher Particulate Pollution After Water Diverted to San Diego* (May 29, 2024), UC Davis, https://caes.ucdavis.edu/news/drying-salton-sea-pollutes-neighboring-communities#:~:text=%E2%80%9CThere's%20lots%20of%20evidence%20that,over%20long%20periods%20of%20time.%E2%80%9D).

5. The PSA Fails to Adequately Analyze the Project's Significant Impacts on Human Health from Hydrogen Sulfide.

The PSA improperly dismisses the impacts of H_2S emissions by labeling it as only a nuisance, and mentioning that the Salton Sea are has episodic events that contribute to H_2S in the ambient air.[49] These factors do not support the PSA's dismissal of H_2S impacts. Rather, "adding tons of additional H_2S would . . . exacerbate whatever natural H_2S impacts . . . may already be occurring in the area."[50]

The PSA's H_2S analysis is also deficient in that it focuses solely on residential receptors. In doing so, it ignores potential impacts on future residential receptors closer than those present today, and it ignores potential impacts to on-site and nearby facility and farm workers. The PSA's "analysis does not provide assurances that workers at the MBGP will not be put in danger, even with OSHA protections such as protective equipment, as a result of the substantial H2S emissions from the MBGP."[51] Impacts from H_2S on facility and nearby farm workers must be analyzed and mitigated.

6. The PSA's Analysis of Secondary $PM_{2.5}$ Emissions is Not Supported by Substantial Evidence Because It Erroneously Omits Analysis of Ammonia and VOCs.

The formation of secondary $PM_{2.5}$ must be analyzed in addition to add to $PM_{2.5}$ directly emitted by the Project. While the PSA claims to have accounted for the formation of secondary $PM_{2.5}$, it is unclear if all precursors of secondary $PM_{2.5}$ were accounted for.[52] Specifically, it appears that secondary $PM_{2.5}$ from ammonia and VOCs was not accounted for.[53] The PSA discloses substantial emissions for amount and VOCs, and the secondary results of these emissions must be accounted for in the PSA analysis.[54] By failing to include secondary $PM_{2.5}$ from ammonia and VOCs, the PSA underestimates $PM_{2.5}$ emissions.[55]

7. Additional Errors in the PSA's Analysis of Particulate Matter Emissions.

i. Improper Assumptions to Minimize Impacts at Fence Line.

The PSA's analysis of the Project's PM emissions makes two unsupported assumptions. First, it assumes "[F]or modeling fugitive dust emissions from roadways, grading activities, and material loading/unloading, the applicant used a single area-poly source within the property, with

[49] PSA, p. 5.1-28, 5.1-29
[50] Ex. A, p. 14.
[51] Ex. A, p. 15.
[52] Ex. A, pp. 13-14
[53] *Id*.
[54] *Id*.
[55] *Id.*

a 10-m buffer from the nearest property boundary and assuming a ground-level release."[56] Second, it assumes that "…grading activities would not continuously occur within 10 m of the proposed facility fence line…"[57] Dr. Sahu explains that both of these assumptions are "designed…to minimize fence line impacts for PM."[58] The assumptions are also unlikely to be true because "internal plant maintenance or security needs will likely require access to the fence line and these roads will require construction and grading for maintenance."[59] To accurately disclose the magnitude of the impact of the Project's PM emissions, the air quality analysis must be redone without the assumption of a 10-meter buffer within which no continuous grading will occur.[60]

8. The PSA Fails to Analyze All of the Project's Potential Health Risks from Air Quality Impacts.

Even if Valley Fever is not considered to be endemic in Imperial Valley, disturbing soil has been linked to outbreaks in places where the fungus was not expected to live, according to the CDC. This potential impact must be fully analyzed in the PSA, and more robust monitoring for Valley Fever infections in the County from exposure to soil pathogens in dust should be required. the PSA should include an analysis of potential to asbestos, lead, bird waste, and other respiratory irritants, with specific attention made in CalEnviroScreen designated areas.

C. The PSA Fails to Adequately Mitigate the Project's Significant Air Quality Impacts.

1. The PSA Proposed Air Quality Mitigation Measures Violate CEQA.

Many of the mitigation measures proposed to address air quality impacts constitute deferred mitigation, while others fail to include an enforceable performance in violation of CEQA.[61]

Dr. Sahu reviewed the PSA's mitigation measures and conditions related to air quality and found that these measures were either inadequate, improperly deferred, lacked meaningful performance measures, or were unenforceable.[62] Specifically, Dr. Sahu reviewed all of the CEC

[56] PSA p. 5.1-23.
[57] *Id.*
[58] Ex. A, p. 13.
[59] *Id*.
[60] *Id.*
[61] See, CEQA Guidelines § 15126.4(a)(1)(B); *City of Maywood v. Los Angeles Unified School Dist.* (2012) 208 Cal.App.4th 362, 407; *Communities for a Better Environment v. City of Richmond* (2010) 184 Cal.App.4th 70, 92-93; *Oro Fino Gold Mining Corp. v. County of El Dorado* (1990) 225 Cal.App.3d 872, 884.
[62] See, Ex. A, pp. 15-17.

AQ-SCxx Conditions of Certification imposed by CEC staff. He also reviewed the various AQ-xx conditions mandated by Imperial County (which are reproduced in the PSA).[63]

Dr. Sahu reviewed the PSA's mitigation measures/conditions to reduce construction emission impacts from all onsite and offsite project activities, including combustion emissions and fugitive dust emissions.[64] These include implementation of the PSA's Conditions of Certification (COC) AQ-SC1 through AQ-SC5; and the applicant's submission of a Dust Control Plan to ICAPCD per Rule 801 and implementation of Best Available Control Measures per ICAPCD Rule 804.[65] Based on Dr. Sahu's review, it is his engineering judgement that these conditions, neither individually nor collectively, whether by the CEC or by Imperial County via its air permit, will:

(i) "provide any ability to verify the many assumptions made in estimating emissions from the various sources and activities as a result of the ENGP…."
(ii) "that mere submittal of "documentation" of control measures, such as dust controls during construction, as required per AQ-SC3, provides no assurance that such "controls" are effective…."
(iii) AQ-SC4, which requires a response to any dust plumes, is even more unenforceable because how it will be implemented is to be left to the future AQCMP, and it is unlikely to be meaningful given its…specificity about 400 feet and 200 feet, noted in the language of this condition.
(iv) the Imperial County's Compliance Conditions are ineffective…. because the verification of all of the General Conditions AQ-1 through AQ-15 all have the same, identical boiler-plate language: "[T]he project owner shall make the site available for inspection of records by representatives of the District, ARB, and the CEC." [66]

Similarly, Dr. Sahu's review also found the PSA's Facility Emissions and Operational Limits (AQ-16 through AQ-33); Emergency Limits (AQ-42, AQ-44, AQ-45); HBI Scrubber (AQ-48); and Monitoring Program (AQ-54) conditions were inadequate for mitigating the Project's operational emissions to less than significant levels because many rely on ineffective boilerplate language for verification as well as unenforceable verification conditions.[67] As such,

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[63] *Id.,* p. 16.
[64] Ex. A, pp. 16-17.
[65] PSA, p. 3-20. Dr. Sahu notes "that the stated Duct Control Plan is not currently available for review. It is not clear that any future submittal of such as Plan will be subject to public review. In addition, AQ-SC2 requires a submittal of an Air Quality Construction Mitigation Plan (AQCMP) – see PSA, p. 5.1-38. This Plan too is unavailable for public review and it is not clear that it will be subject to future public review." (Ex. A, p. 16 fn. 40.) CEQA prohibits deferred mitigation and substantial new information added but no new opportunity for public review.
[66] Ex. A, p. 16.
[67] See, *id.*, p. 17.

the PSA fails to adequately mitigate the geothermal power plant's significant construction and operational air quality impacts.

2. The PSA Fails to Mitigate Significant Cumulative Air Quality Impacts from a Shrinking Salton Sea.

Because the worsening in air quality resulting from the Salton Sea drying out and shrinking would significantly impact public health as a result of increased dust pollution in the region, the impact should also be analyzed and mitigated. Air flow models in the PSA should include those that measure pollutant transport to other areas of Imperial County, air basins, and air districts to determine what appropriate mitigation measures are needed to adequately control dust pollution.

For example, mitigation should be required to pave unpaved roads 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 ICAPCD's PDOC prepared for the Project.[68] Internal combustion engines proposed by the Applicant may be exempt from emission limits if they are emergency standby engines.[69] However, 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.

D. <u>The PSA Fails to Adequately Analyze and Mitigate the Project's Significant Hazards and Hazardous Materials Impacts as Well as Related Water Quality Impacts.</u>

SAFER also retained water quality, hazards, and hazardous materials expert, Dr. Joseph E. Odencrantz, Ph.D., P.E., BCEE, PH, to review the Project and PSA to determine whether the Project's geothermal power plant would have significant hazards and hazardous materials impacts.

Dr. Odencrantz reviewed the PSA's hazards and hazardous materials impact analyses and concluded that there is substantial evidence of potentially significant environmental impacts for two of the PSA's items: *5.7.2 Hazards, Hazardous Materials, and Wildfire sections a. and b*.[70] *Section a.* considers: "Would the project create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?"[71] *Section b.* considers*:* "Would the project create a significant hazard to the public or the environment

[68] See, ICAPCD, MBGP PDOC, 2024, pp. 32; 38.
[69] *Id*., p. 31.
[70] PSA, pp. 5.7-12–5.7-13; Ex. B, p. 1.
[71] PSA, p. 5.7-13.

through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?"[72]

According to Dr. Odencrantz, "[t]he possibility of an accident or upset is real and would create a ***potentially significant impact***/hazard to the environment and the public."[73] As such, he strongly recommends the hazards and hazardous materials impacts discussed in below, are modified from less than significant with mitigation to potentially significant impacts.[74]

1. The PSA Fails to Adequately Analyze the Impacts of a Geothermal Well Failure Resulting in a Potentially Significant Hazardous Material Release.

The PSA's hazards section failed to consider the likelihood of the Project experiencing a geothermal well failure during its lifetime, and the impact of a potential hazardous material release resulting from a failure.[75] Dr. Odencrantz reviewed the Project and PSA and found potentially significant impact resulting from well failure that the PSA fails to disclose, analyze, and mitigate.

Dr. Odencrantz explains that geothermal well failure can occur for a variety of reasons, which the PSA failed to address.[76] For example[77]:

- Strength loss due to temperature elevation
- Mechanical wear of casing inner side
- Buckling due to thermal stress and pure cementing job
- Corrosion (internal and external) and scaling
- Decoupled casing joints due to thermal stress
- Buckling of the casing at some interval in well
- Failure of cement exposed to cyclic loads
- Failure of casing material exposed to cyclic loads
- Well head damage as a result of thermal expansion and poor cementing
- Accident during drilling phases related to caustic soda
- Failing well casings, cement, and rock as a result of stress/strain due to changes in fluid pressure/temperature during geothermal plant operations

[72] *Id.*
[73] Ex. B, p. 1.
[74] See, Ex. B, pp. 2-4.
[75] See, Ex. B, pp. 2-3.
[76] Ex. B, pp. 2-3 (For example, "[c]hanges in pressure and temperature in geothermal wells can result in mechanical failure of the well and the geological formation near the catastrophic blowout area.").
[77] *Id*., pp. 2-3.

According to Dr. Odencrantz, "[t]here are numerous other risk factors for accidents during the operational phase as well as the possibility of a blowout (in the worst-case scenario where an installed blowout prevention device fails or otherwise)."[78] The CEC has stated in a report on geothermal energy production in California, that "[i]t…found that the biggest risk of mechanical failure during the initial startup of production because of large and rapid temperature increases from initially cool temperatures near the ground surface."[79]

There is substantial evidence that a well failure during construction or operation of the Project is reasonably foreseeable. Dr. Odencrantz explains that well failure can have a significant impact by causing shallow groundwater contamination or a discharge to the surface, resulting in waste or exceedance of water quality standards.[80]

The U.S. EPA reported brine from geothermal wells in the Salton Sea contain six chemical constituents that considerably exceed drinking water standards.[81] These include the following drinking water standards and exceedances[82]:

1. Lead: drinking water standard is 0.015 mg/L, while the brine concentration is up to 102 mg/L (6,800 times greater than the standard)
2. Manganese: drinking water standard is 0.050 mg/L, while the brine concentration is up to 1,500 mg/L (30,000 times greater than the standard)
3. Cadmium: drinking water standard is 0.005 mg/L, while the brine concentration is up to 2.3 mg/L (460 times greater than the standard)
4. Barium: drinking water standard is 2 mg/L, while the brine concentration is up to 353 mg/L 176 times greater than the standard)
5. Zinc: drinking water standard is 5 mg/L, while the brine concentration is up to 518 mg/L (103.6 times greater than the standard)
6. Total Dissolved Solids: drinking water standard is 150 mg/L, while the brine concentration is up to 260,000 mg/L (521 times greater than the standard)

There are also likely other hazardous constituents in the brine that must be determined and disclosed, including potentially: radium, thorium, radon, antimony, chloride, arsenic, chromium, copper, orpiment, stibnite, antimony, ammonia, mercaptans, sulfides, mercury, iron, selenium, silver, petroleum hydrocarbons, uranium, methane, nitrate and carbocyclic acids.[83]

Significantly, "[t]he ultra-complex nature of high flow geothermal extraction and reinjection systems cannot be engineered, constructed, designed or monitored such that there is

[78] *Id*., p. 2.
[79] *Id.*, pp. 2-3 (quoting CEC report CEC-500-2-23-042).
[80] Ex. B, p. 2.
[81] Ex. B, p. 3.
[82] *Id*.
[83] *Id*.

no possibility of failure."[84] "A failure resulting in a catastrophic release of hot geothermal brine near the surface must be considered and may result in a potentially significant environmental impact."[85]

The chemical constituents of the brine must be disclosed, and the potential impacts to ground water, surface water, and human health impacts in the event of a well failure or blowout must be disclosed, analyzed, and mitigated in the PSA.

2. The PSA Fails to Adequately Analyze Seismic Activity and Subsidence Hazards Related to the Project.

Numerous studies have reported a correlation between seismic activity and geothermal well system operations. For example, Dr. Odencrantz points to the U.S. Department of Energy's November 22, 2023 report, *Characterizing the Geothermal Lithium Resource at the Salton Sea*, in which a thirty-year time history of seismic activity near geothermal wells located in the Imperial Valley was analyzed and that seismic activity was reported to correlate with the operation of geothermal well system operation.[86]

There have also been instances of geothermal energy projects causing moderate earthquakes in recent history.[87] For example, Dr. Odencrantz points to a geothermal project in Pohang, Korea that was found to have caused a 5.5 magnitude earthquake 2017.[88] In this instance, "[w]ater was injected at pressure in a well which 'began to activate an unknown fault.' The unknow fault intersected the well. It was determined 'Pressure migrating into the fault zone reduced the forces that would normally make it difficult for the fault to move. Small earthquakes lingered for weeks after the operators turned the pumps off or backed off the pressure.'"[89] Accordingly, Dr. Odencrantz states that "[i]t is necessary to perform a detailed examination of all known faults, fractures (fracture mapping), shears and other heterogeneities that may result in either seismic activity or catastrophic land subsidence (settlement)."[90]

Subsidence is also related to geothermal energy projects. According to Dr. Odencrantz, "there are numerous processes that contribute to land subsidence in geothermal areas such as seismic activity, preconsolidation, fracture closing, thermal contraction and a variety of other factors."[91]

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[84] *Id*., p. 4.
[85] *Id*.
[86] *Id*., pp. 3-4.
[87] *Id*., p. 4.
[88] *Id*.
[89] *Id*.
[90] *Id*.
[91] *Id*.

The PSA fails to adequately analyze the potentially significant hazards related to seismic activity and subsidence and the massive amount of geothermal brine extraction proposed by this Project.[92] Given the likely hazardous correlation between seismic activity and the Project's proposed extremely large brine extraction, Dr. Odencrantz determined that "[a] thorough analysis must be conducted to determine the increased risk of hazards caused by earthquakes, as a result of operation of the proposed geothermal production and injection wells, so that the hazards related to significant impacts to the environment can be evaluated."[93]

Even though CALGEM requires an injection plan be submitted as part of the well permitting process, potentially significant risks to the environment from well failure or other operational accidents must be addressed as part of the Project's PSA.[94] This includes an adequate analysis of the significant seismic hazards that could occur as a result of well failure or other operational accidents.

3. The PSA's Conclusion that the Project Will Not Have Significant Hazardous Waste Generation Impacts Lacks Substantial Evidence Because the PSA Omits Information Regarding Transportation of the Project's Hazardous Waste and Landfill Capacity.

The PSA lacks substantial evidence to support its conclusion that the hazardous waste risks from transportation and landfill accidents will be mitigated to less than significant.[95] According to OSHA, geothermal filter cake "causes damage to organs-lungs through prolonged and repeated exposures."[96] The Project will produce an estimated 1,179 metric tons of hazardous filter geothermal filter cake.[97] Storage and disposal of hazardous materials from the Project, including filter cakes, must be stored and disposed of in compliance with numerous laws, and must be disposed of in a licensed treatment, storage, and disposal facility.[98]

The PSA fails to identify what portion of hazardous wastes will be transported to which disposal facility, and whether those facilities have adequate capacity to accept the hazardous wastes.[99] This information is critical to determining whether the transportation, disposal, and storage of hazardous waste that could pose significant risks to public health and safety if improperly transported, discharges, and stored.[100] Without this information, the PSA lacks

[92] See, Ex. B, pp. 3-4.
[93] *Id.*, p. 3.
[94] *Id.*, p. 4.
[95] *Id*., p. 5.
[96] *Id*.
[97] *Id*.
[98] *Id*.
[99] *Id*.
[100] *Id*.

evidence to support its finding that the Project's hazardous waste will have a less than significant impact.[101]

4. The PSA Fails to Adequately Analyze the Project's Potential Impacts to Safe Drinking Water from Underground Injection Wells.

Class V injection wells, such as those proposed as part of the Project, pose a risk to sources of drinking water. The U.S. EPA explains that "Class V wells are a concern because they pose a risk to underground sources of drinking water."[102] Because "[t]he ultra-complex nature of high flow geothermal extraction and reinjection systems cannot be engineered, constructed, designed or monitored such that there is no possibility of failure,"[103] the PSA should include a threat assessment for the Project that assess the risks of the Project's injection wells contaminating underground sources of drinking water in the area.[104]

II. THE PSA FAILS TO ADEQUATELY ANALYZE THE PROJECT'S SIGNIFICANT CUMULATIVE IMPACTS.

PSAs, like EIRs, must analyze and mitigate a Project's cumulative impacts. "The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time."[105] A legally adequate cumulative impacts analysis views a particular project over time and in conjunction with other related past, present, and reasonably foreseeable probable future projects whose impacts might compound or interrelate with those of the project at hand. "Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time."[106]

There are several existing geothermal projects near MBGP including Cal Energy Generation Region 1 (Units 1 to 5); Cal Energy Generation Region 2 (Vulcan, Hoch, and Turbo-expander plants); Elmore; Leathers; and Hudson Ranch Power I. Hell's Kitchen is located near the Project site, and as of January 2024, is currently undergoing construction. In addition, BHE Renewables Black Rock and Elmore North projects are undergoing CEC review at this same time as MBGP. Despite the potential for numerous overlapping environmental impacts, the PSA

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[101] See, PSA, p. 3-14–3-16.
[102] EPA, *Basic Information About Class V Injection Wells*, available at https://www.epa.gov/uic/basic-information-about-class-v-injection-wells.
[103] *Id*., p. 4.
[104] *Id*.
[105] *Communities for a Better Environment v. Cal. Resources Agency* (2002) 103 Cal.App.4th 98, 117.
[106] CEQA Guidelines § 15355(b).

fails to adequately analyze the cumulative impacts of these and other reasonably foreseeable projects.

A. The PSA Fails to Adequately Analyze the Project's Cumulative Air Quality Impacts.

The PSA's analysis failed to adequately evaluate cumulative impacts in the ICAPCD, which is already severely degraded. There are a number of deficiencies in the analysis that must be addressed.

First, it fails to provide information necessary to understand the Project's cumulative emissions in the short and long term.[107] Dr. Sahu explains the PSA must disclose all pollutants that can be emitted from the Project, including both criteria pollutants and all other air pollutants that will result from construction and operation of the Project.[108] Then, "the short-term and long-term maximum emissions rates for all of the pollutants identified in the prior step need to be developed using fully supported assumptions."[109] Finally, the PSA must disclose and evaluate "all presently operating sources and their emissions and foreseeable future sources that affect the same pollutant-specific zones of influence (i.e., on a pollutant-by-pollutant basis) but are not otherwise included in the background value, so that the "cumulative" impacts are addressed."[110] This analysis should also include sources that have already been permitted but have not yet begun operations.[111] The PSA fails to provide all of this information, and of the information that is provided, much of it is unsupported by substantial evidence.

Next, the PSA also improperly limits the scope of the cumulative impact analysis to a "6-mile zone of influence" for all air pollutants based only on "staff's modeling experience." The supposed experience of unidentified staff with unidentified experience does not constitute substantial evidence. No information is provided as to what types of power plants the staff person(s) has experience with, which pollutants, or why any staff person's experience is relevant to this Project. The zone of influence must be calculated on a pollutant-by-pollutant basis, and evidence supporting the zone of influence must be provided beyond just "experience."[112]

The analysis of cumulative air impacts is also deficient because it excludes all stationary sources "with emissions of less than five tons per year (tpy) as *de minimus*" citing to unidentified "previous power plant proceedings."[113] The PSA also lacks substantial evidence to support exclusion of smaller stationary sources. Dr. Sahu explains that "Even if this is true in the context of power plants with tall stacks and different dispersion characteristics, the use of this cut-off in

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[107] Ex. A, pp. 7-8.
[108] *Id*.
[109] *Id*.
[110] *Id*., p. 7.
[111] *Id*.
[112] Ex. A, p. 7.
[113] PSA, 5.1-34.

the case of the MBGP analysis is not supported. As a result, the cumulative impacts analysis only included the three projects: MBGP, Elmore, and Black Rock."[114]

Similarly, the PSA improperly excluded localized impacts during construction based only on a "qualitative demonstration" of "unlikely" overlap of these emissions from nearby sources.[115] The PSA lacks evidence to exclude any other cumulative construction based impacts and is based on nothing more than speculation.[116]

Because the cumulative air quality impact analysis is incomplete and contains unsupported assumptions, it is not reliable and likely underestimate cumulative impacts over the life of the Project.[117] The PSA's cumulative impacts analysis should be updated and revised to reflect Dr. Sahu's comments.

III. THE PSA IMPROPERLY PIECEMEALS THE PROJECT BY OMITTING ANALYSIS OF THE PROJECT'S REASONABLY FORESEEABLE FUTURE LITHIUM EXTRACTION OPERATIONS.

PSAs, like EIRs, must analyze possible future expansion or other actions related to a project that are a "reasonably foreseeable consequence" of the project.[118] This rule implements CEQA's prohibition against dividing a single large project into a series of smaller projects, resulting in "piecemeal" environmental review that fails to consider the impacts of the whole undertaking.[119]

A complete project description is necessary to ensure that the environmental impacts of the entire project are considered.[120] A lead agency may not split a single large project into smaller ones resulting in ***piecemeal*** environmental review that fails to consider the environmental consequences of the entire project.[121] It is irrelevant that the development may not receive all necessary entitlements or may not be built. Piecemeal environmental review that ignores the environmental impacts of the end result is not permitted.[122]

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[114] Ex. A, pp. 8-9 (citing PSA, Table 5.1-15 and associated discussion on p. 5.1-34).
[115] PSA, p. 5.1-34, 5.1-36.
[116] Ex. A, p. 9.
[117] *Id.*, p. 8.
[118] *Laurel Heights Improvement Ass'n v. Regents of Univ. of Cal.* (1988) 47 Cal.3d 376, 396.
[119] See, *East Sacramento Partnership for a Livable City v. City of Sacramento* (2016) 5 Cal.5th 281, 293; *Banning Ranch Conservancy*, 211 Cal.4th at 1222; *Planning & Conserv. League v. Castaic Lake Water Agency* (2009) 180 Cal.4th 210, 235.
[120] *City of Santee v. County of San Diego* (1989) 214 Cal.3d 1438, 1454.
[121] *East Sacramento Partnership for a Livable City v. City of Sacramento* (2016) 5 Cal.5th 281, 293; *Banning Ranch Conservancy v. City of Newport Beach* (2012) 211 Cal.4th 1209, 1222; *Communities for a Better Env't v. City of Richmond* (2010) 184 Cal.4th 70, 98.)
[122] *Christward Ministry v. Superior Court* (1986) 184 Cal.3d 180, 193 (EIR should have been required for general plan amendment designating existing landfill site to permit various waste-

Despite evidence that the geothermal plant is really just the first phase of a larger plan to extract lithium from the Sultan Sea, the PSA ignores the impacts of future lithium extraction operations. In doing so, the PSA improperly piecemeals the Project.

A. Future Direct Lithium Extraction is a Reasonably Foreseeable Consequence of the Project.

Substantial evidence indicates the Applicant's intent to co-locate future lithium extraction operations and use the geothermal infrastructure and brine to support lithium extraction operations. It is well known within the industry that BHE Renewables plans to modify its geothermal power plants in the Salton Sea area to extract lithium from geothermal brine. Numerous sources indicate that geothermal extraction is only the first phase of a larger project, and that BHE Renewables intends to add lithium extractions at the facility.[123] Indeed the Applicant itself, on June 4, 2024, issued a press release to announce that the company formed a joint venture to commercialize TerraLithium extraction technology.[124] The press release states that "[u]pon successful demonstration, BHE Renewables plans to build, own and operate commercial lithium production facilities in California's Imperial Valley.[125]A factsheet about the Applicant's current and future operations is also publicly available on Berkshire Hathaway Energy's website and explains:

> BHE Renewables is developing three geothermal power plants totaling 357 megawatts near its existing facilities in Imperial Valley. Upon successful completion of development, construction of the plants could begin as soon as 2025 and be online starting in 2030, leading to clean baseload energy for California and

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disposal activities even though EIR would be required later if use permits were actually sought for such activities); see also, *Nelson v. County of Kern* (2010) 190 Cal.4th 252 (county's CEQA review of mining project on federal land, reviewed under NEPA and approved by BLM, violated CEQA because it failed to consider impacts of mining operations and was limited to impacts of reclamation plan).

[123] See, e.g., Ernest Scheyder, *Insight: U.S. steps away from flagship lithium project with Buffett's Berkshire* (October 5, 2022), Reuters, available at https://www.reuters.com/markets/us/us-steps-away-flagship-lithium-project-with-berkshire-2022-10-05/.

[124] BHE Renewables, LLC, *Occidental and BHE Renewables Form Joint Venture to Commercialize TerraLithium Extraction Technology* (June 4, 2024), available at https://www.bherenewables.com/news/customers/occidental-and-bhe-renewables-form-joint-venture--to-commercialize-terralithium-extraction-technology.

[125] *Id.*; see also, Occidental, *Occidental and BHE Renewables Form Joint Venture to Commercialize TerraLithium Extraction Technology* (June 6, 2024), available at https://www.oxy.com/news/news-releases/occidental-and-bhe-renewables-form-joint-venture-to-commercialize-terralithium-extraction-technology/.

> an abundant supply of lithium-rich brine to support BHE Renewables' lithium development project.[126]

Additionally, the 2022 Berkshire Hathaway Energy Investor Presentation posted on Berkshire Hathaway's official website states that "[i]If the demonstration projects are successful in confirming commercial viability, BHE Renewables expects to begin construction of its first commercial lithium facility [in Imperial County, California] as early as 2024."[127]

In addition, the Project only proposes to build on 51 acres of a much larger 160-acre parcel.[128] There are no use restrictions on the remainder of the parcel, and it is likely that the remainder will be used for the second phase of the project – lithium extraction.

The PSA ignores the environmental consequences of the Applicant's reasonably foreseeable second phase of the Project.

B. Future Direct Lithium Extraction will have Potentially Significant Environmental Impacts that the PSA Must Analyze and Mitigate.

Future lithium extraction operations at the Project site will have significant impacts on air quality, individual and cumulatively. Dr. Sahu explains:

> The actual pollutants and the levels at which they can be emitted from lithium extraction processes can vary depending on the composition of the groundwater and the various surface activities (and potential air emissions sources) that are implemented. These will likely include particulate matter containing heavy metals as well as potentially acidic gases like hydrogen chloride. In addition, construction-related emissions will occur. And, to the extent that lithium extraction will lead to development of downstream processing such as the conversion of the extracted lithium into batteries, those activities and processes will also generate pollutants. As a result, simply ignoring the air emissions impacts from lithium extraction as the PSA does, underestimates very plausible additional pollutants that will be emitted over the same time period as the MBGP's operational lifetime.[129]

In addition to air quality impacts, lithium extraction will also cause hazardous waste impacts and will create new significant hazards to workers and the public, as well has additional

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[126] Berkshire Hathaway Energy, BHE Renewables Fact Sheet, p. 2, available at https://www.brkenergy.com/our-businesses/bhe-renewables.
[127] Berkshire Hathaway, 2022 Berkshire Hathaway Energy Investor Presentation, *BHE Renewables Lithium Update*, p. 70, available at https://www.berkshirehathaway.com/bhenergy/BHE2022InvestPresent.pdf.
[128] PSA, p. 1-2.
[129] Ex. A, p. 4.

risks to water quality. Dr. Odencrantz found that the Project could result in significant hazardous waste and water quality impacts from the Project's future lithium extraction operations.[130]

Commercial lithium extraction will also have adverse impacts on communities near the Salton Sea. As CCTS explains, "[c]ommunities near the Salton Sea have experienced decades of environmental injustices. The receding Salton Sea has introduced toxic contaminants into the air, and residents there have some of the highest rates of asthma in California. While lithium extraction has the potential to economically revitalize the area, benefits to community members are not guaranteed, nor have communities and Indigenous Tribes had all their questions sufficiently addressed." ("Lithium Extraction from Geothermal Brine – Technology and Impacts," CCST, Dec. 15, 2023, p. 2.)

A revised PSA must consider the potential significant impacts that the Project's reasonably foreseeable future lithium extraction activities may have on the environment.

IV. THE PSA FAILS TO ADEQUATELY ANALYZE THE FORESEEABLE CHANGES TO THE PROJECT'S ENVIRONMENTAL SETTING AS IT RELATES TO AIR QUALITY OVER ITS EXPECTED LIFE.

Dr. Sahu's review of the Project and the PSA's air quality impacts analysis found that the PSA failed to adequately evaluate the environmental setting over the Project's expected lifetime, which is 40 years or longer.[131] While the PSA recognizes this, Dr. Sahu notes that "the air quality analysis presented is premised on an assumption that the context and setting into which the MBGP's air quality impacts will be imposed will remain unrealistically static and unchanging over the same 40+ years as they exist today."[132] According to Dr. Sahu, "[t]his makes no sense," and is improper because there are several examples of setting/context that can or could change over the lifetime of the Project, which should have been considered in the air quality analysis but have not been.[133] Dr. Sahu provided the following non-exhaustive examples of the setting/context that can and could change over the Project's expected life that would impact air quality in the region that should be considered in the PSA, including:

- **Changing regulatory standard** – *e.g.*, the revised annual PM2.5 NAAQS, which became effective on May 6, 2024, after the Project's permit application was deemed complete on June 22, 2023.[134] As Dr. Sahu notes, "[s]ince the revised PM2.5 NAAQS is a certainty" and because "the Project would violate the LORS and would pose unacceptable and significant impacts if the revised PM2.5 NAAQS were properly

[130] Ex. B, pp. 15-16.
[131] See, Ex. A, pp. 4-7.
[132] Ex. A, p. 4.
[133] *Id.*; see also, *id.*, pp. 4-7.
[134] See, Ex. A, pp. 4-6.

considered," "the air quality analysis has an obligation to fully consider and include it in the analysis, in order to fully evaluate the impacts of the Project."[135]

- **Changes to the Salton Sea.** As discussed above, the Salton Sea is drying-out and shrinking as a result of climate impacts in the Southwest United States, causing substantial additional and massive PM (including PM2.5 and PM10 or varying compositions, including toxic metals) to be emitted into the general vicinity of the Sea.[136] However, as Dr. Sahu points out, the PSA's "static air quality analysis makes no mention, much less any consideration, of this very realistic change in the setting that has the potential for dramatic impacts of PM10/PM2.5 in the area. These dramatic impacts will manifest themselves as increased 'background' levels of PM10/PM2.5 over time."[137] According to Dr. Sahu, "these types of secular changes that can and will occur over the same time period as the MBGP itself" and "will be real and unavoidable." As such, "[t]he PSA should consider this impact or make the case as to why the CEC staff believe that this change in the Salton Sea's levels will not occur in the next 40+ years."[138]

- **Changes to the Population and Population Patterns in the Area.** The PSA's air quality impact analysis improperly dismisses potential future adverse and unacceptable impacts at the Project's fence line ass inconsequential.[139] This is because the PSA's analysis only considers a project setting in which there are no nearby residents or neighbors.[140] However, Dr. Sahu states that "[t]he PSA fails to address why, in the future, especially, if there is additional economic activity in the area, there may not be future residents closer than presently, to the MBGP."[141] "Compounding this further, … the impacts analysis even at the fence line is underhandedly deficient because of an assumed, unenforceable, 10-meter 'buffer' inside the fence line, where supposedly no pollutant-generating activities will continuously occur."[142] Dr. Sahu concluded that "the PSA should not minimize high and unacceptable impacts at the facility fence line – and, in effect, accept them – claiming that these impacts decay (rapidly) away from the fence line."[143]

- **High Likelihood for Lithium Extraction.** As discussed above, the PSA and its air quality impacts analysis also failed to consider the high likelihood that the Project

[135] *Id.*, p. 6.
[136] See, Ex. A, p. 6.
[137] *Id.*, p. 6.
[138] *Id.*
[139] Ex. A, p. 7.
[140] *Id.*, p. 7; PSA, p. 5.1-28 (stating that "[t]he closest residence (sensitive receptor) to the project site is about 970 m (about 0.6 miles) west-southwest of the project boundary").
[141] Ex. A, p. 7.
[142] *Id.*
[143] *Id.*

> will be modified in the near future to include lithium extraction and will result in additional air quality impacts on top of those impacts to air already caused by producing power from geothermal energy.[144] These impacts will likely include increased operational particulate matter emissions containing heavy metals and potentially acidic gases like hydrogen chloride; construction-related emissions; "[a]nd, to the extent that lithium extraction will lead to development of downstream processing such as the conversion of the extracted lithium into batteries, those activities and processes will also generate pollutants."[145] Therefore, CEC's failure to evaluate the increased air emission impacts due to future lithium extraction has resulted in the PSA underestimate[ing] very plausible additional pollutants that will be emitted over the same time period as the MBGP's operational lifetime."[146]

By ignoring these reasonably foreseeable changes in critical aspects of the setting and context in the PSA's air quality analysis, the conclusions of the analysis are fatally compromised, and therefore cannot be relied upon. The PSA should be revised to analyze these future reasonably foreseeable changes in the setting/context of the Project, and recirculated for public review.

CONCLUSION

SAFER respectfully requests that CEC address the PSA's shortcomings discussed above in a revised PSA and recirculate that PSA for public review and comment. Thank you for considering these comments.

Sincerely,

Victoria Yundt
Lozeau Drury LLP

[144] Ex. A, p. 4.
[145] *Id.*
[146] *Id*.

EXHIBIT A

Comments on the Deficient Air Quality Analysis in the California Energy Commission Preliminary Staff Assessment for the Morton Bay Geothermal Project, June 2024 CEC-700-2024-003-PSA, DOCKET NUMBER 23-AFC-01

by

Dr. Ranajit (Ron) Sahu, Consultant[1]

A. Summary

Comments are provided on the deficient air quality analysis for the Morton Bay Geothermal Project ("MBGP" or "Project") prepared by the staff of the California Energy Commission (CEC) as part of the Preliminary Staff Assessment (PSA) for that Project dated June 2024. These comments were developed based on a careful review of the PSA[2] as well as documents cited in the PSA's air quality section – namely technical analyses conducted by the MBGP's consultant, Jacobs. In addition, permitting documents relevant to the MBGP were also reviewed.

In summary, the analysis of potential air quality impacts from the proposed MBGP over the course of its anticipated life of 40 years or more[3] is deficient, and often fatally so. As such, for the reasons stated in these comments, the conclusions of the PSA that air quality impacts of the MBGP meet all applicable laws, ordinances, regulations, and standards (LORS) and are not significant after mitigation[4] are unsupported and erroneous. Much of the analysis relies on inputs and assumptions whose basis is not identified or available for the public to review. And, to the extent verification conditions for such assumptions are included in the PSA (including those carried over from the Imperial County Air Pollution Control District's Preliminary Determination of Compliance), they are so general as to be worthless. The poor and unsupported air quality impacts analysis of the MBGP is further magnified in the cumulative impacts analysis presented in the PSA. Based on the analysis presented, the public, including workers at this facility and the two sister facilities that are proposed in the same geographical area, are likely to face significant adverse air quality impacts over the operating duration of the MBGP.

It should be noted that these comments do not address each and every single deficiency in the air quality analysis. Rather, they focus on the major deficiencies. In some cases, deficiencies that are emblematic of a class of deficiencies (such as emissions calculations and estimates, compliance verification conditions, etc.) are provided as examples and not meant to be exhaustive.

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[1] Resume provided in Attachment A.

[2] Unless otherwise indicated, citations are to the PSA and are identified either as page number, section number, or some other readily-identifiable reference such as Table or Figure number.

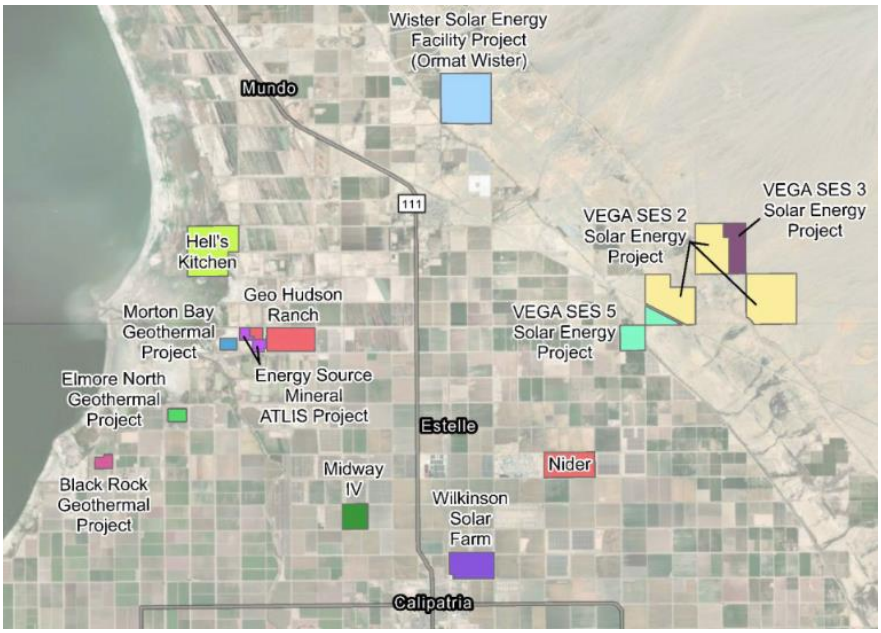
[3] PSA, Section 3-9. This Section confirms that the "….economic life of the MBGP facility is 40 years. However, if the facility were economically viable at the end of the 40-year operating period, it could continue to operate for a much longer period."

[4] PSA, Table 1-1. See also PSA p. 1-4 and Section 5.1.2.

B. The Project

As stated in the PSA:[5] "[T]he MBGP is proposed in the Salton Sea Known Geothermal Resource Area (KGRA), in Imperial County, south of the Salton Sea. The project would be in an agricultural area approximately six miles northwest of the town of Calipatria. The project would consist of a 157-megawatt (MW) (140 MW net) electricity generating facility powered by steam sourced from super-heated geothermal brine. The MBGP would provide electricity via a new 3.2-mile transmission line to deliver power to a new Imperial Irrigation District (IID) switching station to be built adjacent to the proposed Elmore North Geothermal project site, under the same ownership."

The Figure[6] below shows the geographical area of the MBGP as well as other nearby projects. In particular, the Elmore North Geothermal Project and the Black Rock Geothermal Projects are believed to be "sister" projects under common ownership as the MBGP.[7]



Section 3.1 of the PSA confirms that while the MBGP is an electric power generating facility, even the most basic information about the MBGP – namely the manufacturer of the steam turbine, its year of manufacture, and model type – are not known.[8] These details are important in assessing the emissions from the turbine.

Section 3.2 of the PSA notes that "[T]he MBGP facility is sited within a bowl-shaped area that was likely previously used as a freshwater pond(s) for hunting purposes. The ponds are currently

[5] PSA p. 1-1.
[6] PSA Figure 1-1.
[7] PSA p. 4.2-3 refers to the collection of these three related projects as the "BHE Renewables, LLC projects."
[8] PSA, Section 3.1.

dry…." Further, Section 3.2 also notes that "[S]imilar pond basins (some dry) are adjacent to the north, south and west boundaries of the site." In addition, the PSA confirms that there are "[S]everal carbon dioxide (CO_2) gas driven mud volcanoes, approximately 5-10 feet high, are sited at the vacant parcel southeast of the MBGP site."[9]

In addition to the onsite facilities described in Section 3.1, Section 3.4 of the PSA notes the extensive "ancillary" facilities that will be needed for the MBGP and its sister facilities. As Section 3.4 confirms, "[P]roject-related ancillary facilities within five miles of the project site, include production and injection well sites, utilities, wells, and well pads, aboveground production and injection pipelines, laydown yards, construction camps, and borrow pits and require jurisdictional approval by agencies other than the CEC. An integral plant instrument air system provides compressed, dry air for use in instruments and control devices. A standby air compressor and standby ancillary equipment (regenerative air drier, receiver, and instrumentation) also will be provided for added reliability. The fire water system will provide fire protection for all plant personnel and equipment; it includes a primary fire water pump, a backup diesel-powered pump, and the fire water pipeline system."

Just the borrow pits to support the MBGP and sister projects will extend to be a "total of approximately 460 acres."[10] The PSA confirms that "[P]roduction and injection well pads constitute approximately 50 acres. The proposed project will have nine production wells (on five well pads), and 11 injection wells (on six well pads). One additional injection well pad (backup) is identified for resource support. Well drilling operations are conducted 24 hours per day, seven days per week. Eight weeks is estimated to drill each well, and approximately 17 people will be working at each drilling site at any one time. A diesel/electric drilling rig would be used to construct the production and injection wells."[11] The PSA also confirms that "[A] system of aboveground pipelines will be constructed to connect the MBGP with the production and injection wells. Wherever possible, these pipelines will be placed next to the borders of fields or along access roads to minimize the amount of land affected."[12]

[9] PSA, Section 3.2. Emphasis added.
[10] PSA p. 3-18, 3-19.
[11] *Id.*
[12] *Id.*

C. Discussion

As noted previously, the list of comments below is not comprehensive. Only the more substantial deficiencies are addressed in these comments. The lack of information supporting the Applicants and Staff's analyses is a glaring deficiency preventing this commentor, and arguably the Commission itself, from evaluating the significant impacts of this Project.

C.1 The PSA Does Not Adequately Consider Entirely Reasonable Changes to the "Setting" of the MBGP Over Its Expected Life

As noted prior, the expected life of the MBGP is expected to be 40 years or longer. Yet, even though the PSA recognizes this, the air quality analysis presented is premised on an assumption that the context and setting into which the MBGP's air quality impacts will be imposed will remain unrealistically static and unchanging over the same 40+ years as they exist today. This makes no sense. As non-exhaustive examples of the setting/context that can or could change over the lifetime of the MBGP – and, which therefore, should have been considered in the air quality analysis but have not been, consider the following:

C.1.1 High Likelihood for Lithium Extraction. The PSA fails to consider, in its air quality impacts analysis, the likelihood that the MBGP (and its sister projects) may be modified in the near future or certainly within their expected lifetimes to extract lithium metal in addition to producing power from geothermal energy. It is well known within the industry that BHE Renewables, the owner of MBGP and its sister projects, plans to modify its geothermal power plants in the Salton Sea area to also extract lithium.[13] This is entirely and reasonably foreseeable and not speculative. Therefore, this contextual change of the purpose of the MBGP and its impact on additional air pollutant emissions associated with lithium extraction and processing should be considered and included in the air quality analysis. The actual pollutants and the levels at which they can be emitted from lithium extraction processes can vary depending on the composition of the groundwater and the various surface activities (and potential air emissions sources) that are implemented. These will likely include particulate matter containing heavy metals as well as potentially acidic gases like hydrogen chloride. In addition, construction-related emissions will occur. And, to the extent that lithium extraction will lead to development of downstream processing such as the conversion of the extracted lithium into batteries, those activities and processes will also generate pollutants. As a result, simply ignoring the air emissions impacts from lithium extraction as the PSA does, underestimates very plausible additional pollutants that will be emitted over the same time period as the MBGP's operational lifetime.

C.1.2 Changing Regulatory Standards. A simple review of the last 40 years (or even the last 20 years) should confirm that regulatory standards can change, and usually become more stringent. While no one expects the CEC to speculate on what specific pollutant standards may be 40 years

[13] *See, e.g.,* Ernest Scheyder, *Insight: U.S. steps away from flagship lithium project with Buffett's Berkshire* (October 5, 2022), Reuters, available at https://www.reuters.com/markets/us/us-stepsaway-flagship-lithium-project-with-berkshire-2022-10-05/.

or more into the future, even when it is readily apparent that standards will change in the near future, specifically the $PM_{2.5}$ NAAQS, the PSA refuses to include this in the analysis. The PSA states the following in this regard:

> "….revised annual $PM_{2.5}$ NAAQS (citation omitted), at the effective date (60 days after publication in the Federal Register [i.e., May 6, 2024]) of the final rule, all applicants for permits to construct a new major source or major modification of an existing stationary source will need to conduct an air quality analysis that considers the revised $PM_{2.5}$ NAAQS. Because this project's permit application was deemed complete on June 22, 2023, which is well before the effective date of the final rule, and because the project is neither a major source nor a Prevention of Significant Deterioration (PSD) source of $PM_{2.5}$ emissions, an air quality analysis considering the revised $PM_{2.5}$ NAAQS is not required. Considering the above factors, the project is evaluated against the 2012 annual $PM_{2.5}$ NAAQS of 12.0 $\mu g/m^3$ according to the NSR program that was in place at the time the application was deemed complete, which was well before the new NAAQS was promulgated."[14]
>
> Use of the existing 12.0 $\mu g/m^3$ $PM_{2.5}$ limit is also consistent with the Imperial County Air Pollution Control District's (ICAPCD) Rule 207 A.2.b. Rule 207 states, 'Applications received by the District shall be subject to the requirements of this Rule in effect at the time such application is deemed complete, except when a more stringent new federal requirement not yet incorporated into this Rule shall apply to the new or modified Stationary Source.' In this case, the new federal standard was not a requirement at the time the application was complete."[15]

While it is true that the Project's application was deemed complete a few months before the promulgation of the revised NAAQS, the analysis confirms, plainly, that the $PM_{2.5}$ impacts (even with all of their other deficiencies noted later in these comments) would pose a threat to compliance with the revised $PM_{2.5}$ annual NAAQS. Further, the PSA bases its assessment, in part, on compliance with all air quality LORS. The PSA's conclusions are inherently erroneous because MBGP will not meet all applicable LORS, e.g., 2024 NAAQS, even after mitigation.[16] The PSAs conclusions rely on compliance with LORS. This reasoning is flawed and contradictory because the PSA relies on the now-older 2012 standard when new 2024 regulatory standards are available and applicable (especially when the three sister projects' combined emissions would satisfy the "major source" criteria). Using the PSA's myopic logic (that the date the application is deemed complete is determinative as to compliance with all laws) proves the point I raise, which is changing regulatory standards must be analyzed as reasonable changes to the Project's setting. Further, failure to consider changes to regulatory standards, when one such substantive law change occurred during the pendency of the application, is a disservice to the public and workers who will

[14] PSA, p. 5.1-3. Emphasis added.
[15] PSA p. 5.1-3.
[16] PSA, Table 1-1. See also PSA p. 1-4 and 5.1.2.

be affected by the Project's emissions. To skirt the issue, as the PSA does, undermines the very purpose of the air quality analysis.

Since the revised $PM_{2.5}$ NAAQS is a certainty, the air quality analysis has an obligation to fully consider and include it in the analysis, in order to fully evaluate the impacts of the Project. And, as is clear, the Project would violate the LORS and would pose unacceptable and significant impacts if the revised $PM_{2.5}$ NAAQS were properly considered. That the air quality analysis, as presented, avoids this, confirms that the analysis and its conclusions would be obsolete when the MBGP is constructed and begins operation and in every other year going forward. More importantly, there are no mitigation measures considered to address the inevitable impacts created by this regulatory change.

C.1.3 Changes to the Salton Sea. It is clear from the previously shown Figure that the MBGP and its sister projects are located adjacent to the Salton Sea. Due to climate impacts in the Southwest United States, the Salton see is drying-out and shrinking. As this occurs, the smaller future footprint of the Salton Sea has and will continue to expose substantial new dry playas and these would be sources of increased fugitive dust based on wind entrainment. Substantial additional and massive PM (including $PM_{2.5}$ and PM_{10} or varying compositions, including toxic metals) will be emitted into the general vicinity of the Sea. It is well known that dry playas exposed due to shrinking bodies of water such as the Salton Sea can be very large sources of emissions. In fact, this has been noted specifically for the Salton Sea itself. Researchers at UC Davis note,[17] in particular that newly exposed playas are "more susceptible to wind erosion" and "particularly emissive in terms of dust." UC Riverside researchers have confirmed this as well, calling the consequences of this drying lake "an environmental catastrophe."[18]

Yet, the static air quality analysis makes no mention, much less any consideration, of this very realistic change in the setting that has the potential for dramatic impacts of $PM_{10}/PM_{2.5}$ in the area. These dramatic impacts will manifest themselves as increased "background" levels of $PM_{10}/PM_{2.5}$ over time. Of course, these types of secular changes that can and will occur over the same time period as the MBGP itself cannot be simply excused-away as "exceptional events" no matter how tempting.[19] They will be real and unavoidable. The PSA should consider this impact or make the case as to why the CEC staff believe that this change in the Salton Sea's levels will not occur in the next 40+ years. I note also that the greenhouse gas emissions from the MBGP (and its sister plants) will contribute to climate change and changes to the Salton Sea levels.

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[17] https://caes.ucdavis.edu/news/drying-salton-sea-pollutes-neighboring-communities#:~:text=%E2%80%9CThere's%20lots%20of%20evidence%20that,over%20long%20periods%20of%20time.%E2%80%9D

[18] https://news.ucr.edu/articles/2022/10/06/why-salton-sea-turning-toxic-dust

[19] It is telling when the PSA states "[H]igh winds undoubtedly affected many of the maximum PM_{10} concentration values in ICAPCD." (PSA p.5.1-5) The CEC seems to be believe therefore that high winds are exceptional events – thereby, at a stroke, making mother nature confirm to the PSA's convenient analytical framework. That is not how it works. Winds, including high winds, are a fact in the Salton Sea area. And, those high winds have consequences in increases PM_{10} and $PM_{2.5}$ levels. They cannot be ignored simply be designating them as exceptional events on paper.

C.1.4 Changes to the Population and Population Patterns in the Area. The current analysis notes, at various places in the PSA, that there are currently no nearby residents or neighbors. This is of course convenient since adverse and unacceptable impacts at the fence line are dismissed as inconsequential. As an example, in discussing the PM_{10} impacts from operations, the PSA states:

> "…The maximum modeled 24-hour PM_{10} impact of 7.2 $\mu g/m^3$ from project operation would exceed the U.S. EPA PM_{10} SILs of 5 $\mu g/m^3$ for 24-hour impacts. However, the results provided in Table 5.1-12 are maximum impacts predicted to occur at the project fence line. The impacts would decrease rapidly with distance from the fence line, and for any location beyond 30 m (98 feet) of the fence line, the 24-hour PM_{10} impacts would be below the U.S. EPA PM_{10} SILs levels. The closest residence (sensitive receptor) to the project site is about 2,160 m (about 1.3 miles) north-northeast of the project boundary (based on staff analysis of applicant's modeling files). The 24-hour PM_{10} impacts at the sensitive receptors would be below the U.S. EPA PM_{10} SILs levels."[20]

Of course, the above statement is meaningless because it presumes that there would be no future sensitive receptors any closer to the fence line in the future. The PSA fails to address why, in the future, especially, if there is additional economic activity in the area, there may not be future residents closer than presently, to the MBGP. Compounding this further, as I note elsewhere in these comments, the impacts analysis even at the fence line is underhandedly deficient because of an assumed, unenforceable, 10-meter "buffer" inside the fence line, where supposedly no pollutant-generating activities will continuously occur. As such, therefore, the PSA should not minimize high and unacceptable impacts at the facility fence line – and, in effect, accept them – claiming that these impacts decay (rapidly) away from the fence line.

These are four examples of reasonably foreseeable changes in critical aspects of the setting and context that the PSA's air quality analysis does not consider. And, by ignoring these, the conclusions of the analysis are fatally compromised. I note that these examples are not examples of deficient cumulative analysis, but stand alone as additional to deficiencies in the cumulative impacts analysis as presented in the PSA. I will discuss those deficiencies next.

C.2 The Cumulative Analysis Presented in the PSA is Deficient

There are several deficiencies with the PSA's cumulative impacts analysis for air quality. First, I note that the cumulative impacts for applicable air pollutants should include: (i) short-term and long-term background concentrations for each applicable air pollutant – *i.e.*, the short-term and long-term impacts from the MBGP's own emissions plus the impacts from all other sources emitting the same types of pollutants in the area that MBGP will emit (*i.e.*, within the zone of influence of MBGP's air emissions impacts) that are not reflected in background. This means that a proper cumulative impacts analysis needs several technically competent and complete inputs. First, all air pollutants that can be emitted from the MBGP should be identified. This includes not

[20] PSA, p. 5.1-28. Emphasis added.

just the criteria pollutants and few air toxic compounds included in the PSA but also all potential additional air pollutants that result from the construction and operation of the MBGP and its ancillary activities and sources – which would not otherwise be constructed and/or operated but for the MBGP.

Second, the short-term and long-term maximum emissions rates for all of the pollutants identified in the prior step need to be developed using fully supported assumptions. I will discuss later, using examples, how the emissions calculations as presented are simply inadequate and rely on unsupported and unverifiable assumptions.

Third, the PSA identifies 6-miles as the zone of influence for all air pollutants, which is unsupported. The PSA states that the 6-mile zone of influence is based on experience with power plants but does not define what types of power plants, which pollutants, and why that experience is relevant to the Project here. Thus, PSA must be modified to properly identify the zones of influence of MBGP's construction and operating impacts and must be done on a pollutant-by-pollutant basis. I note that, for some pollutants, where so-called Significant Impact Levels (SILs) have been identified, the analysis presumes that the zone of influence only includes areas where pollutant concentrations exceed the SILs. I note that the use of SILs in this manner for the current analysis is not justified in the PSA or any of the other analysis in the record. SILs are a surrogate, with numerous caveats, for the underlying concept of including influence zones where the source (in this case MBGP) can cause or contribute to adverse air quality impacts. Of course, there are many pollutants for which SILs have not been identified and for those pollutants zone of influence impacts should be defined using other parameters, such as incremental risks.

Fourth, the cumulative impacts analysis then needs to consider all presently operating sources and their emissions and foreseeable future sources that affect the same pollutant-specific zones of influence (*i.e.*, on a pollutant-by-pollutant basis) but are not otherwise included in the background value, so that the "cumulative" impacts are addressed. Of course, this analysis should also include sources that have been permitted but also those that have not yet begun operations.

While some of this analysis is presented in the PSA, there are substantial deficiencies and unsupported assumptions. I note a few of them below.

> (i) the cumulative analysis arbitrarily presumes that the zone of influence (of any and all pollutants) would be no greater than six miles citing to "staff's modeling experience" but, as noted above, with no further support;[21]
>
> (ii) excluding stationary sources "with emissions of less than five tons per year (tpy) as deminimis" citing to "previous power plant proceedings…"[22] Even if this is true in the context of power plants with tall stacks and different dispersion characteristics, the use of

[21] PSA, p. 5.1-33.
[22] PSA, p. 5.1-34.

this cut-off in the case of the MBGP analysis is not supported. As a result, the cumulative impacts analysis only included the three projects: MBGP, Elmore, and Black Rock;[23]

(iii) speculatively excluded localized impacts during construction in the cumulative analysis based on a "qualitative demonstration" of "unlikely"[24] overlap of these emissions from other nearby sources;

(iv) misuse of SILs to define zones of influence.[25]

These are unsupported and arbitrary constraints that have been imposed on the cumulative analysis, making it of dubious value. Thus, without far better technical analyses, the cumulative analyses and conclusions presented in the PSA are not reliable and likely underestimate cumulative impacts over the life of the MBGP.

C.3 The PSA Effectively Ignores the Already Significant Impacts of PM_{10}

The excerpt below, from the PSA's Table 5.1-3 confirms that PM_{10} levels in the area are already high.

TABLE 5.1-3 AMBIENT AIR QUALITY MONITORING DATA

Pollutant	Averaging Time	2018	2019	2020	2021	2022
O_3 (ppm)	1-hour	0.06	0.06	0.054	0.065	0.07
	8-hour	0.055	0.055	0.046	0.055	0.062
PM10 (µg/m³)	24-hour	**333.8**	**156.3**	**241.3**	**218.2**	**474.7**
	Annual	**47.5**	**32.7**	**35.9**	**39.8**	**48.6**
PM2.5 (µg/m³)	24-hour (98th percentile)	29.6	20.7	21	21	31.5
	Annual	10.4	8.3	9.4	8.3	8.7
NO_2 (ppb)	1-hour (maximum)	34.1	36.7	44.8	55.8	51.3
	1-hour (98th percentile)	32.1	29.5	35.5	37.9	39.2

I note that the PM_{10} data are from the Niland station which is around 3.8 miles north-northeast of the MBGP. It is quite likely that, given the closeness of the MBGP to the already exposed dry/semi-dry playas of the Salton Sea, as well as the fact that the MBGP will be constructed in the vicinity of dry ponds, as noted prior, that baseline PM_{10} data collected at the site and not miles away, would show even higher levels of PM_{10}. Yet, the PSA really does not have any answer for why additional PM_{10} emissions should be allowed into the local airshed that is currently so significantly impacted.

C.4 The Analysis of $PM_{2.5}$ Impacts is Grossly Deficient

The excerpt above of the PSA' s Table 5.1-3 confirms that the annual $PM_{2.5}$ concentrations range from 8.3 to 10.4 ug/m^3 during the 2018-2022 time period. As the PSA itself recognizes but ignores,

[23] PSA, Table 5.1-15, and associated discussion on p. 5.1-34.
[24] PSA, p. 5.1.34. 5.1-36.
[25] *Id.*

the current $PM_{2.5}$ annual NAAQS is 9 ug/m^3. Thus, the current ambient levels of $PM_{2.5}$, even recognizing that these data were not collected at the MBGP and would be higher if they were (for the reasons noted for PM_{10} above), are over or very close to the current NAAQS.

The excerpt from Table 5.1-12 shows the PSA's determinations of operational impacts, setting aside the other deficiencies I have noted in these comments. Even setting those aside, it is clear from the table excerpt below that the annual $PM_{2.5}$ impact (9.8 ug/m^3) clearly exceeds the new/current $PM_{2.5}$ NAAQS at 9 ug/m^3.

TABLE 5.1-12 MAXIMUM AMBIENT AIR QUALITY IMPACTS DURING OPERATION (µg/m³)

Pollutant	Averaging Time	Project Impact	Background	Total Impact	Limiting Standard	Percent of Standard
PM10	24-hour	7.2	**474.7**	**481.9**	50	**964%**
	Annual	0.7	**48.6**	**49.3**	20	**247%**
PM2.5 [a]	24-hour	4.4	24.5	28.9	35	83%
	Annual	0.4	9.4	9.8	12	82%
	1-hour	1.326.6	5.726	7.053	23.000	31%

C.5 Emissions Estimates, In General, Are Poorly Supported or Wholly Unsupported

The PSA states that "[T]he emissions estimation methodology for the project was developed in coordination with the latest available data and engineering design. Construction emissions were estimated based on emission factors from California Emissions Estimator Model (CalEEMod) and EMFAC2021. The operational emissions were estimated based on analytical data from other geothermal power plants in the area and vendor-provided data. O&M equipment and vehicle emissions were estimated based on emission factors from CalEEMod and EMFAC2021."[26] However, it is not clear what "vendor-provided" data were used in the analysis. Particularly, as noted prior, even the manufacturer of key equipment such as the steam turbine is not known as yet. The PSA should clearly specify what vendor-provided data were relied upon in the analysis. And, equally importantly, why these vendor-provided data reflect the actual and/or potential emissions of the equipment in questions.

This is a particular issue for the cooling tower, which is a significant source of emissions of PM, including $PM_{2.5}$. In many instances, the PSA simply relies on and accepts that the so-called "drift" from the cooling tower will be 0.0005%.[27] Yet, this crucial assumption, which drives the $PM_{2.5}$ (and other PM) emissions, is not supported by how it will actually be achieved (at all times, over the expected life of the cooling tower) and verified. In fact, there is no testing proposed to verify this assumption at all.

The excerpt also states that equipment and vehicle emissions were estimated based on emission factors from CalEEMod and EMPAC2021. While these emission estimation models are widely

[26] PSA p. 5.1-13. Emphasis added.
[27] PSA p. 3-11, among others.

used for CEQA and similar air quality analyses, the reliability of the "emission factors" that are at the core of these tools are not transparently or easily discernable. These models use specific emission factors and then activity levels (such as hours of equipment use or miles of employee vehicle travel, or acres of soil disturbance, etc.) to estimate project-specific actual and potential emissions. Here, not only are the emission factors that are hard-wired into CalEEMod and EMPAC2021 not known, but the details of the specific pieces of equipment that will be used during construction and operations of the MBGP (such as makes and models) are also not known. It is illogical to assume that the emissions of any pollutant from unknown pieces of equipment can be properly characterized by generic and non-transparent emission factors that may apply, at best, to generic classes of equipment and that are hard-wired into CalEEMod and EMPAC2021. The PSA surely cannot claim that every front-loader, for example, has the same emissions – as depicted in CalEEMod or EMFAC2021. But, by using these tools, that is precisely the type of illogical assumption that is used in the PSA. Compounding the problem, there are no requirements in the PSA to verify, via representative testing, the many emission factors that are implicitly included in CalEEMod and EMFAC2021 for the actual equipment that will be used during construction and operations of the MBGP.

In addition to the deficiencies above, in discussing emissions from operations, the PSA states that, for PGF steam-related processes:

> "[E]missions were estimated based upon analytical data from other geothermal power plants in the area. The analytical data consists of a speciated breakdown of concentrations from a non-condensable gas (NCG) sample, and system inlet and outlet operations from the geothermal system's geothermal steam flows. The Project's geothermal steam flows vary in pressure and are categorized as high, standard, and low pressure, each of which has an assumed NCG concentration. The NCG and system inlet/outlet analytical data are applied to production well estimated steam flows to determine a total mass of species through the geothermal system. During processing and condensing of the geothermal steam, a portion of the species remain in gas phase and are routed through the sparger installed inside the cooling tower basin; the remaining condensed liquid portion of the species are routed through the biological oxidation box and then overflows to the cooling tower. The mass throughputs of these species are used in coordination with estimated control efficiencies and process-specific correction factors to estimate emissions."[28]

I have emphasized several of the key assumptions made in the example above. For example, the relevance of using data from other, unspecified, geothermal plants "in the area" is not clear and raises reasonable (and unanswered) questions. While the PSA does not identify these other plants, the Preliminary Determination of Compliance by the Imperial County Air Pollution Control District, January 2024, notes that they may be the Elmore and Leathers facilities. But neither the PSA nor the Imperial County's analysis provides any justification for why these two plants are

[28] PSA p. 5.1-18. Emphasis added.

similar to the MBGP in terms of emissions. Thus, the reliability of the assumptions above in properly characterizing emissions are simply unknown and unsupported.

As another example, I turn to cooling tower emissions, which are a substantial source of the MBGP's emissions, especially for PM_{10} and $PM_{2.5}$.[29] For the cooling towers, in addition to the unsupported value for the drift, the PSA states, similarly that:

> "[E]missions were estimated based upon two input streams: the gaseous NCG vented into the cooling towers from the PGF steam and the NCG condensate/liquid within the cooling towers. The gaseous NCG stream was characterized using analytical data from other geothermal power plants in the area. Liquid-based emissions are the result of NCG condensate and make-up water input into the cooling towers for circulation. PM emissions from the circulating water were estimated using predicted permit limits of total dissolved solids (TDS). A particle size distribution was applied to TDS emissions to determine PM_{10} and $PM_{2.5}$ emissions. As outlined in the CARB California Emissions Inventory Data and Reporting System database, 70 percent of total particulate matter was assumed to be PM_{10} and 42 percent of total particulate matter was assumed to be $PM_{2.5}$. VOC emissions were developed by applying hot well analytical data from other geothermal power plants in the area to the Project's estimated hot well flow rates. 100 percent of the VOC emissions in the hot well condensate are assumed to be emitted through the cooling towers."[30]

It is clear from the above that critical inputs used for estimating cooling tower emissions such as the composition of the gases that will be vented into the cooling tower as well as the fractions of total particulate matter that are assumed to be $PM_{2.5}$ are unsupported. In addition, additional input data that are necessary for the modeling of the cooling tower are also unsupported. The PSA states that "[s]tack parameters (e.g., stack height, exit temperature, stack diameter, and stack exit velocity) were based on the parameters given by the vendor data and the applicant."[31] Yet the record fails to include the underlying data on which the PSA's conclusions were based.

Note the repeated references to "other geothermal power plants in the area" that I have emphasized above with no specificity. Also note the reliance on a CARB document for the fractions of total PM that are "assumed to be" PM_{10} (i.e., 70%) or $PM_{2.5}$ (42%). While citing to the CARB document, the PSA provides no discussion as to why any such speciations developed in the CARB document are: (i) universal; or (ii) should apply here. There is simply no discussion about why, even if true in other instances, these assumptions are relevant for the as-yet unknown cooling tower at the MBGP. Blindly grabbing historical documents and using them for emissions calculations makes

[29] PSA, Table 5.1-8.
[30] PSA p. 5.1-19. Emphasis added.
[31] PSA, p. 5.1-26. Emphasis added. The role of the "applicant" is not clear. Frankly, the basis of the vendor data for these parameters is also not clear since there are no engineering drawings or equipment specifications to support these assumptions.

no sense without first establishing their relevance to the MBGP. That important predicate is wholly missing in the air quality analysis in most cases.

C.6 Improper and Underhanded Attempt to Minimize Impacts at the Fence Line

As noted above, emissions of PM, including PM_{10} and $PM_{2.5}$, are critical because even current ambient air quality for these pollutants is unacceptably bad for PM_{10} and similarly bad for $PM_{2.5}$, and that the current annual NAAQS of 9 ug/m^3.

Given this, there is a curious assumption made in the modeling for these pollutants. As noted in the PSA: "[F]or modeling fugitive dust emissions from roadways, grading activities, and material loading/unloading, the applicant used a single area-poly source within the property, with a 10-m buffer from the nearest property boundary and assuming a ground-level release."[32] In addition, the PSA notes that "…grading activities would not continuously occur within 10 m of the proposed facility fence line…"[33]

The purpose of the 10-meter (or approximately 30 foot) buffer and the promise to not "continuously" grade within 10 meters of the fence line – are both designed, on paper, to minimize fence line impacts for PM. In fact, even with these clearly unenforceable assumptions, PM_{10} and $PM_{2.5}$ impacts are already substantial and adverse at the fence line. Those impacts would, of course, be much greater still without these "buffers." The air quality modeling analysis should be redone without this assumption of a 10-meter internal buffer within which no continuous grading will occur. This is an unverifiable assumption and unlikely to be true as a practical matter – for example, internal plant maintenance or security needs will likely require access to the fence line and these roads will require construction and grading for maintenance.

C.7 Secondary Formation of $PM_{2.5}$ Is Not Properly Addressed

While the PSA claims to have addressed the formation of secondary $PM_{2.5}$, due to atmospheric chemistry, which adds to the ambient burden of $PM_{2.5}$ directly emitted by the source, it is not clear if all precursors of secondary $PM_{2.5}$ were included in the analysis. Typically, NO_x and SO_2 are included as precursors for secondary $PM_{2.5}$. However, EPA has made it clear[34] that, in addition, ammonia and VOCs are also precursors for secondary $PM_{2.5}$. But it is not clear if these two pollutants were included in this analysis.

There are substantial expected emissions of ammonia (almost 500 tons per year or over 1 ton per day) from the MBGP, as confirmed by the excerpted Table 5.1-10 below.

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[32] PSA p. 5.1-23.
[33] *Id.*
[34] May 30, 2019. EPA. Fine Particulate Matter ($PM_{2.5}$) Precursor Guidance. This guidance identifies the four main $PM_{2.5}$ precursor pollutants (sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOC), and ammonia (NH_3). Available at https://www.epa.gov/pm-pollution/pm25-precursor-demonstration-guidance

TABLE 5.1-10 MAXIMUM FACILITY-WIDE ANNUAL EMISSIONS (TPY)			
Pollutant	**First Year of Operation**	**Subsequent Year of Operation with Startups, Shutdowns and Emission Control Downtime**	**Subsequent Year of Operation without Startups, Shutdowns and Emission Control Downtime**
NOx	2.00	2.00	2.00
CO	8.35	8.35	8.35
VOC	1.35	2.15	2.28
SOx	0.02	0.02	0.02
PM10	3.73	13.5	15.8
PM2.5	2.23	8.12	9.50
H_2S	183	65.6	8.92
Ammonia	179	476	493

Source: Jacobs 2023ii

Based on all of the reasons stated above, the PSA likely substantially underestimates the $PM_{2.5}$ emissions from the project.

C.8 Hydrogen Sulfide (H_2S) Impacts

The excerpted Table 5.1.10 confirms that emissions of H_2S, especially in the first year of operation, will be very high, at an estimated 183 tons per year, by MBGP's own analysis. I note that even this high value and the other values in Table 5.1.10 are likely underestimated because the PSA assumes that "H_2S emissions from the NCG stream are assumed to split between the gas phase and the condensate/liquid phase prior to reaching the cooling tower at a ratio of 60 to 40%, respectively (based on average source test results from Elmore). Thus, 60% of the total mass of H_2S in the NCG steam is assumed to be part of the gas phase (i.e., air quality) emissions calculations described above, while the other 40% is incorporated into the liquid/condensate calculations."[35] However, the basis for this 60:40 split – such as actual analytical data from testing or from process calculations – is not provided anywhere in the record. If, in fact, more of the H_2S partitions to the gas phase than the assumed 60%, the emissions noted in Table 5.1-10 would be even greater.

As such, the PSA attempts to dismiss H_2S impacts as a nuisance alone,[36] and also notes that the ambient air near the Salton Sea "is subject to episodic events" which are "well known." Even if this is true and "well-known[,]" adding tons of additional H_2S would of course exacerbate whatever natural H_2S impacts that may already be occurring in the area. The PSA does not provide a baseline of H_2S concentrations in the area and vicinity of where the MBGP is proposed to be located. In fact, it pre-empts the usefulness of monitoring data, stating that such data "…may not be representative for use in a CAAQS [California Ambient Air Quality Standard] modeling analysis…"[37] Overall, the PSA simply seeks to dismiss any potential H_2S impacts, including from

[35] Imperial County, Preliminary Determination of Compliance, p. 12.
[36] PSA, p. 5.1-28.
[37] *Id.*

bypass operations, which can be substantial,[38] and simply accepts that "…the applicant did not include these [bypass] emission sources in the H_2S impacts analysis."[39]

The extent of the PSA's deficient H_2S analysis is vividly illustrated in Table 5.1-13 below. While the maximum modeled impacts "in the modeling domain" are clearly many times greater than the CAAQS, the modeling instead chooses to focus on potential exceedances at residential receptors – concluding that there are not CAAQS exceedances there, even though a predicted value of 39.9 ug/m^3 is very close to the CAAQS of 42 ug/m^3. But this analysis is misleading because, as noted above, it presumes that there can never be residential receptors closer than those present today, over the life of the MBGP. The PSA also fails to evaluate H_2S impacts on-site and nearby facility and farm workers.

TABLE 5.1-13 MAXIMUM H_2S IMPACTS DURING OPERATION/COMMISSIONING (µg/m^3)

Emission Source	Averaging Time	Maximum Modeled Impact in Modeling Domain	Maximum Modeled Impact at Residential Receptors	CAAQS [a]	Exceeds CAAQS at Residential Receptors?
Routine Operations	1-hour	37.5	6.1	42	No
PTU		154.8	11.5	42	No
RM		386.2	39.9	42	No
MTU		148.4	26.0	42	No

Note: [a] The H_2S CAAQS of 0.03 ppm (or 42 µg/m^3) for a one-hour average was adopted based on its odor detection level. If the standard were based on adverse health effects, it would be set at a much higher level. For example, OSHA set an acceptable ceiling limit of 28,000 µg/m^3 (or 20 ppm) for H_2S in workplace air. NIOSH recommends a 10-minute ceiling limit of 14,000 µg/m^3 (or 10 ppm [ATSDR 2024]).
Sources: Jacobs 2023ii, Table 5.1-31, Table 5.1-32 with modeling files, CEC staff analysis

In addition, the analysis does not provide assurances that workers at the MBGP will not be put in danger, even with OSHA protections such as protective equipment, as a result of the substantial H_2S emissions from the MBGP. Protective equipment for workers is not fool-proof. And, using protective equipment often reduces worker productivity and increases inconvenience, leading to poor or improper use of such equipment. Thus, relying on 100% compliance as the basis of non-exposure to workers is not practical. OSHA non-compliance occurs routinely. The consequences of H_2S exposures with and without 100% compliance with OSHA requirements should therefore be examined.

C.9 Lack of Verifiable and Meaningful Conditions to Ensure Verification of Assumptions for Emissions Calculations and Mitigation Measures

Section 3.5 of the PSA states that "[C]onstruction emissions from all onsite and offsite project activities, including combustion emissions and fugitive dust emissions, would be controlled, and monitored with the implementation of Conditions of Certification (COC) AQ-SC1 through AQ-SC5. The applicant would also be required to submit a Dust Control Plan to Imperial County Air

[38] PSA, p. 5.1-29.
[39] *Id.*

Pollution Control District (ICAPCD) per ICAPCD Rule 801 and implement Best Available Control Measures per ICAPCD Rule 804."[40]

I have carefully reviewed all of the CEC AQ-SCxx Conditions of Certification imposed by CEC staff. I have also carefully reviewed the various AQ-xx conditions mandated by Imperial County (which are reproduced in the PSA). Based on this, it is my engineering judgement that these conditions, neither individually nor collectively, whether by the CEC or by Imperial County via its air permit, will:

> (i) provide any ability to verify the many assumptions made in estimating emissions from the various sources and activities as a result of the MBGP – some of which I have discussed in these comments;
>
> (ii) that mere submittal of "documentation" of control measures, such as dust controls during construction, as required per AQ-SC3, provides no assurance that such "controls" are effective. AQ-SC3, for example, contains plainly unverifiable conditions such as limiting vehicle speeds to 10 mph on unpaved areas, the requirement to inspect "all construction equipment vehicle tires" and to ensure that they are "washed as necessary to be cleaned free of dirt prior to entering paved roadways," and the requirement to cover or treat with "appropriate" dust suppressant compounds all soil storage piles that "remain inactive for longer than 10 days"…. and many others.
>
> (iii) AQ-SC4, which requires a response to any dust plumes, is even more unenforceable because it requires "[O]bservations of visible dust plumes that have the potential to be transported (A) off the project site and within 400 feet upwind of any regularly occupied structures not owned by the project owner or (B) 200 feet beyond the centerline of the construction of linear facilities indicate that existing mitigation measures are not resulting in effective mitigation." How this will be implemented is left to the future AQCMP but it is unlikely to be meaningful given its ludicrous specificity about 400 feet and 200 feet, noted in the language of this condition.
>
> (iv) the Imperial County's Compliance Conditions are equally ineffective. Just for starters, the verification of all of the General Conditions AQ-1 through AQ-15 all have the same, identical boiler-plate language: "[T]he project owner shall make the site available for inspection of records by representatives of the District, ARB, and the CEC."

The Facility Emissions and Operational Limits conditions AQ-16 through AQ-30 all contain the same boiler-plate language for verification: "[T]he project owner shall submit to the CPM operating data to demonstrate compliance with this condition as part of the Quarterly Operation

[40] PSA, Section 3.5. I note that the stated Duct Control Plan is not currently available for review. It is not clear that any future submittal of such as Plan will be subject to public review. In addition, AQ-SC2 requires a submittal of an Air Quality Construction Mitigation Plan (AQCMP) – see PSA, p. 5.1-38. This Plan too is unavailable for public review and it is not clear that it will be subject to future public review.

Reports (AQ- SC8)." Subsequent conditions AQ-31 through AQ-33 revert to the same boiler-plate language as the verification for AQ-1 through AQ-15 noted above. The conditions for emergency units also have similar/identical verification conditions as the previous conditions noted above with few exceptions, such as AQ-42, AQ-44, AQ-45 dealing with testing of emergency equipment, etc.

Even the conditions dealing with verification of the control efficiency of the HCl scrubber (AQ-48) has non-specific boiler-plate language. Likewise for monitoring conditions, with few exceptions. Just to provide an example of the drift (0.0005%) assumed for the cooling tower, as I have noted previously, condition AQ-54 cites to the verification of this drift loss based on an annual inspection – but, crucially, does not address how merely inspecting the cooling tower will ensure that its drift will not exceed the assumed drift loss. As with previous conditions, the same boilerplate language of making the site available for inspection of records is noted for this condition.

Overall, my review of the various Imperial County and CEC conditions provide little to no assurance that any of the many assumptions inherent in the air quality analysis will be meaningfully verifiable, even when the facility first begins operation, much less over time, as it ages and inevitable equipment deterioration occurs – to the detriment of community, workers, and environment from the Project's increased air pollutant emissions.

Attachment A – Resume

RANAJIT (RON) SAHU, PH.D, CEM (NEVADA)

CONSULTANT, ENVIRONMENTAL AND ENERGY ISSUES

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EXPERIENCE SUMMARY

Dr. Sahu has over thirty two years of experience in the fields of environmental, mechanical, and chemical engineering including: program and project management services; design and specification of pollution control equipment for a wide range of emissions sources including stationary and mobile sources; soils and groundwater remediation including landfills as remedy; combustion engineering evaluations; energy studies; multimedia environmental regulatory compliance (involving statutes and regulations such as the Federal CAA and its Amendments, Clean Water Act, TSCA, RCRA, CERCLA, SARA, OSHA, NEPA as well as various related state statutes); transportation air quality impact analysis; multimedia compliance audits; multimedia permitting (including air quality NSR/PSD permitting, Title V permitting, NPDES permitting for industrial and storm water discharges, RCRA permitting, etc.), multimedia/multi-pathway human health risk assessments for toxics; air dispersion modeling; and regulatory strategy development and support including negotiation of consent agreements and orders.

He has over thirty years of project management experience and has successfully managed and executed hundreds of projects in this time period. This includes basic and applied research projects, design projects, regulatory compliance projects, permitting projects, energy studies, risk assessment projects, and projects involving the communication of environmental data and information to the public.

He has provided consulting services to numerous private sector, public sector and public interest group clients. His major clients over the past three decades include various trade associations as well as individual companies such as steel mills, petroleum refineries, chemical plants, cement manufacturers, aerospace companies, power generation facilities, lawn and garden equipment manufacturers, spa manufacturers, chemical distribution facilities, land development companies, and various entities in the public sector including EPA, the US Dept. of Justice, several states (including New York, New Jersey, Connecticut, Kansas, Oregon, New Mexico, Pennsylvania, and others), various agencies such as the California DTSC, and various cities and municipalities. Dr. Sahu has executed projects in all 50 US states, numerous local jurisdictions and internationally.

In addition to consulting, for approximately two decades, Dr. Sahu taught numerous courses in several Southern California universities as adjunct faculty, including UCLA (air pollution), UC Riverside (air pollution, process hazard analysis), and Loyola Marymount University (air pollution, risk assessment, hazardous waste management). He also taught at Caltech, his alma mater (various engineering courses), at the University of Southern California (air pollution controls) and at California State University, Fullerton (transportation and air quality).

Dr. Sahu has and continues to provide expert witness services in a number of environmental and engineering areas discussed above in both state and Federal courts as well as before administrative bodies (please see Annex A).

EXPERIENCE RECORD

2000-present **Independent Consultant.** Providing a variety of private sector (industrial companies, land development companies, law firms, etc.), public sector (such as the US Department of Justice), and public interest group clients with project management, environmental consulting, project management, as well as regulatory and engineering support consulting services.

1995-2000 Parsons ES, **Associate, Senior Project Manager and Department Manager for** Air Quality/Geosciences/Hazardous Waste Groups, Pasadena, CA.

Parsons ES, **Manager for Air Source Testing Services**. Responsible for the management of 8 individuals in the area of air source testing and air regulatory permitting projects located in Bakersfield, California.

1992-1995 Engineering-Science, Inc. **Principal Engineer and Senior Project Manager** in the air quality department.

1990-1992 Engineering-Science, Inc. **Principal Engineer and Project Manager** in the air quality department.

1989-1990 Kinetics Technology International, Corp. **Development Engineer.** Involved in thermal engineering R&D and project work related to low-NOx ceramic radiant burners, fired heater NOx reduction, SCR design, and fired heater retrofitting.

1988-1989 Heat Transfer Research, Inc. **Research Engineer**. Involved in the design of fired heaters, heat exchangers, air coolers, and other non-fired equipment. Also did research in the area of heat exchanger tube vibrations.

EDUCATION

1984-1988 Ph.D., Mechanical Engineering, California Institute of Technology (Caltech), Pasadena, CA.

1984 M. S., Mechanical Engineering, California Institute of Technology (Caltech), Pasadena, CA.

1978-1983 B. Tech (Honors), Mechanical Engineering, Indian Institute of Technology (IIT) Kharagpur, India

TEACHING EXPERIENCE

Caltech

"Thermodynamics," Teaching Assistant, California Institute of Technology, 1983, 1987.

"Air Pollution Control," Teaching Assistant, California Institute of Technology, 1985.

"Caltech Secondary and High School Saturday Program," - taught various mathematics (algebra through calculus) and science (physics and chemistry) courses to high school students, 1983-1989.

"Heat Transfer," - taught this course in the Fall and Winter terms of 1994-1995 in the Division of Engineering and Applied Science.

“Thermodynamics and Heat Transfer,” Fall and Winter Terms of 1996-1997.

U.C. Riverside, Extension

"Toxic and Hazardous Air Contaminants," University of California Extension Program, Riverside, California. Various years since 1992.

"Prevention and Management of Accidental Air Emissions," University of California Extension Program, Riverside, California. Various years since 1992.

"Air Pollution Control Systems and Strategies," University of California Extension Program, Riverside, California, Summer 1992-93, Summer 1993-1994.

"Air Pollution Calculations," University of California Extension Program, Riverside, California, Fall 1993-94, Winter 1993-94, Fall 1994-95.

"Process Safety Management," University of California Extension Program, Riverside, California. Various years since 1992-2010.

"Process Safety Management," University of California Extension Program, Riverside, California, at SCAQMD, Spring 1993-94.

"Advanced Hazard Analysis - A Special Course for LEPCs," University of California Extension Program, Riverside, California, taught at San Diego, California, Spring 1993-1994.

"Advanced Hazardous Waste Management" University of California Extension Program, Riverside, California. 2005.

Loyola Marymount University

"Fundamentals of Air Pollution - Regulations, Controls and Engineering," Loyola Marymount University, Dept. of Civil Engineering. Various years beginning 1993.

"Air Pollution Control," Loyola Marymount University, Dept. of Civil Engineering, Fall 1994.

"Environmental Risk Assessment," Loyola Marymount University, Dept. of Civil Engineering. Various years beginning 1998.

"Hazardous Waste Remediation" Loyola Marymount University, Dept. of Civil Engineering. Various years beginning 2006.

University of Southern California

"Air Pollution Controls," University of Southern California, Dept. of Civil Engineering, Fall 1993, Fall 1994.

"Air Pollution Fundamentals," University of Southern California, Dept. of Civil Engineering, Winter 1994.

University of California, Los Angeles

"Air Pollution Fundamentals," University of California, Los Angeles, Dept. of Civil and Environmental Engineering, Spring 1994, Spring 1999, Spring 2000, Spring 2003, Spring 2006, Spring 2007, Spring 2008, Spring 2009.

International Programs

"Environmental Planning and Management," 5 week program for visiting Chinese delegation, 1994.

"Environmental Planning and Management," 1 day program for visiting Russian delegation, 1995.

"Air Pollution Planning and Management," IEP, UCR, Spring 1996.

"Environmental Issues and Air Pollution," IEP, UCR, October 1996.

PROFESSIONAL AFFILIATIONS AND HONORS

President of India Gold Medal, IIT Kharagpur, India, 1983.

Member of the Alternatives Assessment Committee of the Grand Canyon Visibility Transport Commission, established by the Clean Air Act Amendments of 1990, 1992.

American Society of Mechanical Engineers: Los Angeles Section Executive Committee, Heat Transfer Division, and Fuels and Combustion Technology Division, 1987-mid-1990s.

Air and Waste Management Association, West Coast Section, 1989-mid-2000s.

PROFESSIONAL CERTIFICATIONS

EIT, California (#XE088305), 1993.

REA I, California (#07438), 2000.

Certified Permitting Professional, South Coast AQMD (#C8320), since 1993.

QEP, Institute of Professional Environmental Practice, 2000 - 2021.

CEM, State of Nevada (#EM-1699).

PUBLICATIONS (PARTIAL LIST)

"Physical Properties and Oxidation Rates of Chars from Bituminous Coals," with Y.A. Levendis, R.C. Flagan and G.R. Gavalas, *Fuel*, **67**, 275-283 (1988).

"Char Combustion: Measurement and Analysis of Particle Temperature Histories," with R.C. Flagan, G.R. Gavalas and P.S. Northrop, *Comb. Sci. Tech.* **60**, 215-230 (1988).

"On the Combustion of Bituminous Coal Chars," PhD Thesis, California Institute of Technology (1988).

"Optical Pyrometry: A Powerful Tool for Coal Combustion Diagnostics," *J. Coal Quality*, **8**, 17-22 (1989).

"Post-Ignition Transients in the Combustion of Single Char Particles," with Y.A. Levendis, R.C. Flagan and G.R. Gavalas, *Fuel*, **68**, 849-855 (1989).

"A Model for Single Particle Combustion of Bituminous Coal Char." Proc. ASME National Heat Transfer Conference, Philadelphia, **HTD-Vol. 106**, 505-513 (1989).

"Discrete Simulation of Cenospheric Coal-Char Combustion," with R.C. Flagan and G.R. Gavalas, *Combust. Flame*, **77**, 337-346 (1989).

"Particle Measurements in Coal Combustion," with R.C. Flagan, in "**Combustion Measurements**" (ed. N. Chigier), Hemisphere Publishing Corp. (1991).

"Cross Linking in Pore Structures and Its Effect on Reactivity," with G.R. Gavalas in preparation.

"Natural Frequencies and Mode Shapes of Straight Tubes," Proprietary Report for Heat Transfer Research Institute, Alhambra, CA (1990).

"Optimal Tube Layouts for Kamui SL-Series Exchangers," with K. Ishihara, Proprietary Report for Kamui Company Limited, Tokyo, Japan (1990).

"HTRI Process Heater Conceptual Design," Proprietary Report for Heat Transfer Research Institute, Alhambra, CA (1990).

"Asymptotic Theory of Transonic Wind Tunnel Wall Interference," with N.D. Malmuth and others, Arnold Engineering Development Center, Air Force Systems Command, USAF (1990).

"Gas Radiation in a Fired Heater Convection Section," Proprietary Report for Heat Transfer Research Institute, College Station, TX (1990).

"Heat Transfer and Pressure Drop in NTIW Heat Exchangers," Proprietary Report for Heat Transfer Research Institute, College Station, TX (1991).

"NOx Control and Thermal Design," Thermal Engineering Tech Briefs, (1994).

“From Purchase of Landmark Environmental Insurance to Remediation: Case Study in Henderson, Nevada,” with Robin E. Bain and Jill Quillin, presented at the AQMA Annual Meeting, Florida, 2001.

“The Jones Act Contribution to Global Warming, Acid Rain and Toxic Air Contaminants,” with Charles W. Botsford, presented at the AQMA Annual Meeting, Florida, 2001.

PRESENTATIONS (PARTIAL LIST)

"Pore Structure and Combustion Kinetics - Interpretation of Single Particle Temperature-Time Histories," with P.S. Northrop, R.C. Flagan and G.R. Gavalas, presented at the AIChE Annual Meeting, New York (1987).

"Measurement of Temperature-Time Histories of Burning Single Coal Char Particles," with R.C. Flagan, presented at the American Flame Research Committee Fall International Symposium, Pittsburgh, (1988).

"Physical Characterization of a Cenospheric Coal Char Burned at High Temperatures," with R.C. Flagan and G.R. Gavalas, presented at the Fall Meeting of the Western States Section of the Combustion Institute, Laguna Beach, California (1988).

"Control of Nitrogen Oxide Emissions in Gas Fired Heaters - The Retrofit Experience," with G. P. Croce and R. Patel, presented at the International Conference on Environmental Control of Combustion Processes (Jointly sponsored by the American Flame Research Committee and the Japan Flame Research Committee), Honolulu, Hawaii (1991).

"Air Toxics - Past, Present and the Future," presented at the Joint AIChE/AAEE Breakfast Meeting at the AIChE 1991 Annual Meeting, Los Angeles, California, November 17-22 (1991).

"Air Toxics Emissions and Risk Impacts from Automobiles Using Reformulated Gasolines," presented at the Third Annual Current Issues in Air Toxics Conference, Sacramento, California, November 9-10 (1992).

"Air Toxics from Mobile Sources," presented at the Environmental Health Sciences (ESE) Seminar Series, UCLA, Los Angeles, California, November 12, (1992).

"Kilns, Ovens, and Dryers - Present and Future," presented at the Gas Company Air Quality Permit Assistance Seminar, Industry Hills Sheraton, California, November 20, (1992).

"The Design and Implementation of Vehicle Scrapping Programs," presented at the 86th Annual Meeting of the Air and Waste Management Association, Denver, Colorado, June 12, 1993.

"Air Quality Planning and Control in Beijing, China," presented at the 87th Annual Meeting of the Air and Waste Management Association, Cincinnati, Ohio, June 19-24, 1994.

Annex A

Expert Litigation Support

A. Occasions where Dr. Sahu has provided Written or Oral testimony before Congress:

1. In July 2012, provided expert written and oral testimony to the House Subcommittee on Energy and the Environment, Committee on Science, Space, and Technology at a Hearing entitled "Hitting the Ethanol Blend Wall – Examining the Science on E15."

B. Matters for which Dr. Sahu has provided affidavits and expert reports include:

2. Affidavit for Rocky Mountain Steel Mills, Inc. located in Pueblo Colorado – dealing with the technical uncertainties associated with night-time opacity measurements in general and at this steel mini-mill.

3. Expert reports and depositions (2/28/2002 and 3/1/2002; 12/2/2003 and 12/3/2003; 5/24/2004) on behalf of the United States in connection with the Ohio Edison NSR Cases. *United States, et al. v. Ohio Edison Co., et al.*, C2-99-1181 (Southern District of Ohio).

4. Expert reports and depositions (5/23/2002 and 5/24/2002) on behalf of the United States in connection with the Illinois Power NSR Case. *United States v. Illinois Power Co., et al.*, 99-833-MJR (Southern District of Illinois).

5. Expert reports and depositions (11/25/2002 and 11/26/2002) on behalf of the United States in connection with the Duke Power NSR Case. *United States, et al. v. Duke Energy Corp.*, 1:00-CV-1262 (Middle District of North Carolina).

6. Expert reports and depositions (10/6/2004 and 10/7/2004; 7/10/2006) on behalf of the United States in connection with the American Electric Power NSR Cases. *United States, et al. v. American Electric Power Service Corp., et al.*, C2-99-1182, C2-99-1250 (Southern District of Ohio).

7. Affidavit (March 2005) on behalf of the Minnesota Center for Environmental Advocacy and others in the matter of the Application of Heron Lake BioEnergy LLC to construct and operate an ethanol production facility – submitted to the Minnesota Pollution Control Agency.

8. Expert Report and Deposition (10/31/2005 and 11/1/2005) on behalf of the United States in connection with the East Kentucky Power Cooperative NSR Case. *United States v. East Kentucky Power Cooperative, Inc*., 5:04-cv-00034-KSF (Eastern District of Kentucky).

9. Affidavits and deposition on behalf of Basic Management Inc. (BMI) Companies in connection with the BMI vs. USA remediation cost recovery Case.

10. Expert Report on behalf of Penn Future and others in the Cambria Coke plant permit challenge in Pennsylvania.

11. Expert Report on behalf of the Appalachian Center for the Economy and the Environment and others in the Western Greenbrier permit challenge in West Virginia.

12. Expert Report, deposition (via telephone on January 26, 2007) on behalf of various Montana petitioners (Citizens Awareness Network (CAN), Women's Voices for the Earth (WVE) and the Clark Fork Coalition (CFC)) in the Thompson River Cogeneration LLC Permit No. 3175-04 challenge.

13. Expert Report and deposition (2/2/07) on behalf of the Texas Clean Air Cities Coalition at the Texas State Office of Administrative Hearings (SOAH) in the matter of the permit challenges to TXU Project Apollo's eight new proposed PRB-fired PC boilers located at seven TX sites.

14. Expert Testimony (July 2007) on behalf of the Izaak Walton League of America and others in connection with the acquisition of power by Xcel Energy from the proposed Gascoyne Power Plant – at the State of

Minnesota, Office of Administrative Hearings for the Minnesota PUC (MPUC No. E002/CN-06-1518; OAH No. 12-2500-17857-2).

15. Affidavit (July 2007) Comments on the Big Cajun I Draft Permit on behalf of the Sierra Club – submitted to the Louisiana DEQ.

16. Expert Report and Deposition (12/13/2007) on behalf of Commonwealth of Pennsylvania – Dept. of Environmental Protection, State of Connecticut, State of New York, and State of New Jersey (Plaintiffs) in connection with the Allegheny Energy NSR Case. *Plaintiffs v. Allegheny Energy Inc., et al.,* 2:05cv0885 (Western District of Pennsylvania).

17. Expert Reports and Pre-filed Testimony before the Utah Air Quality Board on behalf of Sierra Club in the Sevier Power Plant permit challenge.

18. Expert Report and Deposition (October 2007) on behalf of MTD Products Inc., in connection with *General Power Products, LLC v MTD Products Inc*., 1:06 CVA 0143 (Southern District of Ohio, Western Division) .

19. Expert Report and Deposition (June 2008) on behalf of Sierra Club and others in the matter of permit challenges (Title V: 28.0801-29 and PSD: 28.0803-PSD) for the Big Stone II unit, proposed to be located near Milbank, South Dakota.

20. Expert Reports, Affidavit, and Deposition (August 15, 2008) on behalf of Earthjustice in the matter of air permit challenge (CT-4631) for the Basin Electric Dry Fork station, under construction near Gillette, Wyoming before the Environmental Quality Council of the State of Wyoming.

21. Affidavits (May 2010/June 2010 in the Office of Administrative Hearings))/Declaration and Expert Report (November 2009 in the Office of Administrative Hearings) on behalf of NRDC and the Southern Environmental Law Center in the matter of the air permit challenge for Duke Cliffside Unit 6. Office of Administrative Hearing Matters 08 EHR 0771, 0835 and 0836 and 09 HER 3102, 3174, and 3176 (consolidated).

22. Declaration (August 2008), Expert Report (January 2009), and Declaration (May 2009) on behalf of Southern Alliance for Clean Energy in the matter of the air permit challenge for Duke Cliffside Unit 6. *Southern Alliance for Clean Energy et al., v. Duke Energy Carolinas, LLC*, Case No. 1:08-cv-00318-LHT-DLH (Western District of North Carolina, Asheville Division).

23. Declaration (August 2008) on behalf of the Sierra Club in the matter of Dominion Wise County plant MACT.us

24. Expert Report (June 2008) on behalf of Sierra Club for the Green Energy Resource Recovery Project, MACT Analysis.

25. Expert Report (February 2009) on behalf of Sierra Club and the Environmental Integrity Project in the matter of the air permit challenge for NRG Limestone's proposed Unit 3 in Texas.

26. Expert Report (June 2009) on behalf of MTD Products, Inc., in the matter of *Alice Holmes and Vernon Holmes v. Home Depot USA, Inc., et al.*

27. Expert Report (August 2009) on behalf of Sierra Club and the Southern Environmental Law Center in the matter of the air permit challenge for Santee Cooper's proposed Pee Dee plant in South Carolina).

28. Statements (May 2008 and September 2009) on behalf of the Minnesota Center for Environmental Advocacy to the Minnesota Pollution Control Agency in the matter of the Minnesota Haze State Implementation Plans.

29. Expert Report (August 2009) on behalf of Environmental Defense, in the matter of permit challenges to the proposed Las Brisas coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

30. Expert Report and Rebuttal Report (September 2009) on behalf of the Sierra Club, in the matter of challenges to the proposed Medicine Bow Fuel and Power IGL plant in Cheyenne, Wyoming.

31. Expert Report (December 2009) and Rebuttal reports (May 2010 and June 2010) on behalf of the United States in connection with the Alabama Power Company NSR Case. *United States v. Alabama Power Company*, CV-01-HS-152-S (Northern District of Alabama, Southern Division).

32. Pre-filed Testimony (October 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed White Stallion Energy Center coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

33. Pre-filed Testimony (July 2010) and Written Rebuttal Testimony (August 2010) on behalf of the State of New Mexico Environment Department in the matter of Proposed Regulation 20.2.350 NMAC – *Greenhouse Gas Cap and Trade Provisions,* No. EIB 10-04 (R), to the State of New Mexico, Environmental Improvement Board.

34. Expert Report (August 2010) and Rebuttal Expert Report (October 2010) on behalf of the United States in connection with the Louisiana Generating NSR Case. *United States v. Louisiana Generating, LLC*, 09-CV100-RET-CN (Middle District of Louisiana) – Liability Phase.

35. Declaration (August 2010), Reply Declaration (November 2010), Expert Report (April 2011), Supplemental and Rebuttal Expert Report (July 2011) on behalf of the United States in the matter of DTE Energy Company and Detroit Edison Company (Monroe Unit 2). *United States of America v. DTE Energy Company and Detroit Edison Company*, Civil Action No. 2:10-cv-13101-BAF-RSW (Eastern District of Michigan).

36. Expert Report and Deposition (August 2010) as well as Affidavit (September 2010) on behalf of Kentucky Waterways Alliance, Sierra Club, and Valley Watch in the matter of challenges to the NPDES permit issued for the Trimble County power plant by the Kentucky Energy and Environment Cabinet to Louisville Gas and Electric, File No. DOW-41106-047.

37. Expert Report (August 2010), Rebuttal Expert Report (September 2010), Supplemental Expert Report (September 2011), and Declaration (November 2011) on behalf of Wild Earth Guardians in the matter of opacity exceedances and monitor downtime at the Public Service Company of Colorado (Xcel)'s Cherokee power plant. No. 09-cv-1862 (District of Colorado).

38. Written Direct Expert Testimony (August 2010) and Affidavit (February 2012) on behalf of Fall-Line Alliance for a Clean Environment and others in the matter of the PSD Air Permit for Plant Washington issued by Georgia DNR at the Office of State Administrative Hearing, State of Georgia (OSAH-BNR-AQ-1031707-98-WALKER).

39. Deposition (August 2010) on behalf of Environmental Defense, in the matter of the remanded permit challenge to the proposed Las Brisas coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

40. Expert Report, Supplemental/Rebuttal Expert Report, and Declarations (October 2010, November 2010, September 2012) on behalf of New Mexico Environment Department (Plaintiff-Intervenor), Grand Canyon Trust and Sierra Club (Plaintiffs) in the matter of *Plaintiffs v. Public Service Company of New Mexico* (PNM), Civil No. 1:02-CV-0552 BB/ATC (ACE) (District of New Mexico).

41. Expert Report (October 2010) and Rebuttal Expert Report (November 2010) (BART Determinations for PSCo Hayden and CSU Martin Drake units) to the Colorado Air Quality Commission on behalf of Coalition of Environmental Organizations.

42. Expert Report (November 2010) (BART Determinations for TriState Craig Units, CSU Nixon Unit, and PRPA Rawhide Unit) to the Colorado Air Quality Commission on behalf of Coalition of Environmental Organizations.

43. Declaration (November 2010) on behalf of the Sierra Club in connection with the Martin Lake Station Units 1, 2, and 3. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Case No. 5:10-cv-00156-DF-CMC (Eastern District of Texas, Texarkana Division).

44. Pre-Filed Testimony (January 2011) and Declaration (February 2011) to the Georgia Office of State Administrative Hearings (OSAH) in the matter of Minor Source HAPs status for the proposed Longleaf Energy Associates power plant (OSAH-BNR-AQ-1115157-60-HOWELLS) on behalf of the Friends of the Chattahoochee and the Sierra Club).

45. Declaration (February 2011) in the matter of the Draft Title V Permit for RRI Energy MidAtlantic Power Holdings LLC Shawville Generating Station (Pennsylvania), ID No. 17-00001 on behalf of the Sierra Club.

46. Expert Report (March 2011), Rebuttal Expert Report (June 2011) on behalf of the United States in *United States of America v. Cemex, Inc.*, Civil Action No. 09-cv-00019-MSK-MEH (District of Colorado).

47. Declaration (April 2011) and Expert Report (July 16, 2012) in the matter of the Lower Colorado River Authority (LCRA)'s Fayette (Sam Seymour) Power Plant on behalf of the Texas Campaign for the Environment. *Texas Campaign for the Environment v. Lower Colorado River Authority,* Civil Action No. 4:11-cv-00791 (Southern District of Texas, Houston Division).

48. Declaration (June 2011) on behalf of the Plaintiffs MYTAPN in the matter of Microsoft-Yes, Toxic Air Pollution-No (MYTAPN) v. State of Washington, Department of Ecology and Microsoft Corporation Columbia Data Center to the Pollution Control Hearings Board, State of Washington, Matter No. PCHB No. 10-162.

49. Expert Report (June 2011) on behalf of the New Hampshire Sierra Club at the State of New Hampshire Public Utilities Commission, Docket No. 10-261 – the 2010 Least Cost Integrated Resource Plan (LCIRP) submitted by the Public Service Company of New Hampshire (re. Merrimack Station Units 1 and 2).

50. Declaration (August 2011) in the matter of the Sandy Creek Energy Associates L.P. Sandy Creek Power Plant on behalf of Sierra Club and Public Citizen. *Sierra Club, Inc. and Public Citizen, Inc. v. Sandy Creek Energy Associates, L.P.,* Civil Action No. A-08-CA-648-LY (Western District of Texas, Austin Division).

51. Expert Report (October 2011) on behalf of the Defendants in the matter of *John Quiles and Jeanette Quiles et al. v. Bradford-White Corporation, MTD Products, Inc., Kohler Co., et al.,* Case No. 3:10-cv-747 (TJM/DEP) (Northern District of New York).

52. Declaration (October 2011) on behalf of the Plaintiffs in the matter of *American Nurses Association et. al. (Plaintiffs), v. US EPA (Defendant)*, Case No. 1:08-cv-02198-RMC (US District Court for the District of Columbia).

53. Declaration (February 2012) and Second Declaration (February 2012) in the matter of *Washington Environmental Council and Sierra Club Washington State Chapter v. Washington State Department of Ecology and Western States Petroleum Association,* Case No. 11-417-MJP (Western District of Washington).

54. Expert Report (March 2012) and Supplemental Expert Report (November 2013) in the matter of *Environment Texas Citizen Lobby, Inc and Sierra Club v. ExxonMobil Corporation et al.,* Civil Action No. 4:10-cv-4969 (Southern District of Texas, Houston Division).

55. Declaration (March 2012) in the matter of *Center for Biological Diversity, et al. v. United States Environmental Protection Agency,* Case No. 11-1101 (consolidated with 11-1285, 11-1328 and 11-1336) (US Court of Appeals for the District of Columbia Circuit).

56. Declaration (March 2012) in the matter of *Sierra Club v. The Kansas Department of Health and Environment*, Case No. 11-105,493-AS (Holcomb power plant) (Supreme Court of the State of Kansas).

57. Declaration (March 2012) in the matter of the Las Brisas Energy Center *Environmental Defense Fund et al., v. Texas Commission on Environmental Quality,* Cause No. D-1-GN-11-001364 (District Court of Travis County, Texas, 261st Judicial District).

58. Expert Report (April 2012), Supplemental and Rebuttal Expert Report (July 2012), and Supplemental Rebuttal Expert Report (August 2012) on behalf of the states of New Jersey and Connecticut in the matter of the Portland Power plant *State of New Jersey and State of Connecticut (Intervenor-Plaintiff) v. RRI Energy Mid-Atlantic Power Holdings et al.,* Civil Action No. 07-CV-5298 (JKG) (Eastern District of Pennsylvania).

59. Declaration (April 2012) in the matter of the EPA's EGU MATS Rule, on behalf of the Environmental Integrity Project.

60. Expert Report (August 2012) on behalf of the United States in connection with the Louisiana Generating NSR Case. *United States v. Louisiana Generating, LLC*, 09-CV100-RET-CN (Middle District of Louisiana) – Harm Phase.

61. Declaration (September 2012) in the Matter of the Application of *Energy Answers Incinerator, Inc.* for a Certificate of Public Convenience and Necessity to Construct a 120 MW Generating Facility in Baltimore City, Maryland, before the Public Service Commission of Maryland, Case No. 9199.

62. Expert Report (October 2012) on behalf of the Appellants (Robert Concilus and Leah Humes) in the matter of Robert Concilus and Leah Humes v. Commonwealth of Pennsylvania Department of Environmental Protection and Crawford Renewable Energy, before the Commonwealth of Pennsylvania Environmental Hearing Board, Docket No. 2011-167-R.

63. Expert Report (October 2012), Supplemental Expert Report (January 2013), and Affidavit (June 2013) in the matter of various Environmental Petitioners v. North Carolina DENR/DAQ and Carolinas Cement Company, before the Office of Administrative Hearings, State of North Carolina.

64. Pre-filed Testimony (October 2012) on behalf of No-Sag in the matter of the North Springfield Sustainable Energy Project before the State of Vermont, Public Service Board.

65. Pre-filed Testimony (November 2012) on behalf of Clean Wisconsin in the matter of Application of Wisconsin Public Service Corporation for Authority to Construct and Place in Operation a New Multi-Pollutant Control Technology System (ReACT) for Unit 3 of the Weston Generating Station, before the Public Service Commission of Wisconsin, Docket No. 6690-CE-197.

66. Expert Report (February 2013) on behalf of Petitioners in the matter of Credence Crematory, Cause No. 12-A-J-4538 before the Indiana Office of Environmental Adjudication.

67. Expert Report (April 2013), Rebuttal report (July 2013), and Declarations (October 2013, November 2013) on behalf of the Sierra Club in connection with the Luminant Big Brown Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 6:12-cv-00108-WSS (Western District of Texas, Waco Division).

68. Declaration (April 2013) on behalf of Petitioners in the matter of *Sierra Club, et al., (Petitioners) v Environmental Protection Agency et al. (Respondents),* Case No., 13-1112, (Court of Appeals, District of Columbia Circuit).

69. Expert Report (May 2013) and Rebuttal Expert Report (July 2013) on behalf of the Sierra Club in connection with the Luminant Martin Lake Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 5:10-cv-0156-MHS-CMC (Eastern District of Texas, Texarkana Division).

70. Declaration (August 2013) on behalf of A. J. Acosta Company, Inc., in the matter of *A. J. Acosta Company, Inc., v. County of San Bernardino*, Case No. CIVSS803651.

71. Comments (October 2013) on behalf of the Washington Environmental Council and the Sierra Club in the matter of the Washington State Oil Refinery RACT (for Greenhouse Gases), submitted to the Washington State Department of Ecology, the Northwest Clean Air Agency, and the Puget Sound Clean Air Agency.

72. Statement (November 2013) on behalf of various Environmental Organizations in the matter of the Boswell Energy Center (BEC) Unit 4 Environmental Retrofit Project, to the Minnesota Public Utilities Commission, Docket No. E-015/M-12-920.

73. Expert Report (December 2013) on behalf of the United States in *United States of America v. Ameren Missouri*, Civil Action No. 4:11-cv-00077-RWS (Eastern District of Missouri, Eastern Division).

74. Expert Testimony (December 2013) on behalf of the Sierra Club in the matter of Public Service Company of New Hampshire Merrimack Station Scrubber Project and Cost Recovery, Docket No. DE 11-250, to the State of New Hampshire Public Utilities Commission.

75. Expert Report (January 2014) on behalf of Baja, Inc., in *Baja, Inc., v. Automotive Testing and Development Services, Inc. et. al*, Civil Action No. 8:13-CV-02057-GRA (District of South Carolina, Anderson/Greenwood Division).

76. Declaration (March 2014) on behalf of the Center for International Environmental Law, Chesapeake Climate Action Network, Friends of the Earth, Pacific Environment, and the Sierra Club (Plaintiffs) in the matter of *Plaintiffs v. the Export-Import Bank (Ex-Im Bank) of the United States*, Civil Action No. 13-1820 RC (District Court for the District of Columbia).

77. Declaration (April 2014) on behalf of Respondent-Intervenors in the matter of *Mexichem Specialty Resins Inc., et al., (Petitioners) v Environmental Protection Agency et al.,* Case No., 12-1260 (and Consolidated Case Nos. 12-1263, 12-1265, 12-1266, and 12-1267), (Court of Appeals, District of Columbia Circuit).

78. Direct Prefiled Testimony (June 2014) on behalf of the Michigan Environmental Council and the Sierra Club in the matter of the Application of DTE Electric Company for Authority to Implement a Power Supply Cost Recovery (PSCR) Plan in its Rate Schedules for 2014 Metered Jurisdictional Sales of Electricity, Case No. U-17319 (Michigan Public Service Commission).

79. Expert Report (June 2014) on behalf of ECM Biofilms in the matter of the US Federal Trade Commission (FTC) v. ECM Biofilms (FTC Docket #9358).

80. Direct Prefiled Testimony (August 2014) on behalf of the Michigan Environmental Council and the Sierra Club in the matter of the Application of Consumers Energy Company for Authority to Implement a Power Supply Cost Recovery (PSCR) Plan in its Rate Schedules for 2014 Metered Jurisdictional Sales of Electricity, Case No. U-17317 (Michigan Public Service Commission).

81. Declaration (July 2014) on behalf of Public Health Intervenors in the matter of *EME Homer City Generation v. US EPA* (Case No. 11-1302 and consolidated cases) relating to the lifting of the stay entered by the Court on December 30, 2011 (US Court of Appeals for the District of Columbia).

82. Expert Report (September 2014), Rebuttal Expert Report (December 2014) and Supplemental Expert Report (March 2015) on behalf of Plaintiffs in the matter of *Sierra Club and Montana Environmental Information Center (Plaintiffs) v. PPL Montana LLC, Avista Corporation, Puget Sound Energy, Portland General Electric Company, Northwestern Corporation, and Pacificorp (Defendants)*, Civil Action No. CV 13-32-BLG-DLC-JCL (US District Court for the District of Montana, Billings Division).

83. Expert Report (November 2014) on behalf of Niagara County, the Town of Lewiston, and the Villages of Lewiston and Youngstown in the matter of CWM Chemical Services, LLC New York State Department of Environmental Conservation (NYSDEC) Permit Application Nos.: 9-2934-00022/00225, 9-2934-00022/00231, 9-2934-00022/00232, and 9-2934-00022/00249 (pending).

84. *Declaration (January 2015) relating to Startup/Shutdown in the MATS Rule (EPA Docket ID No. EPA-HQ-OAR-2009-0234) on behalf of the Environmental Integrity Project.*

85. Pre-filed Direct Testimony (March 2015), Supplemental Testimony (May 2015), and Surrebuttal Testimony (December 2015) on behalf of Friends of the Columbia Gorge in the matter of the Application for a Site Certificate for the Troutdale Energy Center before the Oregon Energy Facility Siting Council.

86. Brief of Amici Curiae Experts in Air Pollution Control and Air Quality Regulation in Support of the Respondents, On Writs of Certiorari to the US Court of Appeals for the District of Columbia, No. 14-46, 47, 48. *Michigan et. al., (Petitioners) v. EPA et. al., Utility Air Regulatory Group (Petitioners) v. EPA et. al., National Mining Association et. al., (Petitioner) v. EPA et. al.,* (Supreme Court of the United States).

87. Expert Report (March 2015) and Rebuttal Expert Report (January 2016) on behalf of Plaintiffs in the matter of *Conservation Law Foundation v. Broadrock Gas Services LLC, Rhode Island LFG GENCO LLC, and Rhode Island Resource Recovery Corporation (Defendants)*, Civil Action No. 1:13-cv-00777-M-PAS (US District Court for the District of Rhode Island).

88. Declaration (April 2015) relating to various Technical Corrections for the MATS Rule (EPA Docket ID No. EPA-HQ-OAR-2009-0234) on behalf of the Environmental Integrity Project.

89. Direct Prefiled Testimony (May 2015) on behalf of the Michigan Environmental Council, the Natural Resources Defense Council, and the Sierra Club in the matter of the Application of DTE Electric Company for Authority to Increase its Rates, Amend its Rate Schedules and Rules Governing the Distribution and Supply of Electric Energy and for Miscellaneous Accounting Authority, Case No. U-17767 (Michigan Public Service Commission).

90. Expert Report (July 2015) and Rebuttal Expert Report (July 2015) on behalf of Plaintiffs in the matter of *Northwest Environmental Defense Center et. al., v. Cascade Kelly Holdings LLC, d/b/a Columbia Pacific Bio-Refinery, and Global Partners LP (Defendants)*, Civil Action No. 3:14-cv-01059-SI (US District Court for the District of Oregon, Portland Division).

91. Declaration (August 2015, Docket No. 1570376) in support of "Opposition of Respondent-Intervenors American Lung Association, et. al., to Tri-State Generation's Emergency Motion;" Declaration (September 2015, Docket No. 1574820) in support of "Joint Motion of the State, Local Government, and Public Health Respondent-Intervenors for Remand Without Vacatur;" Declaration (October 2015) in support of "Joint Motion of the State, Local Government, and Public Health Respondent-Intervenors to State and Certain Industry Petitioners' Motion to Govern, *White Stallion Energy Center, LLC v. US EPA*, Case No. 12-1100 (US Court of Appeals for the District of Columbia).

92. Declaration (September 2015) in support of the Draft Title V Permit for Dickerson Generating Station (Proposed Permit No 24-031-0019) on behalf of the Environmental Integrity Project.

93. Expert Report (Liability Phase) (December 2015) and Rebuttal Expert Report (February 2016) on behalf of Plaintiffs in the matter of *Natural Resources Defense Council, Inc., Sierra Club, Inc., Environmental Law and Policy Center, and Respiratory Health Association v. Illinois Power Resources LLC, and Illinois Power Resources Generating LLC (Defendants)*, Civil Action No. 1:13-cv-01181 (US District Court for the Central District of Illinois, Peoria Division).

94. Declaration (December 2015) in support of the Petition to Object to the Title V Permit for Morgantown Generating Station (Proposed Permit No 24-017-0014) on behalf of the Environmental Integrity Project.

95. Expert Report (November 2015) on behalf of Appellants in the matter of *Sierra Club, et al. v. Craig W. Butler, Director of Ohio Environmental Protection Agency et al.,* ERAC Case No. 14-256814.

96. Affidavit (January 2016) on behalf of Bridgewatch Detroit in the matter of *Bridgewatch Detroit v. Waterfront Petroleum Terminal Co., and Waterfront Terminal Holdings, LLC.*, in the Circuit Court for the County of Wayne, State of Michigan.

97. Expert Report (February 2016) and Rebuttal Expert Report (July 2016) on behalf of the challengers in the matter of the Delaware Riverkeeper Network, Clean Air Council, et. al., vs. Commonwealth of Pennsylvania Department of Environmental Protection and R. E. Gas Development LLC regarding the Geyer well site before the Pennsylvania Environmental Hearing Board.

98. Direct Testimony (May 2016) in the matter of Tesoro Savage LLC Vancouver Energy Distribution Terminal, Case No. 15-001 before the State of Washington Energy Facility Site Evaluation Council.

99. Declaration (June 2016) relating to deficiencies in air quality analysis for the proposed Millenium Bulk Terminal, Port of Longview, Washington.

100. Declaration (December 2016) relating to EPA's refusal to set limits on PM emissions from coal-fired power plants that reflect pollution reductions achievable with fabric filters on behalf of Environmental Integrity Project, Clean Air Council, Chesapeake Climate Action Network, Downwinders at Risk represented by Earthjustice in the matter of *ARIPPA v EPA, Case No. 15-1180.* (D.C. Circuit Court of Appeals).

101. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Huntley and Huntley Poseidon Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

102. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Apex Energy Backus Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

103. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Apex Energy Drakulic Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

104. Expert Report (January 2017) on the Environmental Impacts Analysis associated with the Apex Energy Deutsch Well Pad on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

105. Affidavit (February 2017) pertaining to deficiencies water discharge compliance issues at the Wood River Refinery in the matter of *People of the State of Illinois (Plaintiff) v. Phillips 66 Company, ConocoPhillips Company, WRB Refining LP (Defendants)*, Case No. 16-CH-656, (Circuit Court for the Third Judicial Circuit, Madison County, Illinois).

106. Expert Report (March 2017) on behalf of the Plaintiff pertaining to non-degradation analysis for waste water discharges from a power plant in the matter of *Sierra Club (Plaintiff) v. Pennsylvania Department of Environmental Protection (PADEP) and Lackawanna Energy Center*, Docket No. 2016-047-L (consolidated), (Pennsylvania Environmental Hearing Board).

107. Expert Report (March 2017) on behalf of the Plaintiff pertaining to air emissions from the Heritage incinerator in East Liverpool, Ohio in the matter of *Save our County (Plaintiff) v. Heritage Thermal Services, Inc. (Defendant), Case No. 4:16-CV-1544-BYP*, (US District Court for the Northern District of Ohio, Eastern Division).

108. Rebuttal Expert Report (June 2017) on behalf of Plaintiffs in the matter of *Casey Voight and Julie Voight (Plaintiffs) v Coyote Creek Mining Company LLC (Defendant),* Civil Action No. 1:15-CV-00109 (US District Court for the District of North Dakota, Western Division).

109. Expert Affidavit (August 2017) and Penalty/Remedy Expert Affidavit (October 2017) on behalf of Plaintiff in the matter of *Wildearth Guardians (Plaintiff) v Colorado Springs Utility Board (Defendant,)* Civil Action No. 1:15-cv-00357-CMA-CBS (US District Court for the District of Colorado).

110. Expert Report (August 2017) on behalf of Appellant in the matter of *Patricia Ann Troiano (Appellant) v. Upper Burrell Township Zoning Hearing Board (Appellee)*, Court of Common Pleas of Westmoreland County, Pennsylvania, Civil Division.

111. Expert Report (October 2017), Supplemental Expert Report (October 2017), and Rebuttal Expert Report (November 2017) on behalf of Defendant in the matter of *Oakland Bulk and Oversized Terminal (Plaintiff) v City of Oakland (Defendant,)* Civil Action No. 3:16-cv-07014-VC (US District Court for the Northern District of California, San Francisco Division).

112. Declaration (December 2017) on behalf of the Environmental Integrity Project in the matter of permit issuance for ATI Flat Rolled Products Holdings, Breckenridge, PA to the Allegheny County Health Department.

113. Expert Report (Harm Phase) (January 2018), Rebuttal Expert Report (Harm Phase) (May 2018) and Supplemental Expert Report (Harm Phase) (April 2019) on behalf of Plaintiffs in the matter of *Natural Resources Defense Council, Inc., Sierra Club, Inc., and Respiratory Health Association v. Illinois Power Resources LLC, and Illinois Power Resources Generating LLC (Defendants)*, Civil Action No. 1:13-cv-01181 (US District Court for the Central District of Illinois, Peoria Division).

114. Declaration (February 2018) on behalf of the Chesapeake Bay Foundation, et. al., in the matter of the Section 126 Petition filed by the state of Maryland in *State of Maryland v. Pruitt (Defendant)*, Civil Action No. JKB-17-2939 (Consolidated with No. JKB-17-2873) (US District Court for the District of Maryland).

115. Direct Pre-filed Testimony (March 2018) on behalf of the National Parks Conservation Association (NPCA) in the matter of *NPCA v State of Washington, Department of Ecology and BP West Coast Products, LLC*, PCHB No. 17-055 (Pollution Control Hearings Board for the State of Washington.

116. Expert Affidavit (April 2018) and Second Expert Affidavit (May 2018) on behalf of Petitioners in the matter of *Coosa River Basin Initiative and Sierra Club (Petitioners) v State of Georgia Environmental Protection Division, Georgia Department of Natural Resources (Respondent) and Georgia Power Company (Intervenor/Respondent)*, Docket Nos: 1825406-BNR-WW-57-Howells and 1826761-BNR-WW-57-Howells, Office of State Administrative Hearings, State of Georgia.

117. Direct Pre-filed Testimony and Affidavit (December 2018) on behalf of Sierra Club and Texas Campaign for the Environment (Appellants) in the contested case hearing before the Texas State Office of Administrative Hearings in Docket Nos. 582-18-4846, 582-18-4847 (Application of GCGV Asset Holding, LLC for Air Quality Permit Nos. 146425/PSDTX1518 and 146459/PSDTX1520 in San Patricio County, Texas).

118. Expert Report (February 2019) on behalf of Sierra Club in the State of Florida, Division of Administrative Hearings, Case No. 18-2124EPP, Tampa Electric Company Big Bend Unit 1 Modernization Project Power Plant Siting Application No. PA79-12-A2.

119. Declaration (March 2019) on behalf of Earthjustice in the matter of comments on the renewal of the Title V Federal Operating Permit for Valero Houston refinery.

120. Expert Report (March 2019) on behalf of Plaintiffs for Class Certification in the matter of *Resendez et al v Precision Castparts Corporation* in the Circuit Court for the State of Oregon, County of Multnomah, Case No. 16cv16164.

121. Expert Report (June 2019), Affidavit (July 2019) and Rebuttal Expert Report (September 2019) on behalf of Appellants relating to the NPDES permit for the Cheswick power plant in the matter of *Three Rivers Waterkeeper and Sierra Club (Appellants) v. State of Pennsylvania Department of Environmental Protection (Appellee) and NRG Power Midwest (Permittee)*, before the Commonwealth of Pennsylvania Environmental Hearing Board, EHB Docket No. 2018-088-R.

122. Affidavit/Expert Report (August 2019) relating to the appeal of air permits issued to PTTGCA on behalf of Appellants in the matter of *Sierra Club (Appellants) v. Craig Butler, Director, et. al., Ohio EPA (Appellees)* before the State of Ohio Environmental Review Appeals Commission (ERAC), Case Nos. ERAC-19-6988 through -6991.

123. Expert Report (October 2019) relating to the appeal of air permit (Plan Approval) on behalf of Appellants in the matter of *Clean Air Council and Environmental Integrity Project (Appellants) v. Commonwealth of Pennsylvania Department of Environmental Protection and Sunoco Partners Marketing and Terminals L.P*., before the Commonwealth of Pennsylvania Environmental Hearing Board, EHB Docket No. 2018-057-L.

124. Expert Report (December 2019), Affidavit (March 2020), Supplemental Expert Report (July 2020), and Declaration (February 2021) on behalf of Earthjustice in the matter of *Objection to the Issuance of PSD/NSR and Title V permits for Riverview Energy Corporation*, Dale, Indiana, before the Indiana Office of Environmental Adjudication, Cause No. 19-A-J-5073.

125. Affidavit (December 2019) on behalf of Plaintiff-Intervenor (Surfrider Foundation) in the matter of *United States and the State of Indiana (Plaintiffs), Surfrider Foundation (Plaintiff-Intervenor), and City of Chicago (Plaintiff-Intervenor) v. United States Steel Corporation (Defendant),* Civil Action No. 2:18-cv-00127 (US District Court for the Northern District of Indiana, Hammond Division).

126. Declarations (January 2020, February 2020, May 2020, July 2020, and August 2020) and Pre-filed Testimony (April 2021) in support of Petitioner's Motion for Stay of PSCAA NOC Order of Approval No. 11386 in the matter of the *Puyallup Tribe of Indians v. Puget Sound Clean Air Agency (PSCAA) and Puget Sound Energy (PSE),* before the State of Washington Pollution Control Hearings Board, PCHB No. P19-088.

127. Expert Report (April 2020) on behalf of the plaintiff in the matter of Orion Engineered Carbons, GmbH (Plaintiff) vs. Evonik Operations, GmbH (formerly Evonik Degussa GmbH) (Respondent), before the German Arbitration Institute, Case No. DIS-SV-2019-00216.

128. Expert Independent Evaluation Report (June 2020) for *PacifiCorp's Decommissioning Costs Study Reports dated January 15, 2020 and March 13, 2020 relating to the closures of the Hunter, Huntington, Dave Johnston, Jim Bridger, Naughton, Wyodak, Hayden, and Colstrip (Units 3&4) plants*, prepared for the Oregon Public Utility Commission (Oregon PUC).

129. Direct Pre-filed Testimony (July 2020) on behalf of the Sierra Club in the matter of *the Application of the Ohio State University for a certificate of Environmental Compatibility and Public Need to Construct a Combined Heat and Power Facility in Franklin County, Ohio*, before the Ohio Power Siting Board, Case No. 19-1641-EL-BGN.

130. Expert Report (August 2020) and Rebuttal Expert Report (September 2020) on behalf of WildEarth Guardians (petitioners) in the matter of *the Appeals of the Air Quality Permit No. 7482-M1 Issued to 3 Bear Delaware Operating – NM LLC (EIB No. 20-21(A) and Registrations Nos. 8729, 8730, and 8733 under General Construction Permit for Oil and Gas Facilities (EIB No. 20-33 (A)*, before the State of New Mexico, Environmental Improvement Board.

131. Expert Report (July 2020) on the *Initial Economic Impact Analysis (EIA) for A Proposal To* Regulate *NOx Emissions from Natural Gas Fired Rich-Burn Natural Gas Reciprocating Internal Combustion Engines (RICE) Greater Than 100 Horsepower* prepared on behalf of Earthjustice and the National Parks Conservation Association in the matter of Regulation Number 7, Alternate Rules before the Colorado Air Quality Control Commission.

132. Expert Report (August 2020) and Supplemental Expert Report (February 2021) on the Potential Remedies to Avoid Adverse Thermal Impacts from the Merrimack Station on behalf of Plaintiffs in the matter of *Sierra Club Inc. and the* Conservation *Law Foundation (Plaintiffs) v. Granite Shore Power, LLC et. al., (Defendants)*, Civil Action No. 19-cv-216-JL (US District Court for the District of New Hampshire.)

133. Expert Report (August 2020) and Supplemental Expert Report (December 2020) on behalf of Plaintiffs in the matter of *PennEnvironment Inc., and Clean Air Council (Plaintiffs) and Allegheny County Health Department (Plaintiff-Intervenor) v. United States Steel Corporation (Defendant)*, Civil Action No. 2-19-cv-00484-MJH (US District Court for the Western District of Pennsylvania.)

134. Pre-filed Direct Testimony (October 2020) and Sur-rebuttal Testimony (November 2020) on behalf of petitioners (Ten Persons Group, including citizens, the Town of Braintree, the Town of Hingham, and the City of Quincy) in the matter of Algonquin Gas Transmission LLC, Weymouth MA, No. X266786 Air Quality Plan Approval, before the Commonwealth of Massachusetts, Department of Environmental Protection, the Office of Appeals and Dispute Resolution, OADR Docket Nos. 2019-008, 2019-009, 2019010, 2019-011, 2019-012 and 2019-013.

135. Expert Report (November 2020) on behalf of Protect PT in the matter of *Protect PT v. Commonwealth of Pennsylvania Department of Environmental Protection and Apex Energy (PA) LLC*, before the Commonwealth of Pennsylvania Environmental Hearing Board, Docket No. 2018-080-R (consolidated with 2019-101-R)(the "Drakulic Appeal").

136. Expert Report (December 2020) on behalf of Plaintiffs in the matter of *Sierra Club Inc. (Plaintiff) v. GenOn Power Midwest LP (Defendants)*, Civil Action No. 2-19-cv-01284-WSS (US District Court for the Western District of Pennsylvania.)

137. Pre-filed Testimony (January 2021) on behalf of the Plaintiffs (Shrimpers and Fishermen of the Rio Grande Valley represented by Texas RioGrande Legal Aid, Inc.) in the matter of the Appeal of Texas Commission on Environmental Quality (TCEQ) Permit Nos. 147681, PSDTX1522, GHGPSDTX172 for the Jupiter Brownsville Heavy Condensate Upgrader Facility, Cameron County, before the Texas State Office of Administrative Hearings, SOAH Docket No. 582-21-0111, TCEQ Docket No. 2020-1080-AIR.

138. Expert Reports (March 2021 and May 2021) regarding the Aries Newark LLC Sludge Processing Facility, Application No. CPB 20-74, Central Planning Board, City of Newark, New Jersey.

139. Expert Report (April 2021) for *Charles Johnson Jr. (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant),* Civil Action No. 2:20-CV-01329 (Related to 12-968 BELO in MDL No. 2179). (US District Court for the Eastern District of Louisiana, New Orleans Division).

140. Affidavit (April 2021) for *Clayton Faerber et.al., (Plaintiff), v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 20-CV-00328 01329 (Related to 12-968 BELO in MDL No. 2179). (US District Court for the Southern District of Mississippi).

141. Expert Report (April 2021, June 2023) for *Floyd Ruffin (Plaintiff), v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 2:20-cv-00334-CJB-JCW (US District Court for the Eastern District of Louisiana, New Orleans Division).

142. Expert Report (April 2021) and Sur-Rebuttal Report (June 2021) on behalf of the Plaintiffs in the matter of *Modern Holdings, LLC, et al. (Plaintiffs) v. Corning Inc., et al. (Defendants)*, Civil Action No. 5:13-cv-00405-GFVT, (US District Court for the Eastern District of Kentucky, Central Division at Lexington).

143. Expert Report (May 2021) for *Clifford Osmer (Plaintiff) v. BP Exploration and Production Inc., et. al., (Defendants)* related to No. 18-CV-12557 (US District Court for the Eastern District of Louisiana).

144. Expert Report (May 2021) and Rebuttal Expert Report (January 2022) for *James Noel (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant),* Civil Action No. 1:19-CV-00694-JB-MU-C (US District Court for the Southern District of Alabama, Southern Division).

145. Expert Report (June 2021) and Declarations (May 2021 and June 2021) on behalf of Plaintiffs in the matter of *Sierra Club (Plaintiff) v. Woodville Pellets, LLC (Defendant)*, Civil Action No. 9:20-cv-00178-MJT (US District Court for the Eastern District of Texas, Lufkin Division.)

146. Expert Witness Disclosure (June 2021) on behalf of the Plaintiffs in the matter of *Jay Burdick, et. al., (Plaintiffs) v. Tanoga Inc. (d/b/a Taconic) (Defendant)*, Index No. 253835, (State of New York Supreme Court, County of Rensselaer).

147. Expert Report (June 2021) on behalf of Appellants in the matter of *PennEnvironment and Earthworks (Appellants) v. Commonwealth of Pennsylvania Department of Environmental Protection (Appellee) and MarkWest Liberty Midstream and resource, LLC (Permittee)*, before the Commonwealth of Pennsylvania Environmental Hearing Board, EHB Docket No. 2020-002-R.

148. Expert Report (June 2021) for *Antonia Saavedra-Vargas (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 2:18-CV-11461 (US District Court for the Eastern District of Louisiana, New Orleans Division).

149. Affidavit (June 2021) for Lourdes Rubi in the matter of *Lourdes Rubi (Plaintiff) v. BP Exploration and Production Inc., et. al., (Defendants)*, related to 12-968 BELO in MDL No. 2179 (US District Court for the Eastern District of Louisiana, New Orleans Division).

150. Expert Report (June 2021) for *Wallace Smith (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 2:19-CV-12880 (US District Court for the Eastern District of Louisiana, New Orleans Division).

151. Declaration (July 2021) on behalf of Plaintiffs in the matter of *Stephanie Mackey and Nick Migliore, on behalf* of *themselves and all others similarly situated (Plaintiffs) v. Chemtool Inc. and Lubrizol Corporation (Defendants)*, Case No. 2021-L-0000165, State of Illinois, Circuit Court of the 17th Judicial Circuit, Winnebago County.

152. Declaration (July 2021, August 2021) on behalf of Petitioners in the matter of the Petition for a Hearing on the Merits Regarding Air Quality Permit No. 3340-RMD issued to New Mexico Terminal Services, LLC by *Mountain View Neighborhood Association et. al., (Petitioners) v. City of Albuquerque Environmental Health Department*, AQCB Petition No. 2020-1 before the Albuquerque-Bernalillo County Air Quality Control Board.

153. Expert Disclosure (September 2021) and Affidavit (May 2023) on behalf of the Plaintiffs in the matter of *State of New York, Town of Hempstead, Town of Brookhaven, Incorporated Village of Garden City and Long Island Power Authority et. al., (Plaintiffs) v. Covanta Hempstead Company et. al., (Defendants)*, Index No. 7549/2013 before the Supreme Court of the State of New York, County of Nassau.

154. Expert Report (October 2021) for *John A. Battiste (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant),* Civil Action No. 1:21-CV-00118 (US District Court for the Southern District of Alabama, Mobile Division)

155. Declaration/Expert Report (October 2021) for *Charles K. Grasley et. al., (Plaintiffs) v. Chemtool Incorporated (Defendant)*, Case No. 2021-L-0000162 (State of Illinois, In the Circuit Court of the 17th Judicial Circuit, Winnebago County).

156. Declaration (October 2021) and Expert Report (November 2021) on behalf of the Plaintiffs in the matter of Toll Brothers, Inc., and Porter Ranch Development Company (Plaintiffs) v. Sempra Energy, Southern California Gas Company et. al., (Defendants), Southern California [Aliso Canyon] Gas Leak Cases, JCCP No.: 4861, Lead Case No.: BC674622, Superior Court of the State of California for the County of Los Angeles.

157. Expert Report (November 2021) and Declaration (September 2022) on behalf of Plaintiffs in Re: Deepwater Horizon BELO Cases, Case No. 3:19cv963-MCR-GRJ (US District Court for the Northern District of Florida, Pensacola Division).

158. Declaration (November 2021) for the *United States of America and the State of Kansas, Department of Health and Environment (Plaintiffs) v. Coffeyville Resources Refining & Marketing, LLC (Defendant)*, Civ. No. 6:04-cv-01064-JAR-KGG (US District Court for the District of Kansas).

159. Expert Report/Affidavit (December 2021) on behalf of the City of Detroit in the matter of Marathon Petroleum Company (Claimant) v. City of Detroit Building Safety Engineering and Environmental

Department, BSEED Case No. MCR 2018-2525, DAH Appeal No. 21-SWA-01, before the State of Michigan, City of Detroit Department of Appeals and Hearings.

160. Expert Report (December 2021) for *John Pabst (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 21-CV-00290 (US District Court for the Eastern District of Louisiana).

161. Expert Report (December 2021) for *Audrey Annette Tillery-Perdue individually and as person representative of the estate of Eddie Lewis Perdue (Plaintiff) v. BP Exploration and Production Inc., et. al., (Defendant)*, Civil Action No. 5:19-cv-00052-MCR-GRJ (US District Court for the Northern District of Florida, Pensacola Division).

162. Expert Report (February 2022) for *Richard Dufour (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 19-cv-00591 (US District Court for the Southern District of Mississippi).

163. Expert Report (February 2022) and Rebuttal Expert Report (June 2022, in preparation) for *Kamuda (Plaintiff) v. Sterigenics U.S., LLC, et. al., (Defendant)*, Case No. 2018-L-010475 (Circuit Court of Cook County, Illinois).

164. Expert Report (February 2022) in the matter of the *Appeal Petition for Hearing on Air Quality Permit No. 8585 on behalf of Earth Care New Mexico et. al., (Petitioners) v. New Mexico Environment Department and Associated Asphalt and Materials, LLC (Applicant),* No. EIB 21-48 before the State of New Mexico Environmental Improvement Board.

165. Expert Report (March 2022), Affidavit (June 2022), Supplemental Expert Report (April 2023) in the matter of *Clean Air Council et. al., (Appellants) v. Commonwealth of Pennsylvania, Department of Environmental Protection (Appellee) and Renovo Energy Center (Permittee)* EHB Docket No. 2021-055-R before the Commonwealth of Pennsylvania Environmental Hearing Board.

166. Declaration (March 2022) in the matter of Max Midstream Texas LLC Air Quality Permit No. 162941 for the Seahawk Crude Condensate Terminal in Calhoun County Texas, TCEQ Docket No. 2022-0157-AIR, before the Texas Commission on Environmental Quality.

167. Expert Pre-filed Testimony (April 2022) in the matter of Application of TPC Group LLC for New State and PSD Air Quality Permits (various), TCEQ Docket No. 2021-1422-AIR, SOAH Docket No. 582-22-0799, Before the Texas State Office of Administrative Hearings.

168. Expert Report (April 2022) and Rebuttal Report (August 2022) for *Teresa Fornek (Plaintiff) v. Sterigenics U.S., LLC, et. al., (Defendant)*, Case No. 2018-L-010744 (Circuit Court of Cook County, Illinois.)

169. Rule 26 Disclosure (May 2022) in the matter of the *Water Works and Sewer Board of the City of Gadsden (*Plaintiff*) v. 3M Company, et. al., (Defendants)*, Civil Action No.: 31 CV-2016-900676.00 (Circuit County of Etowah County, Alabama)

170. Expert Report (June 2022) for *Heather Schumacher (Plaintiff) v. Sterigenics U.S., LLC, et. al., (Defendant)*, Case No. 2018-L-011939 (Circuit Court of Cook County, Illinois.)

171. Expert Report (June 2022), Rebuttal Reports (August 2022, September 2022) for Plaintiffs in *Phylliss Grayson et. al. (Plaintiffs), v Lockheed Martin Corporation (Defendant),* Case No. 6:20-cv-01770. (US District Court for the Middle District of Florida – Orlando Division.)

172. Expert Affidavit (July 2022) for Center for Environmental Rights in connection with the 2019 South Africa Integrated Resource Plan in *African Climate Alliance et. al. v. The Minister of Mineral Resources and Energy et. al.*, in the High Court of South Africa, Gauteng Division, Pretoria.

173. Expert Affidavit (July 2022) for Center for Environmental Rights in connection with the Limpopo Mine (Lephalale Coal Mines Ltd.) in *Earthlife Africa v. The Minister of Forestry, Fisheries and Environment et. al.*, in the High Court of South Africa, Gauteng Division, Pretoria, Case No. 9149/2022.

174. Pre-filed Testimony (July 2022) and Rebuttal Testimony (September 2020) on behalf of the Puyallup Tribe of Indians in the matter of *Washington Utilities and Transportation Commission (Complainant) v. Puget Sound Energy (Respondent)* before the Washington Utilities and Transportation Commission, Docket UE-220066 and UG-220067 (Consolidated).

175. Expert Report (September 2022) *Clean Air Council, Citizens for Pennsylvania's Future, Mountain Watershed Association (Appellants) v. Allegheny County Health Department (Appellee) and Allegheny Energy Center (*Intervenor*, Permittee),* Case No. 21-043 before the Hearing Officer of the Allegheny County Health Department.

176. Expert Affidavit (October 2022) for *Concerned Citizens of Cook County GA (Petitioner) v. Georgia Department of Natural Resources (Respondent) and Spectrum Energy Georgia, LLC (Respondent Intervenor)* before the Office of State Administrative Hearings, State of Georgia, Docket No: 2303405-OSAH-BNR-AQ-37-Barnes.

177. Expert Rebuttal Report (January 2023), Supplemental Rebuttal Expert Report (March 2023, May 2023, November 2023) for *Ann Jordan et. al., and Blake Darnell (Plaintiffs) v. Terumo BCT et. al., (Defendants)* before District Court, Jefferson County, Colorado Case Numbers: 2020CV031457, 2021CV030474 (consolidated with 2020CV031457) and 2020CV03148.

178. Expert Report (January 2023) and Rebuttal Expert Report (April 2023) for *Potomac Riverkeeper and Sierra Club (Plaintiffs) v. Virginia Electric and Power Company (Defendant)*, Civil Action No. 2:21-CV-23 (Kleeh) (US District Court for the Northern District of West Virginia, Elkins Division).

179. Affidavit (January 2023) for *Richard Dufour (Plaintiff), v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 1:19-cv-00591-HSO-BWR (Related to 12-968 BELO in MDL No. 2179). (US District Court for the Southern District of Mississippi).

180. Expert Report (January 2023) and Supplemental Expert Report (July 2023) on behalf of Plaintiffs in the matter of *Stephanie* Mackey *et. al., (Plaintiffs) v. Chemtool Inc. et. al., (Defendants) and Holian Insulation Company Inc. (Third-party Defendant)*, Case No.: 3:21-cv-50283, U.S. District Court, Northern District of Ilinois, Western Division.

181. Expert Report (February 2023) for *Vervicia Henderson, et al. (Plaintiff) v. Lockheed Martin Corporation (Defendant)*, Case No. 6:21-cv-01363, U.S. District Court, Middle District of Florida, Orlando Division.

182. Expert Report (February 2023) for *Carol Davis (Plaintiff) v. Lockheed Martin Corporation (*Defendant*)*, Case No. 6:22-cv-81-RBD-EJK, U.S. District Court, Middle District of Florida, Orlando Division.

183. Expert Report (February 2023) for Mark Letart (Plaintiff), et al. v. Union Carbide Corporation, et al. (Defendants), Case No. 2:19-cv-877, U.S. District Court, Southern District of West Virginia, Charleston Division.

184. Affidavit (March 2023) on behalf of plaintiffs in the matter of the *State of New Mexico, ex rel. Raul Torrez, Attorney General (Plaintiffs) v. Sterigenics US LLC, Sotera Health Holdings, LLC, Sotera Health LLC and Sotera Health Company (Defendants)*, Case No.: D-307-CV-2020-02629, State of New Mexico, Third Judicial District Court, County of Dona Ana

185. Pre-filed Direct Testimony (March 2023) in the matter of *Algonquin Gas Transmission LLC., on behalf of Community Residents (*Petitioners*)*, Commonwealth of Massachusetts Department of Environmental Protection, Office of Appeals and Dispute Resolution, OADR Docket Nos. 2017-011 and 012, Waterways Application License No. W16-4600, Weymouth Mass.

186. Declaration (April 2023) in the matter of Sierra Club (Plaintiff) v. Tennessee Valley Authority in the matter of the Johnsonville Aeroderivative Combustion Turbines Project, Case No.: 3:22-cv-1054, U.S>, District Court, Middle District of Tennessee, Nashville Division.

187. Expert Report (May 2023/June 2023), Affidavit (April 2023) and Declaration (July 2023) for *Ezequiel Caraballo-Pache (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 8:20-cv-00263-SCB-JSS (US District Court for the Middle District of Florida, Tampa Division).

188. Affidavit (May 2023) for *Lawrence Tucei (Plaintiff), v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 1:22-cv-00078-HSO-BWR (US District Court for the Southern District of Mississippi).

189. Expert Report (May 2023/June 2023) for *Vincent Culliver (Plaintiff), v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 3:21-cv-4942-MCR/HTC (US District Court for the Northern District of Florida).

190. Expert Report (June 2023) for *Matthew Williams (Plaintiff), v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 1:22-cv-00278-LG-BWR (US District Court for the Southern District of Mississippi).

191. Declaration (June 2023) in support of public commenters relating to the Michigan Department of Environment Great Lakes and Energy (EGLE)'s Annual Network Monitoring Plan 2024.

192. Expert Report (July 2023) and Rebuttal Expert Report (September 2023) relating to Greenhouse Gas and Energy Management (GEMM2) for Manufacturing in Colorado (September 2023) on behalf of Environmental Defense Fund.

193. Pre-filed Direct Testimony (July 2023) on behalf of Citizens for Environmental Justice in the matter of the permit Application of Valero Refining-Texas, LP for Modification to State and Prevention of Significant Deterioration Air Quality Permits No. 38754 and PSDTX324M15 before the Texas State Office of Administrative Hearings, SOAH Docket No. 582-23-14975, TCEQ Docket No. 2023-0203-AIR.

194. Declaration (August 2023) in support of comments by Environmental Defense Fund in connection with the "Good Neighbor Plan" for the 2015 Ozone National Ambient Air Quality Standards, published at 88 Fed. Reg. 36,654 (June 5, 2023) ("Final Rule"), Docket ID No. EPA-HQ-OAR-2021-0668.

195. Expert Report (August 2023) on behalf of Appellants in the matter of *PennEnvironment and Sierra Club (Appellants) v. Commonwealth of Pennsylvania, Department of Environmental Protection, (Appellee), and PPG Industries, Inc. (Permittee)*, EHB Docket No. 2022-032-B. Environmental Hearing Board, Department of Environmental Protection, State of Pennsylvania.

196. Pre-filed Testimony (September 2023) and Cross Answering Testimony (October 2023) on behalf of the Puyallup Tribe of Indians in the matter of *Washington Utilities and Transportation Commission (Complainant) v. Puget Sound Energy (Respondent)*, Docket: UG-230393. Before the Washington Utilities and Transportation Commission.

197. Expert Report (December 2023) on behalf of plaintiffs in the matter of *PennEnvironment and Sierra Club (Plaintiffs) v. PPG Industries, Inc. (Defendant).* Case No.: Civil Action Nos. 2:12-cv-00342, 2:12-cv-00527, 2:13-cv-01395, 1:13-cv-01396, 2:14cv-00229 (consolidated). U.S. District Court Western District of Pennsylvania.

C. Occasions where Dr. Sahu has provided oral testimony <u>in depositions, at trial or in similar proceedings</u> include the following:

198. Deposition on behalf of Rocky Mountain Steel Mills, Inc. located in Pueblo, Colorado – dealing with the manufacture of steel in mini-mills including methods of air pollution control and BACT in steel mini-mills and opacity issues at this steel mini-mill.

199. Trial Testimony (February 2002) on behalf of Rocky Mountain Steel Mills, Inc. in Denver District Court.

200. Trial Testimony (February 2003) on behalf of the United States in the Ohio Edison NSR Cases, *United States, et al. v. Ohio Edison Co., et al.*, C2-99-1181 (Southern District of Ohio).

201. Trial Testimony (June 2003) on behalf of the United States in the Illinois Power NSR Case, *United States v. Illinois Power Co., et al.*, 99-833-MJR (Southern District of Illinois).

202. Deposition (10/20/2005) on behalf of the United States in connection with the Cinergy NSR Case. *United States, et* al. *v. Cinergy Corp., et al.*, IP 99-1693-C-M/S (Southern District of Indiana).

203. Oral Testimony (August 2006) on behalf of the Appalachian Center for the Economy and the Environment re. the Western Greenbrier plant, WV before the West Virginia DEP.

204. Oral Testimony (May 2007) on behalf of various Montana petitioners (Citizens Awareness Network (CAN), Women's Voices for the Earth (WVE) and the Clark Fork Coalition (CFC)) re. the Thompson River Cogeneration plant before the Montana Board of Environmental Review.

205. Oral Testimony (October 2007) on behalf of the Sierra Club re. the Sevier Power Plant before the Utah Air Quality Board.

206. Oral Testimony (August 2008) on behalf of the Sierra Club and Clean Water re. Big Stone Unit II before the South Dakota Board of Minerals and the Environment.

207. Oral Testimony (February 2009) on behalf of the Sierra Club and the Southern Environmental Law Center re. Santee Cooper Pee Dee units before the South Carolina Board of Health and Environmental Control.

208. Oral Testimony (February 2009) on behalf of the Sierra Club and the Environmental Integrity Project re. NRG Limestone Unit 3 before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

209. Deposition (July 2009) on behalf of MTD Products, Inc., in the matter of *Alice Holmes and Vernon Holmes v. Home Depot USA, Inc., et al*.

210. Deposition (October 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed Coleto Creek coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

211. Deposition (October 2009) on behalf of Environmental Defense, in the matter of permit challenges to the proposed Las Brisas coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

212. Deposition (October 2009) on behalf of the Sierra Club, in the matter of challenges to the proposed Medicine Bow Fuel and Power IGL plant in Cheyenne, Wyoming.

213. Deposition (October 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed Tenaska coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH). (April 2010).

214. Oral Testimony (November 2009) on behalf of the Environmental Defense Fund re. the Las Brisas Energy Center before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

215. Deposition (December 2009) on behalf of Environmental Defense and others, in the matter of challenges to the proposed White Stallion Energy Center coal fired power plant project at the Texas State Office of Administrative Hearings (SOAH).

216. Oral Testimony (February 2010) on behalf of the Environmental Defense Fund re. the White Stallion Energy Center before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

217. Deposition (June 2010) on behalf of the United States in connection with the Alabama Power Company NSR Case. *United States v. Alabama Power Company*, CV-01-HS-152-S (Northern District of Alabama, Southern Division).

218. Trial Testimony (September 2010) on behalf of Commonwealth of Pennsylvania – Dept. of Environmental Protection, State of Connecticut, State of New York, State of Maryland, and State of New Jersey (Plaintiffs) in connection with the Allegheny Energy NSR Case in US District Court in the Western District of Pennsylvania. *Plaintiffs v. Allegheny Energy Inc., et al.,* 2:05cv0885 (Western District of Pennsylvania).

219. Oral Direct and Rebuttal Testimony (September 2010) on behalf of Fall-Line Alliance for a Clean Environment and others in the matter of the PSD Air Permit for Plant Washington issued by Georgia DNR at the Office of State Administrative Hearing, State of Georgia (OSAH-BNR-AQ-1031707-98-WALKER).

220. Oral Testimony (September 2010) on behalf of the State of New Mexico Environment Department in the matter of Proposed Regulation 20.2.350 NMAC – *Greenhouse Gas Cap and Trade Provisions,* No. EIB 10-04 (R), to the State of New Mexico, Environmental Improvement Board.

221. Oral Testimony (October 2010) on behalf of the Environmental Defense Fund re. the Las Brisas Energy Center before the Texas State Office of Administrative Hearings (SOAH) Administrative Law Judges.

222. Oral Testimony (November 2010) regarding BART for PSCo Hayden, CSU Martin Drake units before the Colorado Air Quality Commission on behalf of the Coalition of Environmental Organizations.

223. Oral Testimony (December 2010) regarding BART for TriState Craig Units, CSU Nixon Unit, and PRPA Rawhide Unit) before the Colorado Air Quality Commission on behalf of the Coalition of Environmental Organizations.

224. Deposition (December 2010) on behalf of the United States in connection with the Louisiana Generating NSR Case. *United States v. Louisiana Generating, LLC*, 09-CV100-RET-CN (Middle District of Louisiana).

225. Deposition (February 2011 and January 2012) on behalf of Wild Earth Guardians in the matter of opacity exceedances and monitor downtime at the Public Service Company of Colorado (Xcel)'s Cherokee power plant. No. 09-cv-1862 (D. Colo.).

226. Oral Testimony (February 2011) to the Georgia Office of State Administrative Hearings (OSAH) in the matter of Minor Source HAPs status for the proposed Longleaf Energy Associates power plant (OSAH-BNR-AQ-1115157-60-HOWELLS) on behalf of the Friends of the Chattahoochee and the Sierra Club).

227. Deposition (August 2011) on behalf of the United States in *United States of America v. Cemex, Inc.*, Civil Action No. 09-cv-00019-MSK-MEH (District of Colorado).

228. Deposition (July 2011) and Oral Testimony at Hearing (February 2012) on behalf of the Plaintiffs MYTAPN in the matter of Microsoft-Yes, Toxic Air Pollution-No (MYTAPN) v. State of Washington, Department of Ecology and Microsoft Corporation Columbia Data Center to the Pollution Control Hearings Board, State of Washington, Matter No. PCHB No. 10-162.

229. Oral Testimony at Hearing (March 2012) on behalf of the United States in connection with the Louisiana Generating NSR Case. *United States v. Louisiana Generating, LLC*, 09-CV100-RET-CN (Middle District of Louisiana).

230. Oral Testimony at Hearing (April 2012) on behalf of the New Hampshire Sierra Club at the State of New Hampshire Public Utilities Commission, Docket No. 10-261 – the 2010 Least Cost Integrated Resource Plan (LCIRP) submitted by the Public Service Company of New Hampshire (re. Merrimack Station Units 1 and 2).

231. Oral Testimony at Hearing (November 2012) on behalf of Clean Wisconsin in the matter of Application of Wisconsin Public Service Corporation for Authority to Construct and Place in Operation a New Multi-Pollutant Control Technology System (ReACT) for Unit 3 of the Weston Generating Station, before the Public Service Commission of Wisconsin, Docket No. 6690-CE-197.

232. Deposition (March 2013) in the matter of various Environmental Petitioners v. North Carolina DENR/DAQ and Carolinas Cement Company, before the Office of Administrative Hearings, State of North Carolina.

233. Deposition (August 2013) on behalf of the Sierra Club in connection with the Luminant Big Brown Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 6:12-cv-00108-WSS (Western District of Texas, Waco Division).

234. Deposition (August 2013) on behalf of the Sierra Club in connection with the Luminant Martin Lake Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 5:10-cv-0156-MHS-CMC (Eastern District of Texas, Texarkana Division).

235. Deposition (February 2014) on behalf of the United States in *United States of America v. Ameren Missouri*, Civil Action No. 4:11-cv-00077-RWS (Eastern District of Missouri, Eastern Division).

236. Trial Testimony (February 2014) in the matter of *Environment Texas Citizen Lobby, Inc and Sierra Club v. ExxonMobil Corporation et al.,* Civil Action No. 4:10-cv-4969 (Southern District of Texas, Houston Division).

237. Trial Testimony (February 2014) on behalf of the Sierra Club in connection with the Luminant Big Brown Case. *Sierra Club v. Energy Future Holdings Corporation and Luminant Generation Company LLC*, Civil Action No. 6:12-cv-00108-WSS (Western District of Texas, Waco Division).

238. Deposition (June 2014) and Trial (August 2014) on behalf of ECM Biofilms in the matter of the *US Federal Trade Commission (FTC) v. ECM Biofilms* (FTC Docket #9358).

239. Deposition (February 2015) on behalf of Plaintiffs in the matter of *Sierra Club and Montana Environmental Information Center (Plaintiffs) v. PPL Montana LLC, Avista Corporation, Puget Sound Energy, Portland*

General Electric Company, Northwestern Corporation, and Pacificorp (Defendants), Civil Action No. CV 13-32-BLG-DLC-JCL (US District Court for the District of Montana, Billings Division).

240. Oral Testimony at Hearing (April 2015) on behalf of Niagara County, the Town of Lewiston, and the Villages of Lewiston and Youngstown in the matter of CWM Chemical Services, LLC New York State Department of Environmental Conservation (NYSDEC) Permit Application Nos.: 9-2934-00022/00225, 9-2934-00022/00231, 9-2934-00022/00232, and 9-2934-00022/00249 (pending).

241. Deposition (August 2015) on behalf of Plaintiff in the matter of *Conservation Law Foundation (Plaintiff) v. Broadrock Gas Services LLC, Rhode Island LFG GENCO LLC, and Rhode Island Resource Recovery Corporation (Defendants)*, Civil Action No. 1:13-cv-00777-M-PAS (US District Court for the District of Rhode Island).

242. Testimony at Hearing (August 2015) on behalf of the Sierra Club in the matter of *Amendments to 35 Illinois Administrative Code Parts 214, 217, and 225* before the Illinois Pollution Control Board, R15-21.

243. Deposition (May 2015) on behalf of Plaintiffs in the matter of *Northwest Environmental Defense Center et. al., (Plaintiffs) v. Cascade Kelly Holdings LLC, d/b/a Columbia Pacific Bio-Refinery, and Global Partners LP (Defendants)*, Civil Action No. 3:14-cv-01059-SI (US District Court for the District of Oregon, Portland Division).

244. Trial Testimony (October 2015) on behalf of Plaintiffs in the matter of *Northwest Environmental Defense Center et. al., (Plaintiffs) v. Cascade Kelly Holdings LLC, d/b/a Columbia Pacific Bio-Refinery, and Global Partners LP (Defendants)*, Civil Action No. 3:14-cv-01059-SI (US District Court for the District of Oregon, Portland Division).

245. Deposition (April 2016) on behalf of the Plaintiffs in *Natural Resources Defense Council, Respiratory Health Association, and Sierra Club (Plaintiffs) v. Illinois Power Resources LLC and Illinois Power Resources Generation LLC (Defendants)*, Civil Action No. 1:13-cv-01181 (Central District of Illinois, Peoria Division).

246. Trial Testimony at Hearing (July 2016) in the matter of Tesoro Savage LLC Vancouver Energy Distribution Terminal, Case No. 15-001 before the State of Washington Energy Facility Site Evaluation Council.

247. Trial Testimony (December 2016) on behalf of the challengers in the matter of the Delaware Riverkeeper Network, Clean Air Council, et. al., vs. Commonwealth of Pennsylvania Department of Environmental Protection and R. E. Gas Development LLC regarding the Geyer well site before the Pennsylvania Environmental Hearing Board.

248. Trial Testimony (July-August 2016) on behalf of the United States in *United States of America v. Ameren Missouri*, Civil Action No. 4:11-cv-00077-RWS (Eastern District of Missouri, Eastern Division).

249. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Huntley and Huntley Poseidon Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

250. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Apex energy Backus Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

251. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Apex energy Drakulic Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

252. Trial Testimony (January 2017) on the Environmental Impacts Analysis associated with the Apex energy Deutsch Well Pad Hearing on behalf citizens in the matter of the special exception use Zoning Hearing Board of Penn Township, Westmoreland County, Pennsylvania.

253. Deposition Testimony (July 2017) on behalf of Plaintiffs in the matter of *Casey Voight and Julie Voight v Coyote Creek Mining Company LLC (Defendant)* Civil Action No. 1:15-CV-00109 (US District Court for the District of North Dakota, Western Division).

254. Deposition Testimony (November 2017) on behalf of Defendant in the matter of *Oakland Bulk and Oversized Terminal (Plaintiff) v City of Oakland (Defendant,)* Civil Action No. 3:16-cv-07014-VC (US District Court for the Northern District of California, San Francisco Division).

255. Deposition Testimony (December 2017) on behalf of Plaintiff in the matter of *Wildearth Guardians (Plaintiff) v Colorado Springs Utility Board (Defendant)* Civil Action No. 1:15-cv-00357-CMA-CBS (US District Court for the District of Colorado).

256. Deposition Testimony (January 2018) in the matter of National Parks Conservation Association (NPCA) v. State of Washington Department of Ecology and British Petroleum (BP) before the Washington Pollution Control Hearing Board, Case No. 17-055.

257. Trial Testimony (January 2018) on behalf of Defendant in the matter of *Oakland Bulk and Oversized Terminal (Plaintiff) v City of Oakland (Defendant,)* Civil Action No. 3:16-cv-07014-VC (US District Court for the Northern District of California, San Francisco Division).

258. Trial Testimony (April 2018) on behalf of the National Parks Conservation Association (NPCA) in the matter of NPCA v State of Washington, Department of Ecology and BP West Coast Products, LLC, PCHB No. 17-055 (Pollution Control Hearings Board for the State of Washington.

259. Deposition (June 2018) (harm Phase) on behalf of Plaintiffs in the matter of *Natural Resources Defense Council, Inc., Sierra Club, Inc., and Respiratory Health Association v. Illinois Power Resources LLC, and Illinois Power Resources Generating LLC (Defendants)*, Civil Action No. 1:13-cv-01181 (US District Court for the Central District of Illinois, Peoria Division).

260. Trial Testimony (July 2018) on behalf of Petitioners in the matter of *Coosa River Basin Initiative and Sierra Club (Petitioners) v State of Georgia Environmental Protection Division, Georgia Department of Natural Resources (Respondent) and Georgia Power Company (Intervenor/Respondent)*, Docket Nos: 1825406-BNR-WW-57-Howells and 1826761-BNR-WW-57-Howells, Office of State Administrative Hearings, State of Georgia.

261. Deposition (January 2019) and Trial Testimony (January 2019) on behalf of Sierra Club and Texas Campaign for the Environment (Appellants) in the contested case hearing before the Texas State Office of Administrative Hearings in Docket Nos. 582-18-4846, 582-18-4847 (Application of GCGV Asset Holding, LLC for Air Quality Permit Nos. 146425/PSDTX1518 and 146459/PSDTX1520 in San Patricio County, Texas).

262. Deposition (February 2019) and Trial Testimony (March 2019) on behalf of Sierra Club in the State of Florida, Division of Administrative Hearings, Case No. 18-2124EPP, Tampa Electric Company Big Bend Unit 1 Modernization Project Power Plant Siting Application No. PA79-12-A2.

263. Deposition (June 2019) relating to the appeal of air permits issued to PTTGCA on behalf of Appellants in the matter of *Sierra Club (Appellants) v. Craig Butler, Director, et. al., Ohio EPA (Appellees)* before the State of Ohio Environmental Review Appeals Commission (ERAC), Case Nos. ERAC-19-6988 through -6991.

264. Deposition (September 2019) on behalf of Appellants relating to the NPDES permit for the Cheswick power plant in the matter of *Three Rivers Waterkeeper and Sierra Club (Appellants) v. State of Pennsylvania Department of Environmental Protection (Appellee) and NRG Power Midwest (Permittee)*, before the Commonwealth of Pennsylvania Environmental Hearing Board, EHB Docket No. 2018-088-R.

265. Deposition (December 2019) on behalf of the Plaintiffs in the matter of David Kovac, individually and on behalf of wrongful death class of Irene Kovac v. BP Corporation North America Inc., Circuit Court of Jackson County, Missouri (Independence), Case No. 1816-CV12417.

266. Deposition (February 2020, virtual) and testimony at Hearing (August 2020, virtual) on behalf of Earthjustice in the matter of *Objection to the Issuance of PSD/NSR and Title V permits for Riverview Energy Corporation*, Dale, Indiana, before the Indiana Office of Environmental Adjudication, Cause No. 19-A-J-5073.

267. Hearing (July 14-15, 2020, virtual) on behalf of the Sierra Club in the matter of *the Application of the Ohio State University for a certificate of Environmental Compatibility and Public Need to Construct a Combined Heat and Power Facility in Franklin County, Ohio*, before the Ohio Power Siting Board, Case No. 19-1641-EL-BGN.

268. Hearing (September 2020, virtual) on behalf of WildEarth Guardians (petitioners) in the matter of *the Appeals of the Air Quality Permit No. 7482-M1 Issued to 3 Bear Delaware* Operating *– NM LLC (EIB No. 20-21(A) and Registrations Nos. 8729, 8730, and 8733 under General Construction Permit for Oil and Gas Facilities (EIB No. 20-33 (A)*, before the State of New Mexico, Environmental Improvement Board.

269. Deposition (December 2020, March 4-5, 2021, all virtual) and Hearing (April 2021, virtual) in support of Petitioner's Motion for Stay of PSCAA NOC Order of Approval No. 11386 in the matter of the *Puyallup Tribe of Indians v. Puget Sound Clean Air Agency (PSCAA) and Puget Sound Energy (PSE),* before the State of Washington Pollution Control Hearings Board, PCHB No. P19-088.

270. Hearing (September 2020, virtual) on the *Initial Economic Impact Analysis (EIA) for A Proposal To* Regulate *NOx Emissions from Natural Gas Fired Rich-Burn Natural Gas Reciprocating Internal Combustion Engines (RICE) Greater Than 100 Horsepower* prepared on behalf of Earthjustice and the National Parks Conservation Association in the matter of Regulation Number 7, Alternate Rules before the Colorado Air Quality Control Commission.

271. Deposition (December 2020, virtual and Hearing February 2021, virtual) on behalf of the Plaintiffs (Shrimpers and Fishermen of the Rio Grande Valley represented by Texas RioGrande Legal Aid, Inc.) in the matter of the Appeal of Texas Commission on Environmental Quality (TCEQ) Permit Nos. 147681, PSDTX1522, GHGPSDTX172 for the Jupiter Brownsville Heavy Condensate Upgrader Facility, Cameron County, before the Texas State Office of Administrative Hearings, SOAH Docket No. 582-21-0111, TCEQ Docket No. 2020-1080-AIR.

272. Deposition (January 2021, virtual) on behalf of Plaintiffs in the matter of *PennEnvironment Inc., and Clean Air Council (Plaintiffs) and Allegheny County Health Department (Plaintiff-Intervenor) v. United States Steel Corporation (Defendant)*, Civil Action No. 2-19-cv-00484-MJH (US District Court for the Western District of Pennsylvania.)

273. Deposition (February 2021, virtual) on behalf of Plaintiffs in the matter of *Sierra Club Inc. (Plaintiff) v. GenOn Power Midwest LP (*Defendants*)*, Civil Action No. 2-19-cv-01284-WSS (US District Court for the Western District of Pennsylvania.)

274. Deposition (April 2021, virtual) on the Potential Remedies to Avoid Adverse Thermal Impacts from the Merrimack Station on behalf of Plaintiffs in the matter of *Sierra Club Inc. and the* Conservation *Law Foundation (Plaintiffs) v. Granite Shore Power, LLC et. al., (Defendants)*, Civil Action No. 19-cv-216-JL (US District Court for the District of New Hampshire.)

275. Deposition (June 2021, virtual) on behalf of Plaintiffs in the matter of *Sierra Club (Plaintiff) v. Woodville Pellets, LLC (Defendant)*, Civil Action No. 9:20-cv-00178-MJT (US District Court for the Eastern District of Texas, Lufkin Division).

276. Deposition (June 2021, virtual) on behalf of the Plaintiffs in the matter of *Modern Holdings, LLC, et al. (Plaintiffs) v. Corning Inc., et al. (Defendants)*, Civil Action No. 5:13-cv-00405-GFVT, (US District Court for the Eastern District of Kentucky, Central Division at Lexington).

277. Testimony (June 2021, virtual) regarding the Aries Newark LLC Sludge Processing Facility, Application No. CPB 20-74, (Central Planning Board, City of Newark, New Jersey).

278. Testimony at Hearing (October 2021) on behalf of Evraz Rocky Mountain Steel in the matter of Colorado's Proposed Revisions to Regulation 22, the Greenhouse Gas Emissions and Energy Management for the Manufacturing Sector in Colorado (GEMM Rule), before the Colorado Air Quality Control Commission.

279. Deposition (November 2021) for *Charles Johnson Jr. (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant),* Civil Action No. 2:20-CV-01329 (Related to 12-968 BELO in MDL No. 2179). (US District Court for the Eastern District of Louisiana).

280. Testimony at Hearing (November 2021) on behalf of *National Parks Conservation Association, et. al*., in the matter of the Proposed Revisions to Colorado's Regional Haze State Implementation Plan (SIP) and Colorado Regulation 23, before the Colorado Air Quality Control Commission.

281. Deposition (December 2021) on behalf of Plaintiffs in Re: Deepwater Horizon BELO Cases, Case No. 3:19cv963-MCR-GRJ (US District Court for the Northern District of Florida, Pensacola Division).

282. Deposition (December 2021) for *James Noel (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant),* Civil Action No. 1:19-CV-00694-JB-MU-C (US District Court for the Southern District of Alabama, Southern Division).

283. Testimony at Hearing (February 2022, virtual) in the matter of the *Appeal Petition for Hearing on Air Quality Permit No. 8585 on behalf of Earth Care New Mexico et. al., (Petitioners) v. New Mexico Environment Department and Associated Asphalt and Materials, LLC (Applicant),* No. EIB 21-48 before the State of New Mexico Environmental Improvement Board.

284. Deposition (March 2022) and Rebuttal Deposition (July 2022) for *Kamuda (Plaintiff) v. Sterigenics U.S., LLC, et. al., (Defendant)*, Case No. 2018-L-010475 (Circuit Court of Cook County, Illinois.)

285. Deposition (April 2022, virtual) in the matter of Application of TPC Group LLC for New State and PSD Air Quality Permits (various), TCEQ Docket No. 2021-1422-AIR, SOAH Docket No. 582-22-0799, Before the Texas State Office of Administrative Hearings.

286. Deposition (May 2022, virtual) in the matter of the *Water Works and Sewer Board of the City of Gadsden (Plaintiff) v. 3M Company, et. al., (*Defendants*)*, Civil Action No.: 31 CV-2016-900676.00 (Circuit County of Etowah County, Alabama)

287. Deposition (June 2022 and September 2022, both virtual) for *Teresa* Fornek *(Plaintiff) v. Sterigenics U.S., LLC, et. al., (Defendant)*, Case No. 2018-L-010744 (Circuit Court of Cook County, Illinois.)

288. Deposition (June 2022, virtual) on behalf of the Plaintiffs in the matter of Toll Brothers, Inc., and Porter Ranch Development Company (Plaintiffs) v. Sempra Energy, Southern California Gas Company et. al., (Defendants), Southern California [Aliso Canyon] Gas Leak Cases, JCCP No.: 4861, Lead Case No.: BC674622, Superior Court of the State of California for the County of Los Angeles.

289. Deposition (July 2022) for *Richard Dufour (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 19-cv-00591 (US District Court for the Southern District of Mississippi).

290. Trial (August 2022) on behalf of the Plaintiffs in the matter of Modern *Holdings, LLC, et al. (Plaintiffs) v. Phillips (Defendants)*, Civil Action No. 5:13-cv-00405-GFVT, (US District Court for the Eastern District of Kentucky, Central Division at Lexington).

291. Trial (August 2022, in person) for *Susan Kamuda (Plaintiff) v. Sterigenics U.S., LLC, et. al., (Defendant)*, Case No. 2018-L-010475 (Circuit Court of Cook County, Illinois).

292. Deposition (September 2022, virtual) for *Heather Schumacher (Plaintiff) v. Sterigenics U.S., LLC, et. al., (Defendant)*, Case No. 2018-L-010744 (Circuit Court of Cook County, Illinois.)

293. Deposition (September 2022) on behalf of Plaintiffs in *Phylliss Grayson et. al. (Plaintiffs), v Lockheed Martin Corporation (Defendant),* Case No. 6:20-cv-01770. (US District Court for the Middle District of Florida – Orlando Division.)

294. Deposition (September 2022) for *Teresa Fornek (Plaintiff) v. Sterigenics U.S., LLC, et. al., (Defendant)*, Case No. 2018-L-010475 (Circuit Court of Cook County, Illinois).

295. Hearing (October 2022) on behalf of the Puyallup Tribe of Indians in the matter of *Washington Utilities and Transportation Commission (Complainant) v. Puget Sound Energy (Respondent)* before the Washington Utilities and Transportation Commission, Docket UE-220066 and UG-220067 (Consolidated).

296. Trial (October 2022, in person) for *Teresa Fornek (Plaintiff) v. Sterigenics U.S., LLC, et. al., (Defendant)*, Case No. 2018-L-010475 (Circuit Court of Cook County, Illinois).

297. Depositions (March 2023, June 2023) for *Ann Jordan et. al., and Blake Darnell (Plaintiffs) v. Terumo BCT et. al., (Defendants)* before District Court, Jefferson County, Colorado Case Numbers: 2020CV031457, 2021CV030474 (consolidated with 2020CV031457) and 2020CV03148.

298. Depositions (March 2023, April 2023, May 2023) for Quinn Buczek (Plaintiff) v. Sterigenics US, LLC, Sotera Health, LLC, Prologis First US Properties, LP, et. al., (Defendants) before State Court of Gwinnett County, State of Georgia, Case No. Civil Action File No. 20-C-05918-S1.

299. Deposition (May 2023) for *Potomac Riverkeeper and Sierra Club (Plaintiffs) v. Virginia Electric and Power Company (Defendant)*, Civil Action No. 2:21-CV-23 (Kleeh) (US District Court for the Northern District of West Virginia, Elkins Division).

300. Deposition (May 2023) for Mark Letart (Plaintiff), et al. v. Union Carbide Corporation, et al. (Defendants), Case No. 2:19-cv-877, U.S. District Court, Southern District of West Virginia, Charleston Division.

301. Testimony at Hearing on behalf of Evraz North America In the Matter of Colorado Air Quality Regulation Proposed Revisions to Regulation Number 3 to establish enhanced Modeling, monitoring and permitting requirements for Stationary sources in disproportionately impacted communities 5 CCR 1001-5, before the Air Quality Control Commission, State of Colorado.

302. Deposition (2023) for *Vervicia Henderson, et al. (Plaintiff) v. Lockheed Martin Corporation (Defendant)*, Case No. 6:21-cv-01363, U.S. District Court, Middle District of Florida, Orlando Division.

303. Testimony at Hearing (July 2023) *Clean Air Council, Citizens for Pennsylvania's Future, Mountain* Watershed *Association (Appellants) v. Allegheny County Health Department (Appellee) and Allegheny Energy Center (*Intervenor*, Permittee),* Case No. 21-043 before the Hearing Officer of the Allegheny County Health Department.

304. Deposition (July 2023) for *Ezequiel Caraballo-Pache (Plaintiff) v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 8:20-cv-00263-SCB-JSS (US District Court for the Middle District of Florida, Tampa Division).

305. Deposition (August 2023) for *Floyd Ruffin (Plaintiff), v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 2:20-cv-00334-CJB-JCW (US District Court for the Eastern District of Louisiana, New Orleans Division).

306. Deposition (August 2023) on behalf of petitioners in *Doreen Carey et; al., (Petitioners) v. Fulcrum Centerpoint LLC. (Permittee/Respondent) and Indiana Department of Environmental Management (Respondent)*, Permit Number 089-44042-00660, before the Indiana Office of Environmental Adjudication.

307. Deposition (August 2023) on behalf of the Plaintiff in the *Water Works and Sewer Board of the Town of Centre, Alabama v. 3M Company, et. al.*, Civil Action No.: CV-2017-900049. Circuit Court of Cherokee County, State of Georgia.

308. Deposition (August 2023) for *Matthew Williams (Plaintiff), v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 1:22-cv-00278-LG-BWR (US District Court for the Southern District of Mississippi).

309. Deposition (September 2023) for *Vincent Culliver (Plaintiff), v. BP Exploration and Production Inc., et. al. (Defendant)*, Civil Action No. 3:21-cv-4942-MCR/HTC (US District Court for the Northern District of Florida).

310. Testimony at Hearing for Greenhouse Gas and Energy Management (GEMM2) for Manufacturing in Colorado (September 2023) on behalf of Environmental Defense Fund.

311. Testimony at Hearing (October 2023) in the matter of *Algonquin Gas Transmission LLC., on behalf of Community Residents (*Petitioners*)*, Commonwealth of Massachusetts Department of Environmental Protection, Office of Appeals and Dispute Resolution, OADR Docket Nos. 2017-011 and 012, Waterways Application License No. W16-4600, Weymouth Mass.

312. Testimony at Hearing (August 2023) on behalf of Citizens for Environmental Justice in the matter of the permit Application of Valero Refining-Texas, LP for Modification to State and Prevention of Significant Deterioration Air Quality Permits No. 38754 and PSDTX324M15 before the Texas State Office of Administrative Hearings, SOAH Docket No. 582-23-14975, TCEQ Docket No. 2023-0203-AIR.

313. Testimony at Hearing (September 2023) on behalf of Appellants in the matter of *PennEnvironment and Sierra Club (Appellants) v. Commonwealth of Pennsylvania, Department of Environmental Protection, (Appellee), and PPG Industries, Inc. (Permittee)*, EHB Docket No. 2022-032-B. Environmental Hearing Board, Department of Environmental Protection, State of Pennsylvania.

314. Testimony at Hearing (November 2023) on behalf of the Puyallup Tribe of Indians in the matter of *Washington Utilities and Transportation Commission (Complainant) v. Puget Sound Energy (Respondent)*, Docket: UG-230393. Before the Washington Utilities and Transportation Commission.

EXHIBIT B

TRI-S ENVIRONMENTAL
SENSIBLE STRATEGIES AND SOLUTIONS FOR THE ENVIRONMENT

August 29, 2024

Delivered Via Email

Ms. Victoria Yundt, Attorney
Ms. Rebecca Davis, Attorney
Lozeau Drury
1939 Harrison Street, Suite 150
Oakland, CA 94612

RE: **Environmental Concerns and Comments**
Morton Bay Geothermal Project: California Energy Commission Docket 23-AFC-01
Morton Bay Geothermal Project Preliminary Staff Assessment and Application
Submitted by Morton Bay Geothermal LLC, BHE Renewables
Salton Sea, Imperial County, California

Dear Ms. Yundt and Ms. Davis:

The purpose of this letter is to provide comments and analysis on potential environmental impacts of the subject proposed Morton Bay Geothermal Project (MBGP) project by BHE Renewables (BHER) in Imperial County, California. I have reviewed the Preliminary Staff Assessment Report (1,017 pages in length) and Application for Certification files (including the Application for Certification-560 pages in length). I have also reviewed dozens of publications related to geothermal energy and lithium mining that the author will reference as part of the comments provided below. These comments will be broken into two sections. Section One is Comments on the MBGP Preliminary Staff Assessment (PSA) and Section Two is BHER Direct Lithium Extraction History and Environmental Permitting Issues

Section One: Comments on the Preliminary Staff Assessment (PSA)

Part I Potentially Significant Environmental Impacts

There are nine production wells and eleven injection wells of geothermal brine planned for the operations of the Morton Bay Geothermal Plant to a maximum depth of nearly two miles (~3,000 Elmore 14 to ~9,200 feet Elmore 16-see page 201 LBNL) below the ground surface. The author has conducted an evaluation of the PSA and there is substantial evidence Potentially Significant Environmental Impacts for three items: *5.7.2 Hazards, Hazardous Materials, and Wildfire sections a. and b*. (pages 5.7-12 and 5.7-13) and *5.16.2 Water Resources section a* (page 5.15-7). The possibility of an accident or upset is real and would create a ***potentially significant impact***/hazard to the environment and the public. The author strongly suggests the environmental impacts are modified from less than significant with mitigation to potentially significant impacts. The four

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comments below address the reasoning behind and the evidence supporting the change of the three aforementioned subsections to **potentially significant environmental impacts**.

1) Geothermal Well Failure a Distinct Possibility: Potential for Hazardous Material Release

Changes in pressure and temperature in geothermal wells can result in mechanical failure of the well and the geological formation near the catastrophic blowout area. Carbon dioxide has resulted in as much as 3 millimeters of corrosion of carbon steel well casing per year in the Imperial Valley which led to well plugging after 10-12 years of operation. Attempts at extending the well life by cementing in smaller production strings failed per the 2012 Sandi National Laboratory Handbook of Best Practices for Geothermal Drilling. The failure or plugging of a well can result in expansion of trapped fluid an in the casing to casing annulus that could result in shallow groundwater contamination or a discharge to the surface (waste or exceedance of water quality standards). There are a number of potential causes of geothermal well casing failure and several failure modes are listed below:

- Strength loss due to temperature elevation
- Mechanical wear of casing inner side
- Buckling due to thermal stress and pure cementing job
- Corrosion (internal and external) and scaling
- Decoupled casing joints due to thermal stress
- Buckling of the casing at some interval in well
- Failure of cement exposed to cyclic loads
- Failure of casing material exposed to cyclic loads

There was also mention of well head damage due to thermal expansion as an issue and poor cementing of the casing as a reason for failure (Allahvirdizadeh, P. *A review on geothermal wells: Well integrity issues*, Journal of Cleaner Production 275 (2020) 124009, pages 1-21). There is an entire journal article devoted to the quantification of accidental risks in geothermal energy systems entitled "Comparative accident risk assessment with focus on deep geothermal energy systems in the Organization for Economic Co-operation and Development (OECD) countries" published in 2021 in Geothermics whereby equations for the evaluation risk factors of accidents during various phases of geothermal work (well drilling, stimulation and operations) and for blowouts is presented. The article discusses the accident risks during the drilling phases as it pertains to caustic soda (additive in the drilling mud) which "is a highly caustic metallic base and alkali salt and is extremely corrosive for humans (as well as for metals)." There are numerous other risk factors for accidents during the operational phase as well as the possibility of a blowout (in the worst-case scenario where an installed blowout prevention device fails or otherwise). The evidence presented in this paragraph is justification for there being a potentially significant environmental impact in case of an accident that is reasonably foreseen.

A California Energy Commission (CEC) report CEC-500-2-23-042 entitled *Modeling Flexible-Mode Geothermal Energy Production in California: Comprehensive Physical-Chemical Modeling to Reduce Risks and Costs of Flexible Geothermal Energy Production* describes mechanical failure of well casings, cement and rock as a result of stress/strain changes due to changes in fluid pressure/temperature. CEC's own document describes a failure scenario as follows "It was found that the biggest risk of mechanical failure

occurs during the initial startup of production because of large and rapid temperature increases from initially cool temperatures near the ground surface." It is reasonable to conclude potentially significant impacts to the environmental could occur in the form of hot geothermal brine releases to the shallow groundwater and/or the land surface. It is also possible that an accident could occur during well installation or start up that may be catastrophic and those impacts should be considered as part of the environmental permitting process, e.g. 2010 Deepwater Horizon disaster.

2) Geothermal Brine Contains several known hazardous chemical constituents in excess of standards: Hazard

The USEPA reported brine from geothermal wells in the Salton Sea contain six constituents that are far in excess of drinking water standards. For example, the drinking water standard for a) Lead is listed as 0.015 mg/L and brine concentration as much as 102 mg/L or 6,800 times greater, b) Manganese is listed as 0.050 mg/L and the brine concentration 1,500 mg/L or 30,000 times greater. c) Cadmium is listed as 0.005 mg/L and brine concentration as much as 2.3 mg/L or 460 times greater, d) Barium is listed as 2 mg/L and brine concentration as much as 353 mg/L or 176 times greater, e) Zinc is listed as 5 mg/L and brine concentration as much as 518 mg/L or 103.6 times greater, and f) TDS -Total Dissolved Solids is listed as 150 mg/L and the brine concentration 260,000 mg/L or 521 times greater. There are also hazardous constituents in the brine that should be determined (in addition to those listed at a. through f.) such as radium, thorium, and radon; antimony, chloride, arsenic, chromium, copper, orpiment, stibnite, antimony, ammonia, mercaptans, sulfides, mercury, iron, selenium, and silver; petroleum hydrocarbons, uranium, methane, nitrate and carbocyclic acids (not a complete list) to assess their environmental impacts should there be a catastrophic well failure or blowout. A hot brine release to the shallow subsurface or surface that could create a hazard that would have a potentially significant environmental impact. All potentially hazardous constituents in the hot geothermal brine should be thoroughly tested/characterized, and their impacts considered, as part of the environmental permitting process.

3) Extremely Large Brine Production and Injection Rates are Correlated to Seismic Activity: Hazard Concern

As much as ~13,000 gallons per minutes of geothermal brine production is planned for this project (estimated from a November 2023 LBNL document page 152 at LBNL-2001557). A percentage of that brine will be injected back into the geothermal formation via injection wells. A thirty-year time history of seismic activity near geothermal wells in located in the Imperial Valley was analyzed in the LBNL document and that seismic activity was reported to correlate with the operation of geothermal well system operation. LBNL reports "During the first 14 years of geothermal energy production (1982-1996), background seismicity rates appear to be directly proportional to production and injection rates." from deep geothermal systems located near the Salton Sea. The correlation strength (R^2) varied from 0.71 to 0.85. The authors explained "As geothermal plant activity increased, pore-pressure perturbations propagated away from the injection well flow intervals (i.e., permeable zones in the injection wells between the casing shoe and the bottom of the well), causing many pre-existing faults to become critically stressed and move." It is also reported "During the next 10 years (1996-2006), the correlation can be described as weak to moderate" with correlation strength (R^2) that varied from 0.20 to 0.48. For this analysis of geothermal wells and seismic activity, the authors stated "The seismogenic response of the crust to well activity was strongest early in the history of plant operations." A thorough analysis must be conducted to determine the increased risk of hazards caused by earthquakes, as a result of operation of the proposed geothermal production and injection wells, so that the hazards related to significant impacts to the environment can be evaluated.

A geothermal energy project that consisted of injection and production wells was determined to be the cause of a 5.5 magnitude earthquake in Pohang, Korea in November 2017. Water was injected at pressure in a well which "began to activate an unknown fault" as reported by the StanfordReport in May 2019. The unknown fault intersected the well. It was determined "Pressure migrating into the fault zone reduced the forces that would normally make it difficult for the fault to move. Small earthquakes lingered for weeks after the operators turned the pumps off or backed off the pressure." It is necessary to perform a detailed examination of all known faults, fractures (fracture mapping), shears and other heterogeneities that may result in either seismic activity or catastrophic land subsidence (settlement). There is an entire handbook that should consulted or potentially implemented for further evaluation. The 287-page book is entitled "The analysis of subsidence associated with geothermal development. Volume 1. Handbook" and can be downloaded from the link provided (Atherton, R. W.; Finnemore, E. J. & Gillam, M. L. September 1, 1976.). There are numerous processes that contribute to land subsidence in geothermal areas such as seismic activity, preconsolidation, fracture closing, thermal contraction and a variety of other factors. The book recommends "Tectonic movements may mask induced subsidence and horizontal ground motion associated with production. So that the impacts of production may be identified, it is important to design baseline leveling surveys (Lofgren, 1973) and gravity surveys (Volume 2, Research Report, Chapter 4) before production begins." CALGEM requires an injection plan be submitted as part of the well permitting process, however, potentially significant risks to the environment from well failure or other operational accidents must be addressed as part of the project preliminary staff assessment.

4) The USEPA Safe Drinking Water Act and Underground Injection Program: Threat Assessment

The author would like to provide the USEPA's position on requirements for Class V Injection Wells and how to minimize impacts to shallow groundwater aquifers. The following excerpt is from the USEPA website at Basic Information About Class V Injection Wells | US EPA.

> *Class V wells are a concern because they pose a risk to underground sources of drinking water. Because of this they are regulated by the Underground Injection Control (UIC) program under the Authority of the Safe Drinking Water Act. EPA established minimum requirements to prevent injection wells from contaminating underground sources of drinking water (USDWs). In addition, Class V regulations are linked to EPA's source water assessment program.*

The USEPA Office of Ground Water and Drinking Water published a 69-page document entitled "The Class V Underground Injection Control Study, Volume 17, Electric Power Geothermal Injection Wells" EPA/816-R-99-014q in September 1999. In fact, Figure 2 is a cross-section of the Geothermal System, Imperial County, California (East Mesa Field, Imperial County). Therefore, CalEnergy/BHE/CEC should take note of the USEPA guidance and requirements. The ultra-complex nature of high flow geothermal extraction and reinjection systems can not be engineered, constructed, designed or monitored such that there is no possibility of failure. A failure resulting in a catastrophic release of hot geothermal brine near the surface must be considered and may result in a potentially significant environmental impact. The responsibilities of and procedures to be used by the EPA and DOGGR (now CalGEM) in the administration of the Underground Injection Control (UIC) program for geothermal energy Class V injection wells are set forth in a six-page 1991 Memorandum of Understanding between the two agencies. The USEPA will be involved with all permitting, compliance and enforcement procedures of geothermal injection wells in California.

Part II Additional Considerations Related to Hazardous Waste Generation and Water Supply

5) The hazardous and nonhazardous waste components were broken into multiple categories and to quantities of each waste estimated on a per metric ton basis (Nov 2023 LBNL document at page 150).

Morton Bay Estimated Waste Quantities

Hazardous	**Metric Tons Per Year**
Brine pond solids	6,804
Geothermal Scale	3,175
Geothermal filter cake	1,179
Cooling tower debris and sludge	272
Petroleum contaminated solids (>51%)	50
Oil, water, sludge	50
Used Oil	23
Laboratory analysis waste	1

Nonhazardous	**Metric Tons Per Year**
Geothermal filter cake	21,773
Commercial Trash	109

The Morton Bay Geothermal plant will produce an estimated 1,179 metric tons of hazardous filter geothermal filter cake with a similar composition of the BHER Geothermal plant located in Calipatria, California. The Filter Cake Safety Data Sheet (BHER- CalEnergy Operating Corp, 7030 Gentry Road, Calipatria, CA 92233) is contained on pages 262-272. Section 2: Hazard Identification lists the classification of the mixture as OSHA HSC 2012: Specific Target Organ Toxicity Repeated Exposure 1-H372. H372 hazard statement identifies causes damage to organs-lungs through prolonged and repeated exposures. The storage and disposal must be in accordance with local, regional, national and/or international regulations (P501). All of the hazardous waste items (with the exception of Used Oil) will be disposed of in a treatment, storage, and disposal facility (TSDF). Please identify which portions of all hazardous wastes will be transported to either Clean Harbors Buttonwillow Class I Landfill or Class II Landfill in Wellton, Arizona? Is there adequate landfill capacity over the course of the projected life of the Morton Bay Geothermal Plant?

6) Water Supply Needs and Anticipated Usage

Morton Bay Geothermal (157 MW) plans to use 5560 AF per year of freshwater (35 AF/MW), meeting 50% of their demand and meeting the other 50% with the steam condenser (Morton Bay Geothermal LLC, 2023) per the LBNL document page 90. It is stated that additional water will be required at each of these facilities for startup, fire protection, and maintenance. The MBGP PSA (page 3-12) states an expected average annual use of 5,560 acre-feet per year (afy) of water when operating at full plant load for uses including plant water, dilution water, plant wash down, and cooling tower makeup. Average annual supply requirements will vary, depending on the capacity factor of the overall facility. On page 5.15-7 of the MBGP PSA it is stated:

> *In addition to the proposed MBGP, the applicant is concurrently pursuing certification of two other geothermal projects in the vicinity; Black Rock geothermal (77 MWs) and Morton Bay*

> *geothermal (140 MWs). Therefore, the cumulative environmental impact of all three projects needs to be considered. With respect to water supply, the combined estimated water supply for all three geothermal projects proposed by the applicant is 13,165 acre-feet per year (AFY). IID has available for non-agricultural uses up to 25,000 AFY, of which 6,380 AFY has been committed to other customers. (IID 2009). Based on email communication with IID, as of January 2024, a remainder of 18,620 AFY (IID 2024) is available to future uses. The water supply estimated for the three applicant projects constitutes nearly 71 percent of the available supply.* Note: Morton Bay should read Elmore North (PSA typo)

The author is interested in receiving an explanation as to how the potential water shortfall will be addressed in the event of either drought or additional water demand from other geothermal power plants that may be in the environmental permitting process? Is there a contingency plan? Are there other water supply options available that are not discussed in the MBGP PSA?

Section Two: BHER Direct Lithium Extraction History and Environmental Permitting Issues

Part I Background on Lithium Extraction and Geothermal Brines involving CEC and BHE

Direct Lithium Extraction (DLE) is the process of recovering lithium from geothermal brine using advanced technologies. *Occidental Petroleum is forming a joint venture with Berkshire Hathaway-owned BHE Renewables. The partners aim to extract lithium from brines at a California geothermal power plant that BHE owns. In 2022, Oxy acquired TerraLithium, which is developing technology to chemically extract lithium from brine. Berkshire Hathaway owns a 28% stake in Oxy.* (C&EN June 10/17, 2024 page 12 attached as Exhibit A in an article entitled *Occidental steps up hunt lithium hunt*). In a June 4, 2024 Oxy Press Release, it is stated "Upon successful demonstration, BHE Renewables plans to build, own and operate commercial lithium production facilities in California's Imperial Valley." It is clear that BHER is gearing up to capitalize on the lithium market and the timing of the joint venture with Oxy/TerraLithium occurring nine days prior to the release of the Preliminary Staff Report for the Morton Bay Geothermal Project suggests there is an expectation the future brine streams will lead to lithium extraction from those brines. In fact, RIGZONE, in an article dated June 6, 2024 entitled *Occidental, BHE Form JV to Demo Lithium Tech*, reports "*The joint venture has started a project at BHE Renewables' Imperial Valley geothermal facility to demonstrate the feasibility of using TerraLithium DLE technology to produce lithium in an environmentally safe manner."*

The California Energy Commission (CEC) has a history of funding research on lithium extraction from geothermal brines over the past decade. SRI International report dated March 2020 was funded by CEC (Grant Number EPC-16-020 in the amount of $873,387 per the 2015-2017 EPIC Investment Plan) and involved sorbent technologies (hybrid nanocomposite sorbent beads) designed to recover lithium from brines. It is not clear how a nanostructured lithium manganese oxide, manufactured by a technique described as "hydrothermal synthesis" or a "new hybrid sorbent made from nanostructured inorganic ion sieves embedded into a lithium-imprinted polymer" impact water quality or add hazardous chemical constituents to the brine. The sorbent regeneration process may release potentially hazardous components from the sorbent in a pernicious manner. The CEC/ERDD Final Project Report is entitled Selective Recovery of Lithium from Geothermal Brines and is dated March 2020 (37 pages). Note: ERDD-Energy Research and Development Division.

Part II BHE Renewables Explores Lithium Extraction from Geothermal Brines in 2020

According to a BHE Fact Sheet dated April 2022, "BHE Renewables won a $6 million matching grant award from the California Energy Commission in May 2020 to design and build a demonstration project to recover lithium from geothermal brine to produce lithium chloride." The State of California Grant Form (CGF) is entitled "Salton Sea Geothermal Lithium Recovery Demonstration Project" and the document is 26 pages in length. The CGF indicated CEC's ERDD funded the grant for BHER Minerals, LLC.

The CGF indicates in Section F "Proposed resolution approving agreement EPC-19-020 with BHER Minerals, LLC for a $6,000,000 grant to design, build, and commission an integrated system that includes geothermal brine pre-treatment and lithium recovery processes and adopting staff's determination that this action is exempt from CEQA." Staff determination should be clarified. The 26-page CGF indicates on page 1, Section G) subpart 2: the project is listed as categorical exempt under CEQA per Cal. Code Regs., tit 14, § 15301 and Cal. Code Regs., tit 14, § 15303.

The start date of the lithium extraction demonstration project is listed as June 1, 2020 and the end dated as March 31, 2024. The CEC/ERDD Final Project Report is entitled Pilot Scale Recovery of Lithium from Geothermal Brines and is dated March 2024 which is 54 pages in length. The project succeeded with extracting lithium from a synthetic brine which resulted in the production of lithium carbonate.

In the MBGP PSA (BHER/Jacobs Staff Assessment Report) on Page 5.4-44&45, in a bulleted section entitled "Future Expansion/Related Development", the following appears:

> *"We note that the three projects only propose to build on part of their parcel areas at this time. The remainder of the parcels do not appear subject to any future use restrictions. We are concerned about what future development might occur on these parcels. This is a particular concern as an agent for the applicant stated at the 08/31/23 public hearing that these three plants are being sited where they are because of proximity to existing plants. Also of concern, is Morton Bay Geothermal Project the potential to co-locate future lithium extraction activities at these locations causing additional effects to the TCRs."*

There is some ambiguity regarding the plan for lithium production as part of the Morton Bay facility and it is important to consider the recent history of this regulatory body, CEC, as it relates to development of harvesting technologies with respect to environmental permitting processes. The history of CEC/ERDD funding lithium extraction technology and pilot testing outlined above demonstrates CEC's interest of moving lithium extraction forward. In fact, on Dec. 9, 2020 the CEC appointed nine members to a Blue Ribbon Commission on Lithium Extraction in California (Lithium Valley Commission) as described in the article entitled "CalEnergy/BHE Get $15M Federal Grant for Lithium Plant" that appeared in the Calexico Chronicle, January 21, 2021.

In summary, CEC has funded at least two projects on lithium extraction. One of the two CEC funded projects was a 2020 pilot project for BHE in the amount of $6,000,000 and that CEC/BHE staff deemed that CEQA approvals for the were not necessary (exempt from CEQA). Reports suggest BHE received an additional $15 million from the US Department of Energy. It is also reported "The Department of Energy grant was for $14,894,540, which was a one-for-one cost-share match on an overall project cost of $29,789,0981 to turn

geothermal brine waste from geothermal-energy operations into battery-grade lithium, according to DOE documents." by the Calexico Chronicle, January 21, 2021 (see prior paragraph for link).

Part III Environmental Permitting Issues: Geothermal Energy and Zinc/Lithium Extraction Facilities-Joint Programmatic EIS/EIR and BHE Enterprises Gain Experience 2000-2024

The background provided thus far outlines the underpinnings behind the purpose of this comment regarding the environmental permitting process. Pacific Northwest National Laboratory (PNNL-32717), under contract with The U.S. Department of Energy Contract DE-AC05-76RL01830, prepared a report entitled "*Salton Sea Geothermal Development: Nontechnical Barriers to Entry-Analysis and Perspectives*". The report was authored by D. Goodman, P. Mirick and K. Wilson and is dated June 2022 (122 pages in length). There is an entire section of this report devoted to Permitting (Section 7.2) with State, Federal and Model for Analysis of Geothermal Economics are addressed. The final portion of the Permitting section, Permitting Issues and Recommendations (7.2.4) contains four parts. Part one of four addresses *An areawide determination about CWA Section 404 jurisdiction by the USACE would provide certainty to developers and the public* (Note: USACE-U.S. Army Corps of Engineers). Part four of four addresses *Development and funding of a state permitting coordination office*. The second and third portions are addressed and discussed below.

It is the intent of the author to bring to the forefront the potential environmental concerns regarding lithium extraction and the permitting challenges related to implementing DLE at a geothermal power production facility. Both BHE and CEC have received tax payer funds to explore the implementation of DLE and have performed on-site pilot testing on extracting lithium from geothermal brines which included waste stream(s)/environmental assessment. The following two subsections from the aforementioned PNNL report provide recommendations are reproduced below and certain portions are emphasized in bold by the author.

> *2. Development of a **programmatic EIS/EIR** for the Salton Sea that analyzes the environmental impacts of geothermal development, from exploration to production, encompassing both geothermal and lithium.*
>
> *The 2015 Renewable Energy and Transmission Element from the County of Imperial General Plan is a good starting place for such a review, describing the history of renewable energy generation in the county, describing existing conditions and resource concerns, and including a series of specific goals that "support development of renewable energy resources that will contribute to the restoration efforts of the Salton Sea" (ICPDSD 2015). A comprehensive CEQA/NEPA document could provide greater certainty for geothermal development permitting and approval. **The resource issues and environmental impacts of geothermal development at the Salton Sea are well known and well understood. However, the environmental impacts and considerations for a co-located lithium plant have not been analyzed on a comprehensive scale.** Sponsoring such a **programmatic review** could be a form of a subsidy undertaken by either the federal government, the state of California or Imperial County, or could be issued by a geothermal developer interested in subsequent future developments in the area.*

3. Issuance of a geothermal/lithium MOU between CEC and CalGEM

> *Regardless of whether a comprehensive EIS/EIR is developed for geothermal development at the Salton Sea, it would* ***be beneficial for CEC and CalGEM to issue an agreement, likely in the form of an MOU, making the roles and responsibilities for a co-located geothermal and lithium extraction plant clear****. This would provide greater certainty to developers in obtaining approval through the CEQA process, particularly because of the limited history of such co-located development. Alternately, CalGEM could potentially delegate authority for permitting lithium production to Imperial County for projects below a certain size threshold, as has already been done for conventional geothermal development.*
>
> Note: CalGEM-California Geologic Energy Management Division

A July 25, 2023 letter of support from the Imperial County Board of Supervisors states that Imperial County is actively working on a programmatic environmental impact report "that would result in geothermal and lithium recovery facilities being exempt from mitigation prime and statewide importance agricultural lands.' The subject of the letter is *Black Rock, Morton Bay and Morton Bay Geothermal Projects in Imperial County, CA*. The letter of support emphasizes "significant economic benefit and jobs to benefit Imperial County and California." and the County expressed an interest to "assist in permitting these projects."

The Lithium Valley Specific Plan, Final Baseline Report, created for Imperial Valley, California dated February 2024 (668 pages and prepared by Rick Engineering Company) gives an update on that includes plans for a Programmatic EIR (PEIR) on page 5:

> *Senate Bill (SB) 125 On June 30, 2022, Governor Gavin Newsom signed into law Senate Bill (SB) 125 authorizing the state to assist in the development of Imperial County's lithium resource in an area that is a part of the Salton Sea Known Geothermal Resource Area, known as Lithium Valley. Among other provisions of SB 125, the bill appropriated $5,000,000 from the State General Fund to the County of Imperial (County) for various lithium related activities, including, but not limited to, funding to develop a Programmatic Environmental Impact Report (PEIR) and to distribute grants to local community-based organizations to conduct engagement on the PEIR.*

The Final Programmatic Environmental Impact Report (PEIR), Imperial County Renewable Energy and Transmission Element Update, Imperial County, California review process. More specifically, Morton Bay Geothermal LLC-MBGP (with assistance from Jacobs) in their Data Response Set 2 dated October 27, 2023 writes the CEC as follows:

> *In contrast, the MBGP is a renewable energy project located in the geothermal and renewable energy overlay that is subject to the more specific provisions set forth in the Renewable Energy and Transmission Element, Renewable Energy Overlay Zone, and, where applicable depending on the potential impacts of a renewable energy project, the mitigation measures described in the Programmatic Environmental Impact Report for the Imperial County Renewable Energy and Transmission Element Update ("RE PEIR"). This reading is consistent with the February 23, 2010 resolution of the Board of Supervisors to not accept*

> *any new Williamson Act contracts or renew existing contracts, and the July 25, 2023 letter from the Imperial County Board of Supervisors (TN#251675) stating that the County is developing a programmatic Environmental Impact Report (EIR) for geothermal and lithium recovery development that will identify geothermal and lithium facilities as being exempt from mitigation requirements resulting from significant agricultural impacts to both Prime Farmland and Farmland of Statewide Importance.*

The author researched the July 2015 Final Programmatic Environmental Impact Report, Imperial County Renewable Energy and Transmission Element Update, Imperial County, California ("2015 ProgEIR Update") and was unable to find the document on the internet or on the Imperial County website. The document link was sent to the author by Ms. Diana Robinson on the morning of August 20, 2024 and after telephonic and email requests. The document is 1674 pages in length and ~110 megabytes in size (shared via a Ms. Valerie Grijalva).

CalEnergy comments (Begins with letter dated Feb 23, 2015) starts at page 3-269 (pdf 355) and continue through page 3-296 (pdf 382). Comment 22-45 Page 3-280, reads:

> *CalEnergy asks that the reference to our zinc extraction plant be reworded as follows to more accurately reflect the facts: "CalEnergy owned and operated a zinc extraction plant at their existing geothermal plants before closing due to production and market declines."*

CalEnergy (a subsidiary of BHER) once operated a zinc extraction plant from brines at an existing geothermal plant and have recently tested Direct Lithium Extraction (DLE) on-site to be, undoubtedly, used on brines from existing and future on brines from operating geothermal plants. According to the Calexico Chronicle article entitled "To Get 'White Gold,' We Need More Geothermal- CPUC Ruling for 1,000 Megawatts of New Earthen Energy Opens Door for "Lithium Valley." dated July 2, 2021, the zinc extraction plant started in the early 2000s. There is an interest in moving forward with lithium extraction at new geothermal plants as laid out in the article as four excerpts from the article confirm.

> *That liquid has traditionally been reinjected into the earth around the Salton Sea, or any geothermal plant where energy production occurs, but in the commercial-grade process that brine would run through a second facility to recover the various minerals that have worth and use. Imperial County had two mineral recovery developments in the past, according to county officials. In the early 2000s, CalEnergy developed and operated a zinc-extraction facility. That project was successful but closed after five years.*
>
> *"This is a tremendous win for Imperial, but also for this (Lithium Valley) Commission. We now have a path for putting new geothermal online, and the accompanying brine that will allow us to recover lithium," texted Imperial County Supervisor Ryan Kelley just hours after the decision came down on June 24.*
>
> *"Now the hard work: permitting and financial incentives to make the Lithium Valley a reality," continued Kelley, who represents District 4, which includes the Salton Sea.*

> *CPUC's order does bring up a double-edged sword of trying to get the geothermal plants in Imperial County's queue streamlined and permitted before the 2026 deadline.*
>
> *There are presently 10 geothermal-energy facilities operated by CalEnergy in what is referred to as the Salton Sea Known Geothermal Resource Area, and those plants are generating around 327 net megawatts, according to the U.S. Department of Energy.*

The public in Imperial County is aware of the push for lithium extraction yet BHER chose not to address the permitting of DLE as part of the permitting of new geothermal plants. BHER appears to have a track record influencing environmental regulations and a knack for having things done their way (See comments starting at page 3-269 @pdf 355 and continuing through page 3-296 @ pdf 382 in the 2015 ProgEIR Update referenced above. BHER has business and operational experience of extracting zinc from brine and some additional details from that zinc operation were found in 2006, six-page paper entitled "Economic Benefits of Mineral Extraction From Geothermal Brines" and two paragraphs on the CalEnergy Zinc operation are shown below. The paper was written by Dr. R. Gordon Bloomquist, Ph. D., Washington State University Extension Energy Program, Center for Distributed Generation and Thermal Distribution.

> *Zinc is another metal found in highly concentrated amounts in Salton Sea brines. In the late 1990s, Cal Energy entered into a contract for the construction of a zinc recovery facility that was designed to produce 30,000 metric tons of 99.99 percent pure zinc per year to be sold to Cominco, Ltd. for a value of some $40 million per year. The zinc plant went on line in 2002 and at that time Cal Energy anticipated that the 177-million-dollar facility would generate as much revenue as they were then recovering from energy sales.*
>
> *Unfortunately, by mid-2003, it became common knowledge that the Cal Energy zinc plant was experiencing operational difficulties and on September 10, 2004, the operating company decided to cease operation and liquidate the assets.*

The author expects the CEC will investigate the zinc mining operations conducted by CalEnergy (BHER) to ensure the wastes generated were handled properly, there were no impacts to the environment during the operational period of 2001-2002 and that the zinc recovery plant was properly permitted by Department of Conservation, Division of Oil, Gas, and Geothermal Resources-DOGGR which became CalGEM in 2020 prior to any zinc recovery plant operations. Further, the author is curious, as will readers of these comments, what were the "operational difficulties" encountered and what was the composition of the wastes generated from the zinc extraction plant? Surely BHER gained extensive experience on the pitfalls of the mining process.

The author also supports consideration of a geothermal/lithium Memorandum of Understanding that addresses environmental (water quality, water supply, hazards, toxic and hazardous waste impacts) in addition to clarifying roles and responsibilities. CalGEM *prioritizes protecting public health, safety, and the environment* by using *science and sound engineering practices to regulate the drilling, operation, and permanent closure of energy resource wells* (https://www.conservation.ca.gov/calgem). It is clear the environmental permitting process should include all facets of a co-located geothermal power plant and a lithium production facility, as opposed to independently evaluated and/or permitted piecemeal approach. A complete analysis of waste composition, water quality, water supply, toxicity, pre-treated brine prior to

lithium extraction, post-lithium extracted brine (filtrate), and an evaluation of cross-contamination injection/extraction risks must be conducted. It is vital these unknowns be quantified, evaluated and analyzed prior to permit approval.

Part IV Direct Lithium Extraction: A potential game changing technology-Goldman Sachs April 2023

The Global Metals & Mining Division of Goldman Sachs published a 29-page Equity Research Note whereby 27 global lithium projects "that are using or plan to implement DLE." The table of DLE implementors and technology developers on page 5 includes a Berkshire Hathaway project in the Salton Sea with the following items associated with the project:

Company:	Berkshire Hathaway
Project:	Salton Sea
County:	USA
DLE Project Stage:	Pilot
DLE Technology Provider:	Proprietary
Lithium extraction technology:	Sorption
Tech Origin:	USA
Geothermal:	Yes
Resource (Mt LCE):	-
Start Date:	-
Capacity (ktpa LCE):	90 (Note: Second highest capacity of the 19 projects listed)

LCE- lithium carbonate equivalent
Mt-Million tons
ktpa-Kilotons per acre

It is apparent that Berkshire Hathaway is ramping up their research and business efforts toward lithium extraction of geothermal brines at a rapid pace. The obvious question is why not combine the permitting of the DLE production facility with the geothermal energy project now as opposed to later? The State of California and Federal Government are best served to address water, environmental, waste and hazardous waste issues now for the incorporation of DLE at a later date will, in all likelihood, will be complicated by the potential for unforeseen regulatory and/or economic obstacles.

The author just discovered that the CEC's Notice of Proposed Award (NOPA) was released on August 1, 2024 "GFO-23-304 - Geothermal Energy Operations and Lithium Innovation (GEO/LI)" with the purpose listed as "*The purpose of this solicitation is to fund projects that develop and demonstrate technologies to reduce impacts from scaling and corrosion at geothermal power plants in California or advance processes to enhance the recovery of lithium and other valuable minerals from geothermal brine at the Salton Sea geothermal field."* can be found at this link.

Part V TerraLithium (Oxy/BHE) Patents Related to Lithium Extraction: 2020-2024

The following is a list of patents assigned to TerraLithium obtained from Justia Patents. There is a clear link between patent development for lithium extraction from geothermal brines by an entity owned in part by the permit applicant.

1) Forward osmosis composite membranes for concentration of lithium containing solutions
Patent number: 12030017
Type: Grant
Filed: August 8, 2019
Date of Patent: July 9, 2024
Assignees: UT-Battelle, LLC, TERRALITHIUM LLC

2) Preparation of lithium carbonate from lithium chloride containing brines
Patent number: 11649170
Type: Grant
Filed: August 7, 2020
Date of Patent: May 16, 2023
Assignee: Terralithium LLC

3) Treated geothermal brine compositions with reduced concentration of silica, iron and lithium
Patent number: 11466191
Type: Grant
Filed: October 1, 2020
Date of Patent: October 11, 2022
Assignee: Terralithium LLC

4) Processes for producing lithium compounds using forward osmosis
Patent number: 11235282
Type: Grant
Filed: November 19, 2019
Date of Patent: February 1, 2022
Assignee: Terralithium LLC

5) Preparation of lithium carbonate from lithium chloride containing brines
Patent number: 10773970
Type: Grant
Filed: November 2, 2017
Date of Patent: September 15, 2020
Assignee: TERRALITHIUM LLC

The evaluation and analysis of water quality, water usage, hazardous waste and toxic composition of solids from the pretreatment of brine prior to lithium extraction plus post lithium extraction processes is necessary as part of the permitting process. Further, as a professional environmental expert with over thirty years' experience, it is the author's judgment that BHER is duty-bound to share all data, analysis, reports, waste

manifests, processes descriptions, mass balance calculations, water budgets, analytical results for water/solids analyses, chain of custodies, toxicity characteristic leaching testing results, sorbent media composition, groundwater/brine composition testing results, isotope testing results, flow studies, mass flux estimates, loading calculations, sensitivity analyses, settlement analysis, detailed process flow diagrams and life-cycle assessment results as they relate to lithium extraction from geothermal brine. There is no question the plan is to incorporate direct lithium extraction as part of the geothermal power plant operations as can be from the excerpt below.

Excerpt from the Executive Summary from CEC report dated March 2024 | CEC-500-2024-020

> *The creation of an additional value stream generated from the recovery of useful metals, such as lithium, from geothermal fluids will lead to an expansion of geothermal energy production. Lithium production in the Salton Sea geothermal resource area has the potential to become an important source of lithium for the United States.*

Part VI National Laboratory Estimates Additional Wastes Created from Lithium Production: Nov 2023

A 371-page report prepared by Lawrence Berkeley National Laboratory (LBNL) entitled *Characterizing the Geothermal Lithium Resource at the Salton Sea* (A Project Report to the U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, Geothermal Technologies Office) discussed the Morton Bay project at length and numerous times throughout. The report was completed on November 11, 2023.

On page 22 there were calculations presented on the quantity of lithium contained in the brine-in-place. Table 2.2 lists 760 ktons of proven, 2,600 ktons accessible and 3,400 ktons of probable lithium in the Salton Sea Geothermal Reservoir. Note: kton-kiloton and 2,600 metric kilotons is 5.732 Billion US Pounds.

There is an entire chapter (Chapter 9: Evaluation of Potential Chemical Use and Solid Waste) devoted to landfill capacity, solid waste generation and pretreatment of the geothermal brine prior to Direct Lithium Extraction (DLE). One of the key takeaways from the chapter is reproduced below:

> *To produce lithium chloride from geothermal brine, the brine will be treated to remove silica and metals to produce "clean brine" prior to the direct lithium extraction (DLE) process step, creating a solid byproduct. More silica and metals will need to be removed to prepare the brine for lithium extraction will be more significant than what is currently needed to reinject the spent brine back into the formation.*

With respect to additional waste generation for pretreatment of the brine (based on data from the Elmore Power Plant) prior to DLE, a summary is provided on page 155 as follows:

> *The crystallizer-clarifier is optimized for operation of the power plant, and it is expected that the brine from the power plant will need to be further treated to produce a "clean" brine suitable for the DLE technology step. Based on published requirements for mineral content*

> *of brines suitable for DLE sorbents, it is likely that over 90% of the silica, iron, manganese, and zinc in the geothermal brine will need to be removed prior to DLE.*

Additional language on waste generation for DLE continues on page 158:

> *The amount of solid waste that will be produced during the process for lithium extraction and purification is dependent on the exact process applied and whether the solids produced during pretreatment can be monetized; some solids produced during pretreatment contain manganese and other potentially valuable metals. However, the extraction and purification of lithium will produce iron-silicate solids and possibly solids containing calcium and other elements (e.g., magnesium) that are unlikely to have value, and must be landfilled.*

Portions of the Acknowledgment section on page ii demonstrate BHER's involvement for the authors of the report as shown below:

> *We thank Berkshire Hathaway Energy Renewables (BHER)/CalEnergy and Controlled Thermal Resources for kindly providing access to the brine and some of the rock samples that were analyzed in this study. We also thank Michael Krahmer from BHER for assistance in sampling drill cuttings;*
>
> *We also appreciate Jon Trujillo, Billy Thomas, and Jonathan Weisgall from BHER/CalEnergy for providing critical data and responding to our many queries.*

BHER was involved with the preparation of this report and is gearing up to implement a DLE and, as such, should be compelled to supply all available information related to their on-site pilot studies so that environmental and water supply/quality concerns can be evaluated as part of the permitting process.

<u>Part VII Hazardous Waste Generated as part of Lithium Extraction from Geothermal Brine (CEC 3/2024)</u>

The CEC report entitled "Pilot Scale Recovery of Lithium from Geothermal Brines" dated March 2024 revealed heavy metals were present in the filtered material generated as part of the treatment process. Key portions of the report are presented below and reveal the plan is to use geothermal brine for a new revenue stream plus to generate hazardous wastes including heavy metals.

> *Page 1. The creation of an additional value stream generated from the recovery of useful metals, such as lithium, from geothermal fluids will lead to an expansion of geothermal energy production. Lithium production in the Salton Sea geothermal resource area has the potential to become an important source of lithium for the United States.*
>
> *Page 1. The efficient direct extraction of lithium from geothermal brines promises to make geothermal power generation in the Salton Sea geothermal resource area economically favorable and will secure lithium production in the United States in support of a carbon-free economy.*

> *Page 7. The basic process consisted of four unit-operations: Absorption, Polishing, Concentration and Crystallization. Additional operations included pre-processing brine, water recycling, product washing and drying, return of lithium-depleted brine and waste management.*
>
> *Page 25. Frequent sorbent replacement not only takes plants out of operation, but also creates waste in the form of spent sorbent.*
>
> *Page 29. Solids were disposed of as hazardous waste. An analysis of the filtrate showed the presence of various heavy metals, including iron.*

The author was unable to locate the analytical results for the heavy metals or the hazardous waste manifest/composition in the report. There is no mention of hazardous waste generation, heavy metal presence, geothermal brine pre-treatment processes, water usage or water quality in the Conclusions section.

Part VIII Hell's Kitchen Powerco 1& Lithiumco December 2023 EIR and March 2024 Lawsuit

The Final Environmental Impact Report for The Hell's Kitchen Powerco 1 and Lithiumco 1 Project Imperial County, California dated December 2023 is 200 pages in length and was prepared by Chambers Group, Inc., Costa Mesa, California, The EIR was prepared in accordance with CEQA and examined the potential environmental impacts from a lithium hydroxide plant. The report was submitted to County of Imperial Planning and Development Services Department. The EIR addresses environmental impacts of a co-located geothermal energy plant (to produce as much as 49.9 megawatts) and an "*mineral extraction and processing facilities capable of producing lithium hydroxide, silica and polymetallic products, and possibly boron compounds, for commercial sale*." The EIR demonstrates the importance of considering the joint environmental concerns of connected actions of geothermal brine generated for power production to be used for the production of lithium. The cumulative effects of the combined operations are difficult to assess for the wastes generated from pretreatment of the brine for mineral extraction and the composition of the post-treated brine, that will be injected into the subsurface brine reservoir, will be process dependent.

On March 13, 2024 a legal complaint (CEQA action) was filed in the Superior Court of California, County of Imperial by Comite Civico Del Valle and Earthworks against County of Imperial, Controlled Thermal Resources, Hell's Kitchen PowerCo and Hell's Kitchen LithiumCO. The complaint alleges "*that the Project Approvals violated the California Environmental Quality Act, Pub. Res. Code § 21000 et seq., ("CEQA") and 14 Cal. Code Regs. § 15000 et seq. ("CEQA Guidelines") by relying on a fatally flawed EIR*." There are a multitude of environmental raised in the Complaint such as water supply shortfalls, air quality, hazardous materials, tribal cultural resources and cumulative impacts. On page 13 of the Complaint, it is stated "*Nor did the EIR adequately assess the cumulative impacts of the Project in the context of the three related geothermal projects (i.e., BHE Renewables) and the County's Specific Plan calling for the use of an additional 100,000 AF of water*."

Part IX Geothermal Energy and Lithium Extraction Environmental Permitting Must Be Addressed Together

The author spoke with Mr. Dave Goodman of Pacific Northwest National Laboratory the morning of August 5, 2024 regarding his recommendations in the aforementioned June 2022 *Salton Sea Geothermal*

Development: Nontechnical Barriers to Entry-Analysis and Perspectives report. The author has included 7.2.4 Permitting Issues and Recommendations as Exhibit B (pages 57-59) attached hereto. We discussed the Hell's Kitchen EIR and several aspects of the material presented above as they relate to the possible environmental permitting agencies who could become involved with aspects of combined operation of geothermal energy/lithium production. The author believes the EPA UIC program regulations for Class V injection wells may apply for possible contaminants emanate from the pre- and post-treatment processes that alter the native brine composition. The contaminated brine might impact the geothermal reservoir or shallow groundwater. Mr. Goodman stated that he believes the "best example" of connected actions that requires a robust analysis is the combination of brine produced from geothermal energy production that is then used for lithium production.

Very truly yours,

Joseph E. Odencrantz, Ph.D., P.E., BCEE, PH
California Registered Professional Civil Engineer C 61137 (expiration 12/31/2024)
Board Certified Environmental Engineer 23-E0041 (expiration 12/31/2024)
Professional Hydrologist 24-HGW-05002 (expiration 1/15/2029)

Enclosures

Exhibit A	Occidental steps up hunt lithium hunt. C&EN. June 10/17, 2024 (1 page)
Exhibit B	Section 7.2.4 Permitting Issues and Recommendations *Salton Sea Geothermal Development:* *Nontechnical Barriers to Entry-Analysis and Perspectives* Report from Pacific Northwest National Laboratory for the US Department of Energy dated June 2022 (7 pages)

Exhibit A

Occidental steps up hunt lithium hunt. C&EN.
June 10/17, 2024 (1 page)

ENERGY STORAGE

Occidental steps up hunt lithium hunt

Occidental Petroleum is forming a joint venture with Berkshire Hathaway–owned BHE Renewables. The partners aim to extract lithium from brines at a California geothermal power plant that BHE owns. In 2022, Oxy acquired TerraLithium, which is developing technology to chemically extract lithium from brine. Berkshire Hathaway owns a 28% stake in Oxy. Two other oil companies, ExxonMobil and Equinor, also have plans to extract lithium using similar techniques.—MATT BLOIS

HYDROGEN POWER

Yara starts producing green hydrogen

Yara International has opened its renewable hydrogen plant in Herøya, Norway. The company claims that the unit is Europe's largest electrolysis plant, with

Yara has completed its water electrolysis installation in Norway.

capacity of 24 MW. It will use the hydrogen to produce up to 20,000 metric tons of ammonia annually. Making hydrogen from renewable electricity rather than natural gas will cut emissions by 41,000 metric tons per year, the company says.—ALEX TULLO

RECYCLING

Firms partner on tires to polycarbonate

The Finnish refiner Neste, the Austrian petrochemical maker Borealis, and the German specialty materials firm Covestro are teaming up to recycle tires into plastics that could be used in automotive parts like headlamps and radiator grilles. Neste will upgrade pyrolysis oil made from discarded tires into a feedstock suitable for petrochemicals. Borealis will take this raw material and transform it into phenol and acetone, and Covestro will transform those chemicals into polycarbonate resins. The partners are considering expanding the program into polyurethanes.—ALEX TULLO

INVESTMENT

Air Liquide to supply new chip fab

The industrial gas firm Air Liquide has signed a deal to supply a Micron memory chip fabrication plant under construction in Idaho. As part of the deal, Air Liquide will spend $250 million to build a plant on Micron's site that will make ultrapure nitrogen and other gases. The firm says it will implement a range of advanced plant features that will make the plant 5% more energy efficient than conventional designs. The plant is scheduled to open in 2025.—CRAIG BETTENHAUSEN

BIOBASED CHEMICALS

Trillium and Ineos to partner on acrylonitrile

Trillium Renewable Chemicals, one of C&EN's 10 Start-Ups to Watch in 2023, will scale up its biobased acrylonitrile process by building a demonstration plant at an Ineos Nitriles plant in Port Lavaca, Texas. Trillium's thermochemical technology converts glycerin, a by-product of biodiesel and soap production, into acrylonitrile. Ineos says the deal fits well with its sustainability strategy and Trillium says working with the world's largest acrylonitrile maker underscores its ambitions to bring its biobased technology to commercial scale.—CRAIG BETTENHAUSEN

OUTSOURCING

Siegfried will buy US API facility

The Swiss drug services firm Siegfried has agreed to buy an active pharmaceutical ingredient (API) facility in Grafton, Wisconsin, from Curia Global, another services firm, for an undisclosed sum. The facility, which has more than 80 employees, specializes in the synthesis of small-molecule drug candidates in the early phases of clinical development. Siegfried says the site will feed into its commercial-scale facilities in Europe. Cedarburg Pharmaceuticals opened the Grafton plant in 1997; Curia's predecessor, Albany Molecular Research, acquired it in 2014 for $41 million.—MICHAEL MCCOY

VACCINES

Wacker adds mRNA capacity in Germany

Wacker Chemie, the German specialty chemicals firm, has opened a new facility

PETROCHEMICALS

Styrolution to shutter Sarnia plant

Ineos's Styrolution styrenic resins business says it will permanently close its Sarnia, Ontario, styrene plant by June 2026. "The long-term prospects for the Sarnia site have worsened to the point that it is no longer an economically viable operating asset," Styrolution CEO Steve Harrington says in a press release. The plant has been under scrutiny. The Aamjiwnaang First Nation recently reported spiking air pollution that forced it to shut down community buildings. The Canadian government responded by imposing strict limits on emissions of benzene, the key precursor for styrene. Styrolution shut down the plant temporarily It estimates that it would cost about $50 million to comply with the new regulations and reopen the plant, a plan the company will evaluate over the next 6 months. Beyond that expense, the plant would require outlays to stay open permanently, the company says. These investments are "economically impractical given today's challenging industry environment." The plant has styrene capacity of 430,000 metric tons per year.—ALEX TULLO

CREDIT: YARA INTERNATIONAL

Exhibit B

Section 7.2.4 Permitting Issues and Recommendations
Salton Sea Geothermal Development: Nontechnical Barriers to Entry-Analysis and Perspectives
Report from Pacific Northwest National Laboratory for the US Department of Energy dated June 2022
(7 pages)

Pacific Northwest
NATIONAL LABORATORY

PNNL-32717

Salton Sea Geothermal Development

Nontechnical Barriers to Entry – Analysis and Perspectives

June 2022

Dave Goodman
Patrick Mirick
Kyle Wilson

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Richland, Washington 99354

Abstract

Geothermal energy offers an opportunity to generate baseload, renewable energy that can help support the transition to an energy economy with reduced impacts on climate change and replace older, more expensive, nonrenewable, and more resource-impacting energy-generation facilities. The United States has the largest known geothermal resource in the world, with over 31 GW of conventional geothermal potential. However, due to market conditions, an inability to properly quantify both electrical grid benefits and resource stability, and the difficulty of exploring and developing the geothermal resource, few new geothermal projects have come online over the past three decades.

The Salton Sea, in Imperial County, California, provides a prime location and opportunity to develop new geothermal resources. The Salton Sea contains a robust, well-mapped, geothermal resource, with opportunities for concurrent development of lithium and other mineral resources. This report describes the history of geothermal development at the Salton Sea and compares geothermal to other renewable energy sources in the area. The report then uses a techno-economic analysis (TEA) model referred to as MAGE (Model for Analysis of Geothermal Economics) to analyze the relative benefits and costs of various challenges and opportunities and provides recommendations for streamlining geothermal development at the Salton Sea and elsewhere. The challenges and opportunities analyzed in MAGE were informed by stakeholder interviews and literature reviews.

Based upon the identified challenges and opportunities and the results of MAGE, primary findings are that certain nontechnical barriers such as permitting costs play only a minor role in determining the viability of development of the geothermal resource at the Salton Sea. Other barriers such as permitting timelines, government/agency coordination, and the potential co-location of lithium extraction with a geothermal plant may result in much larger impacts on project viability.

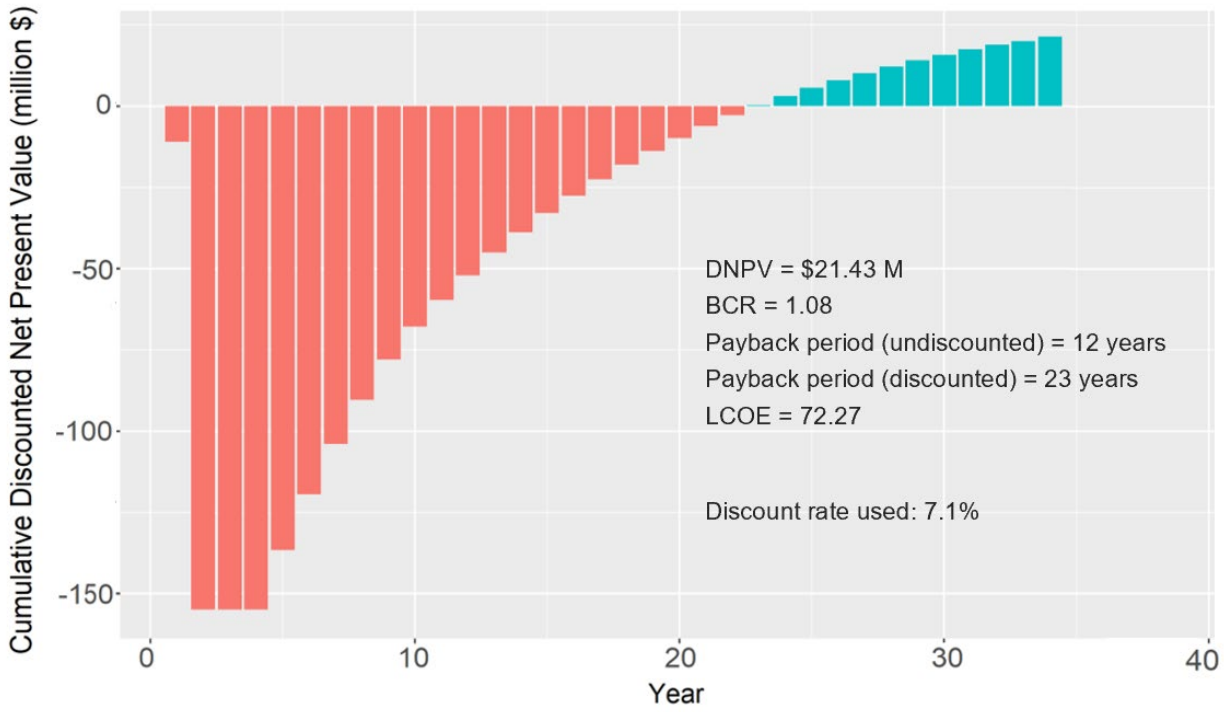

Figure 7-15. Power plant with 3-year reduced permitting time and 1-year reduced construction time.

One aspect of exploration and permitting that is not covered in this section is the risk of failure in exploration. Such failure may occur due to unsatisfactory drilling results or an inability to obtain necessary permits. In those situations, the costs incurred are typically sunk, and cannot be recouped and do not provide a return to investors. A potential benefit of streamlining the permitting process could be to reduce the risk of failure, which would yield a reduction in the discount rate. The benefits of reducing the discount rate are discussed in Section 7.1.1.

7.2.4 Permitting Issues and Recommendations

Overall, the state and local permitting process for geothermal projects at the Salton Sea is well understood. Historically, applicants appeared to prefer the Imperial County CEQA review and permitting process, because many projects, such as the Hudson Ranch I (Power Technology 2013) and Hudson Ranch II (OPR 2022) projects, were sized at 49.9 MW, or just below the 50 MW threshold at which point CEC would be the responsible agency. However, many interviewees mentioned that this no longer appears to be a substantial barrier, and that the CEC process has become better understood and streamlined over time and does not necessarily take longer to complete than the Imperial County process.

Stakeholders and developers have expressed a desire to both speed up and reduce costs associated with the permitting process. While NEPA compliance is generally not required for geothermal projects at the Salton Sea, the federal permitting process under the CWA and ESA is opaque and has created confusion. While reduction of costs is a worthy goal, shortening the timeframe from initiating exploration to bringing a project online has a much larger impact on the profitability of the project.

Below are four concepts which, if implemented, could result in a shorter and less expensive geothermal permitting process.

1. An areawide determination about CWA Section 404 jurisdiction by the USACE would provide certainty to developers and the public.

   Nationwide Permits are issued by the USACE to "help protect the aquatic environment and the public interest by providing incentives to reduce impacts on jurisdictional waters and wetlands while effectively authorizing activities that have no more than minimal individual and cumulative adverse environmental effects." Nationwide Permit 51 authorizes

   > [d]ischarges of dredged or fill material into non-tidal waters of the United States for the construction, expansion, or modification of land-based renewable energy production facilities, including attendant features. Such facilities include infrastructure to collect solar (concentrating solar power and photovoltaic), wind, biomass, or geothermal energy.

   Furthermore, "[t]he discharge must not cause the loss of greater than 1/2-acre of non-tidal waters of the United States" (Corps 2021).

   For geothermal development at the Salton Sea, the determination about whether the irrigation ditches, drainages, and associated wetlands on the playa constitute waters of the United States remains unclear, and thus whether Nationwide Permit 51 applies. USACE determination about CWA Section 404 jurisdiction thus remains a primary barrier and source of frustration to the development community. Identification of locations of suitable geothermal development and certainty about the mitigation that should be applied for the Salton Sea playa would provide a substantial incentive for future development.

2. Development of a programmatic EIS/EIR for the Salton Sea that analyzes the environmental impacts of geothermal development, from exploration to production, encompassing both geothermal and lithium.

   The 2015 Renewable Energy and Transmission Element from the County of Imperial General Plan is a good starting place for such a review, describing the history of renewable energy generation in the county, describing existing conditions and resource concerns, and including a series of specific goals that "support development of renewable energy resources that will contribute to the restoration efforts of the Salton Sea" (ICPDSD 2015). A comprehensive CEQA/NEPA document could provide greater certainty for geothermal development permitting and approval. The resource issues and environmental impacts of geothermal development at the Salton Sea are well known and well understood. However, the environmental impacts and considerations for a co-located lithium plant have not been analyzed on a comprehensive scale. Sponsoring such a programmatic review could be a form of a subsidy undertaken by either the federal government, the state of California or Imperial County, or could be issued by a geothermal developer interested in subsequent future developments in the area.

3. Issuance of a geothermal/lithium MOU between CEC and CalGEM.

   Regardless of whether a comprehensive EIS/EIR is developed for geothermal development at the Salton Sea, it would be beneficial for CEC and CalGEM to issue an agreement, likely in the form of an MOU, making the roles and responsibilities for a co-located geothermal and lithium extraction plant clear. This would provide greater certainty to developers in obtaining approval through the CEQA process, particularly because of the limited history of such co-located development. Alternately, CalGEM could potentially delegate authority for

permitting lithium production to Imperial County for projects below a certain size threshold, as has already been done for conventional geothermal development.

4. Development and funding of a state permitting coordination office.

   While geothermal development at the Salton Sea does not require preparation of a federal NEPA document, the concepts included in the *Federal Consolidated Appropriations Act* of 2021 could be extrapolated to streamline local and state permitting. Dedicated geothermal staff either funded by the state, the development community, or through a general fund can conduct more efficient reviews and coordinate necessary approvals more effectively than staff that currently handle geothermal permitting as an extension of other work.

7.3 Government Intervention

Federal, state, and local governments have all expressed interest in increased renewable energy development at the Salton Sea, including a desire for increased geothermal exploration and production. In some cases, these expressions have led toward financial incentives specific to geothermal. New or increased subsidization or incentivization would render new geothermal development more economically competitive.

Exploration and development incentives provide assurance and reduce risk to geothermal developers, while production tax credits, property tax waivers, and other incentivization of producing and transmitting the geothermal energy can help to reduce the effective LCOE and lower the prices associated with PPAs to be more on par with other energy resources. However, the structure and duration of federal incentives compared to long geothermal development timelines make it difficult for developers to rely on such incentives (Young et al. 2019). For example, the Production Tax Credit has rarely been guaranteed to be in effect for longer than 5 years, and geothermal exploration and development timelines are typically longer than this (DOE 2019).

As an example of how government intervention can lead to development, PURPA (discussed in Section 2.3) required that utilities purchase power at the avoided cost of power, which led to the purchase of geothermal energy at above market rates. The Energy Tax Act of 1978 incentivized geothermal development in the 1980s through various tax incentives, including investment tax and income tax credits. The Economic Recovery Act of 1981 allows for depreciation of geothermal equipment. All of these helped to lead to a boom in geothermal development, including at the Salton Sea, in the 1980s (Owens 2002).

New geothermal development at the Salton Sea could promote various other federal, state, and local goals, including Salton Sea habitat restoration, meeting CA RPS standards, meeting federal renewable energy goals, improving US air quality and reducing CO_2 emissions, and promoting high-paying jobs and economic benefits in Imperial County.

Furthermore, as discussed in Section 5.3.3, geothermal energy contains benefits to the power grid that are not necessarily reflected in the LCOE or PPAs associated with a specific project. To the extent that government incentives exist, they are generally not specific to incentivizing geothermal development, and in some cases, greater incentives exist for solar and wind than for geothermal development.

If the ancillary benefits of geothermal power generation can be better understood and quantified, applicable federal and state governments would have a better reason to incentivize

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Professional Overview

Dr. Joseph E. Odencrantz is a California-based environmental and water specialist with vast experience in the private/public sectors. Dr. Odencrantz is a water and environmental expert with a unique set of qualifications and experience that spans from traditional civil and environmental engineering to current state-of-the-art methods. He directs routine and complex analysis, investigations, water resources, special projects, water treatment, waste water treatment and remediation projects on behalf of a variety of clients. He has extensive report writing and testifying experience as an expert witness.

Education

1992 Ph.D., Civil & Environmental Engineering, Environmental Engineering and Science, University of Illinois at Urbana-Champaign: *Area of Specialization-Groundwater and Environmental.* *https://environmental.cee.illinois.edu/people/phd-alumni/*
Dissertation Title: Modeling the Biodegradation Kinetics of Dissolved Organic Contaminants in a Heterogeneous Two-Dimensional Aquifer

1988 Completed The University of Waterloo Summer Hydrogeology Field School, Canada. A three-week applied program in which two graduate students from the United States are invited to attend each year.

1986 M.S., Civil Engineering, University of Illinois at Urbana-Champaign: *Area of Specialization-Water Resources and Hydrology (Hydrosystems)*
Masters Project Title: Experimental Investigation of Mass Exchange from Recirculating Regions of Rivers and Streams

1984 B.S., Civil Engineering, Chi Epsilon Honor Society, University of Maine at Orono.
Summer Cooperative Education Project Report Title: Effectiveness of Silt Fence at Reducing Sediment Load Through a Sensitive Salmon Spawning Area via Regression Analysis of Sediment Transport Data

Professional Positions

- Tri-S Environmental, Sensible Strategies and Solutions for the Environment, Principal Civil and Environmental Engineer, Newport Beach, California, 1994-present
- Kyoto University, Research Center for Environmental Quality Management, Visiting Scholar and Professor, January-June 2007
- Levine-Fricke: Engineers, Hydrogeologists & Applied Scientists-now Arcadis, Senior Civil Engineer, Emeryville and Irvine, California, 1990-1994
- University of Illinois at Urbana-Champaign, Department of Civil and Environmental Engineering, Graduate Research Assistant, Urbana, Illinois, 1984-1990

- Illinois State Water Survey, Research Assistant, Champaign 1985-1986
- Maine Department of Transportation, Location and Environment Division, Research Assistant, Augusta, Maine, 1983
- U.S. Geological Survey, Water Resources Division, Hydrologic Field Technician/Supervisor, Augusta, Maine, 1980-1982 and 1984.

California Professional Engineer License (PE)

Registered Professional Civil Engineer C 61137, State of California (expiration 12/31/2024)

Board Certified Environmental Engineer (BCEE)

Board Certified Environmental Engineer 13899 (Site Remediation), American Academy of Environmental Engineers and Scientists Certification Board (expiration 12/31/2024)

Board Certified Professional Hydrologist (PH)

Professional Hydrologist 24-HGW-05002 (Groundwater) American Institute of Hydrology Board of Registration (expiration 1/15/2029)

Notable Projects

- Hawaiian Independent Refinery (BHP Australia), Oahu, Hawaii:
  Hydrogeologic Characterization (EPA RCRA/UIC Requirements) Project Manager
- City of Punta Cana, Dominican Republic:
  Seawater Intrusion and Groundwater Protection Consulting Expert
- William Lyon Homes, California:
  Groundwater and Landslide Analysis Expert
- Shell Western Exploration&Production (Now Aera Energy), California:
  Soil and Groundwater Expert on the Taper Site
- City of Dallas, Texas:
  Explorer Pipeline Break/Water Supply Emergency Response Consultant
- City of Fryeburg, Maine:
  Over-Pumping of Local Groundwater Consultant
- City of South Lake Tahoe, California:
  Groundwater Extent of Contamination and Remediation Expert
- Aerojet Rocketdyne Superfund Site, Ranch Cordova, California:
  UV H_2O_2 Oxidation Expert/NDMA in Groundwater Removal (Trojan UVPHOX)
- Occidental Chemical Corporation (Oxy), Port of Los Angeles, California
  Groundwater Remediation and Allocation Expert
- Union Station, City of Los Angeles, California:
  Gateway Center Parking Garage Groundwater Dewatering System Project Design/Manager/Sulfide Removal/UV H_2O_2 Oxidation (PeroxPure)
- Atlas Galvanizing, California:
  Stringfellow Superfund Site Groundwater Impacts and Remediation Expert

- Repsol, Spain:
  Soil, Sediment and Groundwater Consultant for Europe and South America. Some refinery wastewater projects in Europe were implemented using FIDIC conditions of contract.
- Coast Wholesale Florist, California:
  Most Knowledgeable Person Testimony for Transport and General Operations
- Walnut Creek Manor, California:
  Soil and Groundwater Consulting Expert, Hookston Site
- Unocal, California:
  Guadalupe Oil Field Volume Estimation and Remediation Consultant

Editorial Boards

Associate Editor, *Journal of Remediation*-Wiley, 1997-present
Associate Editor, *Biodegradation*-Springer, February 2001-present
Reviewer, Journal of Contaminant Hydrology-Elsevier, 2000-present, Outstanding Reviewer Status-top 10th percentile in terms of number of reviews 2012-2014
Reviewer, Journal of Air &Waste Management Association, 2009-present
Associate Editor, *Environmental Forensics*-Taylor & Francis, January 2007-March 2009
Advisory Board/Editor, *Underground Tank Technology Update*-Department of Engineering Professional Development, Funded by U.S.E.P.A., University of Wisconsin-Madison, 1999-2006
Associate Editor, *Journal of Ground Water Monitoring and Remediation*, NGWA, 1997-2001
Associate Editor, *Journal of Ground Water*, NGWA, 1994-1996

Career Awards and Recognition

Sir Francis T. Crowe Society, Distinguished Member with Medallion, University of Maine at Orono, May 2012 (for recognition of considerable engineering contributions and honor to the profession)

Young Civil Engineering Achievement Award, University of Illinois at Urbana-Champaign Civil Engineering Alumni Association. April 25, 1998.

Certificate of Excellence, City of Costa Mesa, California for Outstanding Performance and lasting Contribution to Stormwater Pollution Prevention, Presented by Mayor Gary Monahan, January 5, 2004.

Examples of Professional Experience

- Served as an expert for Occidental Chemical Corporation (Formerly Hooker Chemical) in the Federal case L.A. Terminals, Inc. *v*. City of Los Angeles (2:18-cv-06754) District Court, Central District of California. The site is located in the Port of Los Angeles. The subject matter involved the history of chlorinated solvent contamination, the extent of contamination, remediation methods, monitoring, beneficial uses of water resources and long-term response cost expenditures.

- Environmental and water expert for international arbitration cases on behalf of several prominent law firms, municipalities, oil companies and insurance organizations. These cases involved impacts to public and private water supply systems (groundwater and surface water), waste water treatment systems and the responsible party's previous knowledge of the fate, transport and taste/odor characteristics of organic compounds.

- Provided expert consulting services to Dallas Water Utilities (DWU), Dallas, Texas in response to the largest surface water impact of MTBE in United States history. Designed and managed the collection of data from surface water, soil and sediments in an effort to track gasoline components released from a substantial pipeline rupture. Participated in numerous public meetings on DWU's behalf in an effort to keep the citizens of Dallas informed of the risk to their water supply and treatment systems.

- Designed and managed a groundwater dewatering and treatment system as part of the construction of the second largest subterranean parking structure west of the Mississippi River and a forty-story tower. The primary goal of the project was to lower the groundwater table 20 feet over approximately ten acres and keep the water level down for a two year period. Located in Los Angeles, the 1.2 million gallons per day Gateway Center Water Treatment Plant consisted of extensive pH adjustment, hydrogen peroxide addition for hydrogen sulfide removal and UV oxidation/activated carbon for trace petroleum hydrocarbons and chlorinated solvent removal. A prototype hydrogen peroxide control system was implemented to minimize the hydrogen peroxide usage. A Catellus Development Corporation and Rapid Transit District of Los Angeles project.

- Directed the Carson Regional Groundwater Group's Groundwater and Hydrocarbon Model (CRGGCAD) calibration (Wilmington-Carson, California). The CRGGCAD model consisted of a groundwater flow model, a hydrocarbon flow model and a dissolved phase transport model that interfaces with a comprehensive database from four oil refineries and one distribution terminal. The model consists of a 30 square mile regional model that communicates to five smaller scale model domains (1.5 square miles) through boundary conditions. The calibration of CRGGCAD was performed by using data from 1,700 monitoring wells in conjunction with the predictions from the CRGGCAD model. The CRGGCAD model serves two primary purposes: a. The Los Angeles Regional Water Quality Control Board sees CRGGCAD as the result of a unique cooperative effort among five major oil companies and b. The calibrated model is used to investigate a variety of specific remedial alternatives.

- Estimated the diluent (diesel) volume in the subsurface at a site in Guadalupe, Central California. The site is an oil field approximately 3,500 acres in size with 29 known pools of product within its boundaries. The "floating product" spread over an area of approximately 100 acres. The estimated volume was a critical element of the project as it was subject to close scrutiny by the regulatory agencies and the public. The Sacramento Bee covered this story extensively.

- Conducted research in the general area of biodegradation modeling/phenomena in groundwater as part of the United States Department of Energy's Subsurface Science Program. Developing and applying a fate and transport model capable of describing different biodegradation kinetics expanded the research. The developed model was used to

examine the interaction of biodegradation, adsorption, advection, and dispersion in stratified porous media at Battelle's Pacific Northwest Laboratory, Richland, Washington.

- Wrote sections of the report entitled *Basinwide Instream Flow Assessment Model to Evaluate Flow Needs*, Bureau of Reclamation, US Department of Interior, Washington, D.C., published in November 1985. A probabilistic model was developed to incorporate hydraulic geometry relationships to average flow parameter values without the necessity of field observations. The results of the model were used to quantify sufficient or minimum flow needed to sustain the aquatic habitat is necessary for satisfactory resolution of water use conflicts and planning of water allocation strategies. Pool and riffle sequences from numerous streams in Central Illinois were correlated to drainage area, slope and other hydrologic variables.

- Wrote sections of the report entitled *Hydraulic Interaction of the Fox River with Shallow Aquifers*, Illinois State Water Survey, published in December 1986. The effect of switching from groundwater to surface water was examined for the community of Elgin by conducting detailed surface water measurements in the Fox River west of Chicago, Illinois. Water withdrawals from the deep sandstone aquifers were reduced because of steeply falling piezometric levels and declining water quality. The results of the analysis were used to properly manage the withdrawals of water from the Fox River and the groundwater aquifer beneath it.

- Supervised data collection and analysis for cost minimization analysis for surface water flow monitoring stations throughout New England for the U.S. Geological Survey, Water Resource Division. Results of the analysis were eventually used to support the elimination of forty percent of the active stations in the district. Also performed pumping and slug tests and installed groundwater monitoring wells at a peat bog located in the “down east” portion of the State of Maine.

- Directed water quality monitoring program of a sensitive salmon-spawning area in a brook that ran through the middle of a large interstate construction project for the Maine Department of Transportation. Developed a sediment transport model through the highway construction project in Brewer, Maine. Thousands of turbidity measurements were taken in Felt’s Brook and dozens of tributaries leading to it during the summer of 1983. Developed a model of the exposed fill erosion potential based upon stream turbidity data, rainfall intensity and duration, land and stream slopes, and other environmental data. The multi-variable nonlinear regression model of the construction area, turbidity measurements and other hydrologic variables proved useful to aid in the placement of erosion control equipment. Field responsibility was to inspect the integrity of various erosion control systems

Publications

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2. Odencrantz, J. 2015. Property Line Contamination Issues and Associated Risks to Buildings plus Cross-Contamination Issues & Water Supply Protection. *Keynote*

Address. Proceedings of the 3rd International Symposium on Advances in Civil and Environmental Engineering Practices for Sustainable Development-ACEPS 2015, held on March 9, 2015. Galle, Sri Lanka. Pages 2-9.

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