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BACT Analysis for Air Abatement Systems at Elmore Facility

Back-Pressure Turbine Installation

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1 Introduction

This memorandum presents the Best Available Control Technology (BACT) analysis prepared as part of the permitting process for the proposed modification of the J.J. Elmore Geothermal Power Plant for submittal to the Imperial County Air Pollution Control District, in order to authorize the installation of a back-pressure turbine at the facility. The initial permit application was submitted on January 3, 2017, and following submittal of the application it was determined (during discussions with the air district) that since the turbine addition constituted a modification of the facility, a BACT analysis would be required to supplement the initial application. The purpose of this BACT analysis is to identify the technologically feasible and cost effective controls for limiting air emissions from the facility. This analysis briefly describes the modifications and impacts to air emissions, the potential to emit levels for air pollutants; several control technologies are described including efficiencies, cost effectiveness, and related results.

The information contained herein is based on CalEnergy's operating experience and data with air pollution controls, and on engineering estimates of the planned modification provided by Geologica Geothermal Group, Inc. (Geologica) and Veizades and Associates, Inc.

1.1 Plant Background, Modifications & BACT Thresholds

Plant Background

CalEnergy Operating Corporation (CalEnergy) owns and operates the J.J. Elmore Geothermal Power Plant (Elmore Plant), located at 786 West Sinclair Road, Calipatria, California. The Elmore Plant entered into commercial operation in 1989 with an air permit issued from the Imperial County Air Pollution Control District (ICAPCD) for 45MWe operation. The Elmore plant is currently operating under amended conditions and authority to construct with permit to operate #1890F-2 from the ICAPCD dated May 31, 2016. CalEnergy is proposing to install a back-pressure turbine at the Elmore Plant to optimize and increase the conversion of geothermal heat into electrical energy. The revised net output for the power plant will be 49.9 MWe.

The Elmore Plant currently uses high pressure steam, via a heat exchanger to augment the standard pressure steam by reheating clean condensate for re-entry into the existing condensing turbine. This system is called a heat recovery system and it generates additional steam without having the impurities in the high pressure steam encounter the turbine. At the time the Elmore facility was designed, the heat recovery system was the best available technology to make additional power without having to mitigate the impurities in high pressure steam.

Modifications

Enhancements in steam purification have been made since the Elmore facility entered commercial operation in 1989 and CalEnergy is proposing to use improved technology to remove the impurities from the high pressure (HP) steam. This improved steam purification technology will allow CalEnergy to use a more efficient high pressure steam turbine in addition to the existing turbine. Using a high pressure steam turbine in place of the heat recovery system will allow the Elmore plant to generate up to 49.9 MWe without increasing fluid flow from the geothermal resource.

In order to use a high pressure steam turbine in place of the heat recovery system, additional equipment will be installed within the existing boundary of the Elmore facility. The heat recovery system will remain in place as a back-up system. The following new equipment will be located within the power generation area of the Elmore plant and within the existing paved site containment:

1. Skid mounted back pressure Turbine and auxiliary equipment
2. Power Distribution Control (PDC) System
3. High Pressure Steam Scrubber
4. High Pressure Steam Demister
5. Standard Pressure Steam Scrubber
6. Non-condensable gas (NCG) removal system
7. High Pressure and Standard Pressure interconnecting piping

BACT Thresholds

Given that the air district has determined that the changes described herein will be determined a modification of the facility, the following requirements become effective:

- ICAPCD Rule 207 C.1.b states that "An applicant shall apply (BACT) on a pollutant by pollutant basis to any modified Emissions Unit with a Potential to Emit of 25 pounds per day or more of any Nonattainment Pollutant or its Precursors". Given that the Elmore facility is located in a non-attainment area for particulate matter and ozone, emissions of particulate matter, and ozone precursors (i.e. nitrogen oxides, volatile organic compounds and benzene) are initially considered in this review. **With potential emissions of particulate matter at 383.6 lbs/day, and potential emission of benzene at 54.7 lbs/day, based on the permit, these parameters were included in the BACT analysis**. However, given that nitrogen oxides, and VOCs (except for benzene), are submitted by combustion engines at the facility (which are not part of the modification), nitrogen oxides and (non-benzene) VOCs are not included in the BACT analysis.
- ICAPCD Rule 207.1.c requires a BACT for " any new or modified Emissions Unit with a Potential to Emit equal to or greater than" 55 lbs/day or hydrogen sulfide; which is emitted by the Elmore facility (and below certain thresholds for pollutants such as fluorides, which are not emitted by the source). **Given potential emission of 547.2 lbs/day of hydrogen sulfide from Elmore (based on the 22.8 lbs/hr permit limit for the source) hydrogen sulfide emissions were included in the BACT review**.

1.2 Unabated Air Pollutants & Historical Actual Emissions

Potential air pollutants, controls and monitoring were previously identified in air permit applications and permits (ATC-PTO #1890F-2) for the Elmore plant. These include hydrogen sulfide (H_2S), benzene (C_6H_6) and particulate matter (PM_{10}). In addition, since Imperial Valley is a non-attainment area for ozone, the effect (or lack thereof) of this project on nitrogen oxide and other volatile organic compound emissions was also verified. Currently, the Elmore plant maintains air emissions below permit levels with two abatement technologies: the Oxidizer Box (OxBox), which abates H_2S in the condensate from the plant, and cooling tower drift eliminators which mitigate PM_{10} emissions.

Although the proposed modifications will not change the total amount of geothermal fluid flowing through the plant, the unabated emissions for H_2S could be affected by the change because H_2S is emitted in both steam condensate (into which it dissolves) and in the non-condensable gas (NCG) flow which remains after the steam is condensed; and the modification is expected to redistribute the H_2S concentrations in these streams. Because H_2S control technologies for the condensate and NCG flow streams can be different and they have been treated differently at Elmore, the emissions and controls for each flow stream are evaluated separately in this analysis, while understanding that H_2S emission limits apply to the combined emissions from each flow stream.

The range of partitioning of H_2S between condensate and NCG is estimated based on field testing by CalEnergy Operations. Steam mass flows and H_2S concentrations also vary depending on the relative contribution of wells supplying the plant. These variables produce a range of potential unabated H_2S emissions from the condensate and NCG flow streams (Table 1.a).

Because there will be no modifications to the cooling tower, which is the only source of particulate emissions under normal operating conditions at Elmore, impacts to PM_{10} emissions are not anticipated. Similarly, since the total flow of geothermal fluid through the plant is not changing, and benzene emissions occur in the NCG flow (partitioning into the condensate phase is minimal), there are no anticipated changes to benzene emissions as a result of the proposed modifications.

The average benzene emissions appear to be about 0.073 lb/hr, with a maximum of 0.103 lb/hr (based on APCD data from 2014-2016). Even at maximum benzene emission, emissions are below the permit (#1890F-2) threshold limit of 2.8 lb/day and significantly below the BACT threshold of 25 lb/day.

Average cooling tower PM_{10} emissions were 2.29 lb/hr (54.96 lb/day) in July, 2014 (based for the July 2014 source test), and are not expected to change (apart for normal fluctuations) with the plant modifications.

At Elmore nitrogen oxides and volatile organic compounds (which the exception of benzene) are emitted in minor quantities from the emergency diesel generators, the emergency diesel fire pump, and portable diesel engines (all of which are permitted by the Imperial County Air Pollution Control District). Given that the installation of this project will have no effect on these sources, a BACT analysis was not conducted for these pollutants (with the exception of benzene emissions from the geothermal brine).

The potential unabated emissions of H_2S without any abatement efforts is between 27.25-43.50 lb/hr based on plant data from 2016, and sampling of HP steam for H_2S analysis on December 7th, 2016 (Table *1*.a). The average hourly rate of H_2S emissions (in NCG + condensate) based on the currently installed abatement systems is 7.28 lb/hr, which is below the current permit limit of 22.8 lb/hr (Table *1*.a). The of PM_{10} and benzene emissions from source test data is included in Table 1.b.

Table 1.a – Unabated H2S Emissions

1) Potential for total H_2S emission with no abatement; 2) current average H_2S emissions using existing abatement system; and 3) current permit limit for H_2S emissions at Elmore.

	Total Unabated Emissions (lb/hr)	Unabated Condensate Emissions (lb/hr)	Unabated Gas Emissions (lb/hr)
	Potential to emit without any abatement		
H_2S minimum	40.37	13.12	27.25
H_2S maximum	64.44	20.94	43.50

H_2S from proposed mass flows from P&ID from June 7, 2016 and proposed Elmore modification; H_2S from plant sampling by CalEnergy on December 7, 2016.

Using an average partitioning ratio of 32.5% condensate and 67.5% gas for H_2S

Table 1.b – Benzene & PM10 Source Test Data Emissions

	2014 Source Test Emissions	Average Emissions (lb/hr)[A]	Current Permit Limit (lb/hr)
Benzene	0.006	0.073	2.28
PM_{10}	2.29	-	15.98

[A] From 2014-2016

Historical actual emissions (HAEs) from the facility are shown in Tables 2.

Table 2- Historical Actual Emissions – For the Brine Process

	Quarterly Average Emissions					
	Hydrogen Sulfide Emissions, (lbs/hr)			**Benzene Emissions, (lbs/hr)**		
	2014	**2015**	**2016**	**2014**	**2015**	**2016**
Quarter I	6.17	3.65	13.04	0.02	0.04	0.04
Quarter II	7.29	3.68	5.65	0.02	0.01	0.01
Quarter III	6.87	8.36	10.81	0.01	0.01	0.03
Quarter IV	3.96	7.67	5.05	0.01	0.02	0.01

	Annual Maximum of Hourly Averages					
	Hydrogen Sulfide Emissions, (lbs/hr)			**Benzene Emissions, (lbs/hr)**		
	2014	**2015**	**2016**	**2014**	**2015**	**2016**
	10.71	10.84	20.57	0.045	0.103	0.07
Sampled during	Aug 2014	Aug 2015	Jan 2016	Feb 2014	Feb 2016	Jan 2016

Notes:
Combined emissions from condensate and non-condensable gasses are shown above.

(1) Historical flows are based on weekly readings that can be taken when plant MW loads/output are low, historical actual emissions should be based on the annual maximum values.
(2) Facility-wide emissions are not shown above – These include emissions from an emergency generator and emissions from portable equipment permitted in 2015 and 2016. The emissions from the portable equipment are offset.

1.3 BACT Process and Options

BACT analysis includes consideration of several possible abatement technologies. The efficiency of the current OxBox, as well as chemical oxidation and iron chelate, were considered to determine which constitutes Best Available Control Technology (BACT) for the abatement of H_2S in sour condensate liquid emissions at Elmore. For potential H_2S emissions in the non-condensable gas (NCG) flow stream, the feasibility of the use of a regenerative thermal oxidizer (RTO), bioreactor, sparger, and BIOX were considered for Elmore. RTO was considered for benzene abatement in NCG.

Both control efficiencies and cost of the abatement processes are considered in this BACT. The BACT analysis includes five steps:

1. Identification of control technologies
2. Elimination of infeasible options
3. Rank of the remaining control technologies
4. Evaluation of the most effective control
5. Selection of BACT

2 Step 1: Identification of Control Technologies

2.1 Sour Condensate Liquid (H2S) Abatement Options

2.1.1 OxBox

After separation of the non-condensable gas and condensate, condensate is routed to the bio-oxidation box (OxBox) in the cooling tower, where the naturally occurring bacteria present in geothermal cooling tower water abates H_2S in the condensate (see Air Permit Applicaion for Cal Energy Region 1, Unit 3 Cooling Tower Bio-oxidation Box Modification, CalEnergy Operations 2016). Average condensate abatement efficiency from the existing OxBox and average total H_2S emissions were calculated using data reported to the APCD by CalEnergy over the last three years (from 2014-2016). The average condensate abatement efficiency of the OxBox over the last three years is 90.9%.

2.1.2 Chemical Oxidation (Iron Chelate)

The chemical oxidation process uses hydrogen peroxide (H_2O_2) to treat water in order to oxidize H_2S into elemental sulfur (S) (if the solution is neutral or acidic) or sulfates (if the solution is basic) (Rodriguez, Harvey and Asbjornsson 2014). In acidic or neutral solutions, the H_2O_2 and H_2S forms S and H_2O:

$$H_2O_2 + H_2S \rightarrow S + 2H_2O$$

In basic solutions, H_2O_2 and S^{-2} react to form sulfate (SO_4^{-2}) and H_2O (Stephens, Hill and Phelps, Jr. 1980):

$$H_2S\text{ (aqueous)} \rightarrow 2H^{+} + S^{-2}$$
$$S^{-2} + 4H_2O_2 \rightarrow SO_4^{-2} + 4H_2O$$

Iron chelate is sometimes added as a catalyst in this oxidation process. This system can generate sulfur solid build-up in the cooling tower, a maintenance issue.

2.1.3 BIOX (liquid) System

The Biox® process consists of adding an oxidizing biocide into the condensate from condenser to convert dissolved hydrogen sulfide to water-soluble sulfates. Biocide-assisted oxidation prevents secondary emissions of hydrogen sulfide from cooling towers that utilize steam condensate for makeup water. The Biox® liquid abatement system is expected to remove at least 98 percent of the H2S in the portion of the condensate used as cooling tower makeup water.

2.2 Non-condensable Gas (H2S) Abatement Options

2.2.1 Regenerative Thermal Oxidizer

A Regenerative Thermal Oxidizer Unit (RTO) allows for the direct oxidizing process for H_2S in the NCG. The RTO is pre-heated with propane, and then a vacuum, created by the downstream vacuum blower, causes the steam and outside air to enter the oxidizing chamber (CE Obsidian Energy LLC 2010). The RTO oxidizes H_2S and supplemental propane in the NCG through an exothermic process (Imperial County Planning & Development Services Department 2011). As a result, H_2S is oxidized to sulfur dioxide (SO_2) and a small amount of sulfur trioxide (SO_3), while hydrogen (H) is oxidized to water vapor (CE Obsidian Energy LLC 2010). The gases then flow through a caustic scrubber and venturi scrubber to remove PM_{10} before discharging in a stack. Small amounts of NOx, SOx, and PM_{10} not present in the geothermal gas are discharged, being generated as a result of the process.

2.2.2 Bioreactor

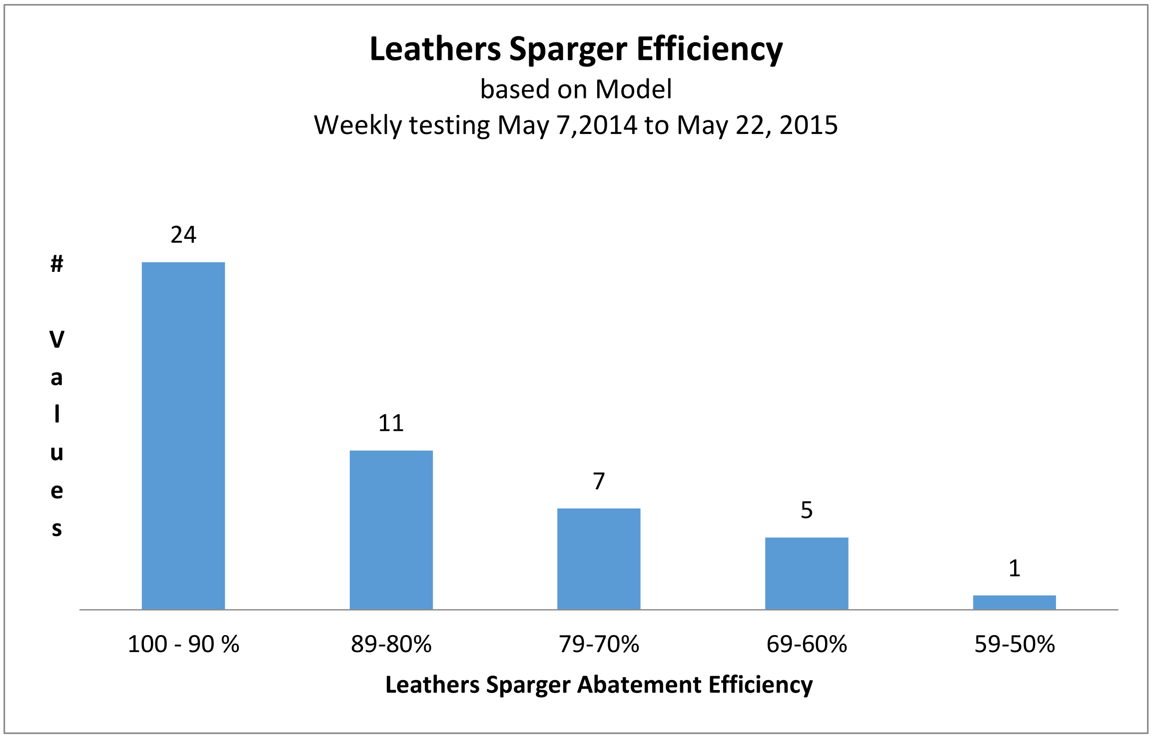
The bioreactor bubbles NCG through columns containing liquid and plastic spheres. The plastic spheres act as a surface to grow biologic agent ("microbes"). These "microbes" consume H_2S and produce sulfuric acid and sulfate. Effluent gasses from the bioreactor are routed to the shrouds on the cooling tower after abatement in the bioreactor, while condensate is discharged to the cooling tower (Gregory Jacobs, personal communication). While published literature provides the average performance of the bioreactor as a control efficiency of 99%, CalEnergy's operating experience with this system finds that the efficiency can be reduced during times of extreme weather to approximately 50%. This is due to fact that overheating during the summer can damage the microbes and equipment; likewise excessive cold can cause the microbes to become less efficient in abating hydrogen sulfide. Heating and cooling systems are therefore used in order to attempt to achieve the optimal temperature for abatement to occur.

2.2.3 Sparger with Biocide Abatement

The sparger system for BIOX process comprises distribution pipes with bubble diffusers/nozzles. The off-gas containing hydrogen sulfide from the condenser is transported and bubbled through the sparger system to the bottom of the cooling tower basin. The hydrogen sulfide contained in the off-gas is dissolved in the cooling tower water and converted to sulfate by reacting with the oxidizing biocides and the dissolved oxygen in the water. If an effective amount of an oxidizing biocide is maintained, the sparger system for BIOX process is expected to remove more than 90%

percent of the H2S in the non-condensable gases based on the sparger system utilized at CalEnergy's Leathers cooling tower (when emissions are measured from the shrouds). It should be noted that historical data from the Leathers sparger system has been evaluated by way of a conservative model, which has estimated an average abatement efficiency of 86% between May 7, 2014, to May 22, 2015. (However, as shown in the figure below, operational fluctuations can cause the removal efficiency to be a low as 50%, when measured by the model).

Figure 1 – Leathers Sparger Modeled Efficiency Results



2.3 Benzene Abatement Options

2.3.1 Regenerative Thermal Oxidizer

Similar to the use of RTO's for the abatement of H_2S in NCG, the RTO oxidizes hydrocarbons (in the non-condensable gas) and supplemental propane (used to pre-heat the unit) to carbon dioxide and water vapor in an exothermic process to abate benzene from NCG (Imperial County Planning & Development Services Department 2011). The gases then flow through a caustic scrubber and venturi scrubber to remove PM_{10} before discharging in a stack. The RTO is not feasible as small amounts of NOx, SOx, and PM_{10}, not present in the geothermal gas are discharged, being generated as a result of the process.

2.4 2.5 Particulate Matter Abatement Options

2.4.1 (Existing) Drift Eliminators

The only source of PM_{10} at Elmore is from Total Dissolved Solids (TDS) in the cooling tower recirculating water. Steam condensate comes from the condenser and fills the cooling tower with steam condensate. The steam condensate carries TDS, including PM_{10}, into the cooling tower. Elmore currently uses drift eliminators to control PM_{10} emissions. Drift eliminators are devices that remove water droplets, which contain dissolved solids, from the exhaust steam and return them to the circulating tower (Calpine Corporation 1998). For the retrofit project the TDS in the cooling tower will be unaffected by the installation of the back-pressure turbine; therefore, the current drift eliminators are deemed adequate for controlling emissions.

3 Step 2 and 3: Eliminate Technically Infeasible Options and Rank Remaining Control Technologies

Eliminating Infeasible Options

Table 3 includes a summary of control efficiencies and technologies. (CH2M Hill 2004). .As shown in the table, the regenerative thermal oxidizer (RTO) is not considered feasible for control of benzene emissions due to fact that more emissions will be created by the use of the technology than the emissions that are abated. That is, the uses propane to attain a combustion temperature of approximately 1500 degrees Fahrenheit, which results in combustion products of nitrogen oxides. Based on CalEnergy's RTO for Units 1 and 2 at Region 1 emission of nitrogen oxide can range from 14.5 lbs/hr (based on a source test on December 2010) which are in excess of the 0.103 lbs/hr of unabated benzene that are emitted from Elmore. **Given that RTO is considered technologically infeasible, no controls are being recommended for benzene emissions; and given that benzene is currently uncontrolled total emissions of benzene from the facility will be unchanged as a result of this project**.

The RTO could also be considered infeasible for hydrogen sulfide gaseous abatement as it produces additional emissions of particulate matter and sulfur dioxide in order to abate hydrogen sulfide. However the quantity of the emissions generated by the RTO unit cannot be definitely stated to exceed the emissions that are abated, therefore this option is not eliminated for hydrogen sulfide control based solely on technology performance.

Ranking Remaining Options

The rank of remaining control technologies (which have not been eliminated based on technology) based on average control efficiency is as follows:

For H_2S condensate abatement,

1. BIOX (liquid, 98% efficient)
2. Bio-oxidation box (ox-box) (90.9% efficient)
3. Chemical Oxidation (the control efficiency for using only H_2O_2 has not been determined)

For NCG H_2S abatement::

1. Bioreactor (99% efficient)
2. RTO (98% efficient)
3. Sparger system for (NCG, 90% efficient average)

Table 1. Control Technology Efficiencies & Feasibilities

Parameter	Technology Alternative	Control Efficiency	Technology Feasible?
Sour Condensate Liquid (H_2S)	Ox-Box	90.9% (3 year average)[1]	Feasible
	Chemical Oxidation	40-70% (without iron chelate), 93-98% (iron catalyst + H_2O_2 combined system)[2]	Feasible
	BIOX (liquid)	98%	Feasible
NCG (H_2S)	Regenerative Thermal Oxidizer (RTO)+caustic scrubber and venturi	~98% but increases SOx, NOx and PM_{10}[4]	Not Feasible
	Bioreactor	99% [5]	Feasible
	Sparger - system	90%	Feasible
NCG (Benzene)	RTO	>98% but increases net emissions by increasing SOx, NOx and PM_{10}[4]	Not Feasible
	No Action	-	Feasible
Cooling Tower recirculating water (PM10)	Drift Eliminators (No Action)	>99%[8]	Feasible (& already installed)

[1] Calculations based on data provided by CalEnergy

[2] Acurex 1980

[3] Nagl 1999

[4] Imperial County Planning & Development Services Department 2011

[5] Rodriguez 2013

[6] Based on Leathers data provided by Calenergy

[8] Salton Sea Unit 6 License California Energy Commission Amendment 1, 2004

4 Steps 4: Cost Evaluation of Most Effective Technologies

4.1 Cost Analysis

Table 4 contains summary of comparative cost analysis for H_2S control technologies and the bases for these costs are included in Attachment A.

Table 4: Cost of Control Alternatives ($/ton)

Parameter	Technology Alternative	Capital Cost	Annual Operating Cost	Abated Emission Rate (US ton/yrs)	Resulting Cost $/ton removal	Reasonable BACT cost from Agency
Sour Condensate Liquid (H_2S)	Ox-Box	$570,000	$25,000	83.4	**$2,247**	$14,230/ton
	Chemical Oxidation	$400,000	$301,000	87.6	$5,588	$14,230/ton
	BIOX (liquid)	$600,000	$250,000	89.9	$5,145	$14,230/ton
NCG (H_2S)	RTO	$3,350,000	$639,185	186.7	$7,495	$14,230/ton
	Bioreactor	$2,000,000	$131,702	188.6	$2,968	$14,230/ton
	Sparger	$200,000	$150,000	171.48	**$1,599**	$14,230/ton

5 Step 5: Selection of BACT

Selection of BACT

For abatement of hydrogen sulfide in the condensate, the BACT cost analysis (in Table 4) found that while there was little difference in the abatement efficiencies of the technologies evaluated, the bio-oxidation box (ox-box) was the most cost effective for the control of hydrogen sulfide in condensate.

For the abatement of hydrogen sulfide emissions in the non-condensable gasses, the BACT cost analysis found that the sparger (with the oxidizing biocide) was the most cost effective for the abatement of hydrogen sulfide in the non-condensable gasses and this technology is recommended in favor of the bioreactor based on cost even though the bioreactor has slightly higher abatement efficiencies as the performance of both systems are subject to fluctuations based on operational conditions. Furthermore, the operational controls for the sparger (which is the addition of chemicals) results in a faster response in improving abatement than does the adjustment of temperature and other conditions needed to optimize the performance of the microbes in bioreactor. The sparger is therefore easier to operate in terms of controlling the abatement efficiency.

Attachment B provides examples of the sparger and bioreactor technologies already in use at CalEnergy, and it provides the conceptual arrangement of this equipment at Elmore). Final specifications for the equipment will be provided before issuance of the operating permit for the equipment.

Estimating Post-retrofit Emissions

Applying these technologies to the calculated post-retrofit control emissions (show in Table 1.a) results in average estimated post-retrofit emissions of 6 lbs/hr of hydrogen sulfide from the brine (as shown in

Table 5). Given that the expected emissions are calculated and the efficiency of the equipment will fluctuate, maximum emissions at any given time are expected to fluctuate but (as demonstrated herein) emissions will not exceed the current historical actual emission rates (shown in Table 2). Post-retrofit hydrogen sulfide emissions also comply with the permit requirement of 22.8 lbs/hr permit limit hydrogen sulfide.

Table 5 – Post-Retrofit Abated H2S Emissions

Post-Retrofit Emissions	Condensate Abated with Bio-oxidation Box	NCG Abated with Biox (gas) system	Total expected emissions
Unabated Maximum H_2S Emissions (lbs/hr)	20.94	43.50	
Average Abatement Efficiency (%)	90.90%	90%	
Expected Average Emissions (lbs/hr)	1.91	4.35	**6.26**
Expected Average Emissions(tons/year)			**27.27**

6 Conclusion

The conclusion of this analysis was that:

- **Hydrogen Sulfide Emissions Control**: Control technologies will be installed to maintain emissions within the range of historical actual emissions for hydrogen sulfide by installing a bio-oxidation box on the condensate and a sparger system for the non-condensable gas stream. Furthermore the technologies selected will allow emissions to be less than or equal to historical actual maximum emission and the historical actual average emissions. Emissions will also be less than the permit limit for the facility.
- **Benzene Emissions Control**: No technology was identified that was technologically practical for controlling benzene emissions; therefore no change/reduction in unabated emissions of benzene is recommended and no changes in emission rates are expected.
- **Nitrogen Oxide & (non-benzene) VOC Emissions**: Given that the modification does not affect nitrogen oxide & (non-benzene) VOC emissions (which result from diesel and gasoline engines at the facility) a BACT analysis was not performed for these emissions.
- **Particulate Matter Emissions**: Given that the modification does not affect particulate matter emissions from the cooling tower recirculating water, or from engines at the facility) a BACT analysis was not performed for these emissions.

In conclusion, additional abatement equipment is proposed herein for this project and emissions levels will not be increased by the project.

7 References

Acurex Corporation. 1980. *Assessment of H2S Control Technologies for Geotheraml Power Plants.* Sacramento, CA: Sponsered by the California Energy Commission.

CalEnergy Operations. 2016. "Air Permit Application for Cal Energy Region 1 Unit 3 Cooling Tower Bio-oxidation Box Modification." Submitted to the Imperial County Air Pollution Control District, October 11.

Calpine Corporation. 1998. *Fourmile Hill Geothermal Development Project Volume I: Final EIS/EIR.* State Clearinghouse.

CE Obsidian Energy LLC. 2010. "Final Determination of Compliance." *Applied for Black Rock Facility: Units 1, 2, and 3.* Calipatria, CA: Imperial County Air Pollution Control District, July 10.

CH2M Hill. 2004. "Salton Sea Unit 6 License California Energy Commission Amendment 1." Prepared for Cal Energy Obsidian Energy LLC. Sumbitted to the California Energy Commission., December 17.

Imperial County Planning & Development Services Department. 2011. "ORNI 21, LLC Wister Geothermal Development Project." Project Summary.

Imperial County Planning & Development Services Department. 2011. "ORNI 21, LLC Wister Geothermal Development Project." Project Summary.

Jacobs, Gregory, Henry Castanieto, Steven J. Butler, and John L. Featherstone. 2016. Hydrogen Sulfide Abatement in Geothermal Facilities. United States Patent US 2016/0023927 A1. January 28.

Kendrick, Cheri, Kenneth E. McIntush, Darryl L. Mamrosh, Carrie Ann M. Beitler, and O. Hileman. 2012. "Review of the Bottle Rock Power Stretford Unit." *GRC Transactions, Vol. 36* 1085-1090.

Mamrosh, Darryl L., Kenneth E. McIntush, Carrie Beitler, Sigurour H. Markusson, and Kristjan Einarsson. 2012. "Screening of H2S Abatement Options for Geothermal Power." *GRC Transactions, Vol. 36* 1217-1226.

Nagl, Gary J. 1999. "Controlling H2S emissions in geothermal power plants." *Bulletin d'Hydrogblogie, 17* 393-402.

Rodriguez, Esteban. 2013. *Review of H2S Abatement in Geothermal Plants and Laboratory Scale Design of Tray Plate Distillation Tower.* Thesis, Reykjavik, Iceland: Icelandic School of Energy.

Rodriguez, Esteban, William Scott Harvey, and Einar Jon Asbjornsson. 2014. "Review of H2S Abatement Methods in Geothermal Plants." *PROCEEDINGS, Thirty-Eighth Workshop on Geothermal Reservoir Engineering.* Stanford, California: Stanford University.

Stephens, Frederick B., John H. Hill, and Paul L. Phelps, Jr. 1980. *State-of-the-Art hydrogen sulfide control for geothermal energy systems:1979.* Technical Report, Washington, D.C.: Department of Energy, Division of Environmental Control Technology.

ATTACHMENT A - BACT Cost Worksheets

Attachment A – BACT Costs Summaries

	Condensate H2S Abatement Technologies			Non-condensable Gas H2S Abatement Technologies		
	Ox-Box	Chemical Oxidation	BIOX (liquid)	RTO	Bioreactor	Sparger
Capital Costs	$570,000	$400,000	$600,000	$3,350,000	$2,000,000	$200,000
Annual O&M cost (Note B)	$25,000	$301,000	$250,000	$639,185	$131,702	$150,000
Source testing	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000
Capital Recovery Cost (see Note A)	$81,155	$56,951	$85,427	$476,965	$284,755	$28,476
Annualized cost	$156,155	$407,951	$385,427	$1,166,150	$466,457	$228,476
Total Annualized Cost with 20 % Contingency	**$187,386**	**$489,541**	**$462,512**	**$1,399,380**	**$559,748**	**$274,171**
Abated Emission						
pre-abatement, lbs/hr	20.94	20.94	20.94	43.50	43.50	43.50
post-abatement, lbs/hr	1.91	0.94	0.42	0.87	0.44	4.35
abated, lbs/hr	19.04	20.00	20.53	42.63	43.07	39.15
abated, tons/yr	83.39	87.61	89.90	186.72	188.62	171.48
BACT, $/ton abated	**$2,247**	**$5,588**	**$5,145**	**$7,495**	**$2,968**	**$1,599**
BACT Threshold,	$14,230	$14,230	$14,230	$14,230	$14,230	$14,230

BACT Threshold is based on SCAQMD 2016 Update - using SOx Threshold for H2S Threshold - see Note B

Note A - Capital Recovery Costs

Equipment life	10
Interest rate	7%
Capital recovery factor	**0.1423775**

The formula for the capital recovery factor is:

$$CRF = \frac{i * (1 + i)n}{(1 + i)n - 1}$$

where:

CRF = capital recovery factor

n = economic life of equipment

i = real interest rate

Note B: Costs have not been broken down for maintenance.

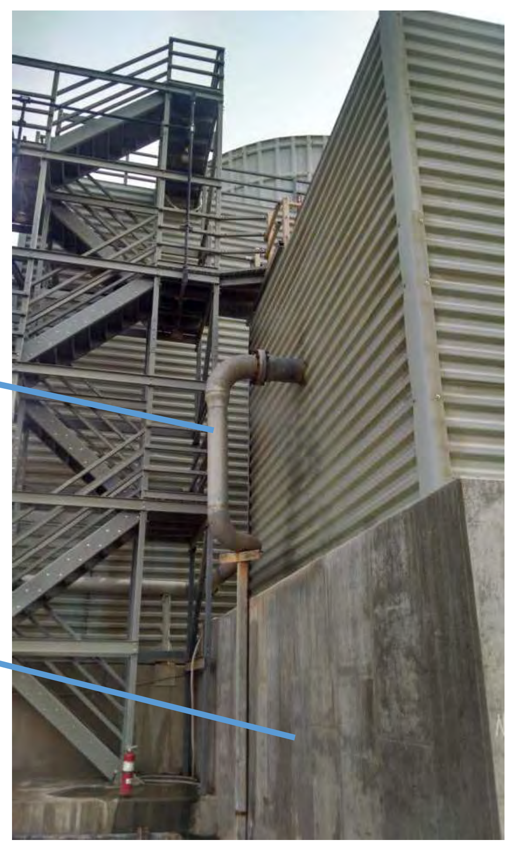
ATTACHMENT B – General Arrangement Selected Technologies

Figure B.1- External Bio-Oxidation Box Proposed for Abating H2S from Condensate

(Southern side of) external bio-oxidation box for Vulcan facility is located adjacent to the Vulcan cooling tower rather than inside the cooling tower. A similar external box will be built for Elmore.

Figure B.2 –

Northern side of Vulcan external ox-box



Condensate enters the box

Condensate falls into the ox-box basin, after abatement by microbes. The abated condensate is routed to the basin of the main tower.

Figure B.3 - Bio-oxidation Box Plan View - (Design will be similar to Unit 3 & 4 shown below)

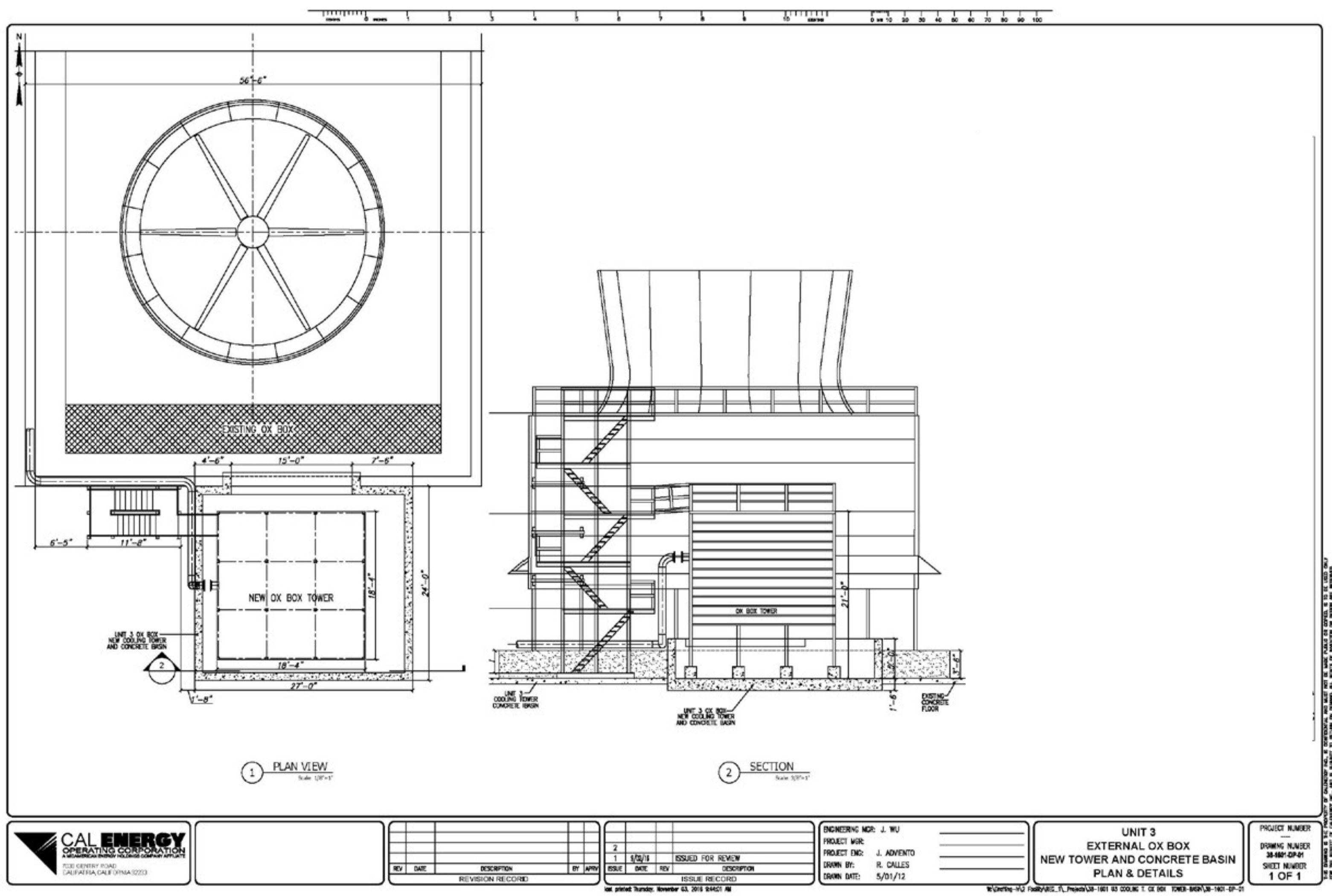
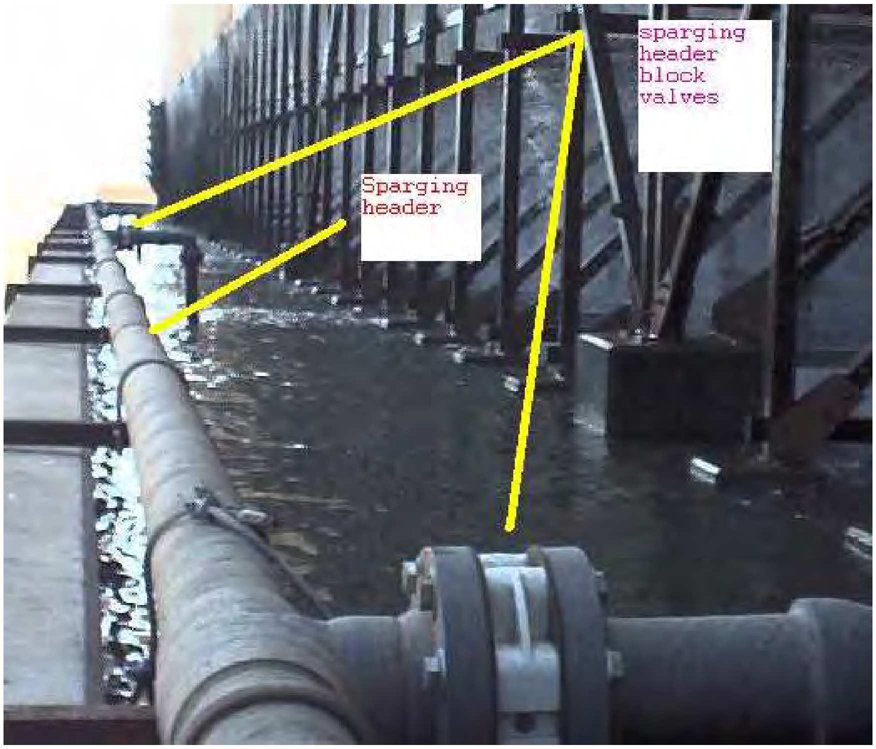


Figure B-4 - Sparger System for Abating H2S Emission in the Non-condensable gasses



Piping for Sparger system at Leathers facility. A similar system will be installed at Elmore.

Chemical feed tank for sparger system at Leathers. Chemicals will be used at Elmore but feed system may differ depending on chemical used.

Figure B-5 - Plan view of Sparger Headers in Cooling Tower Basin

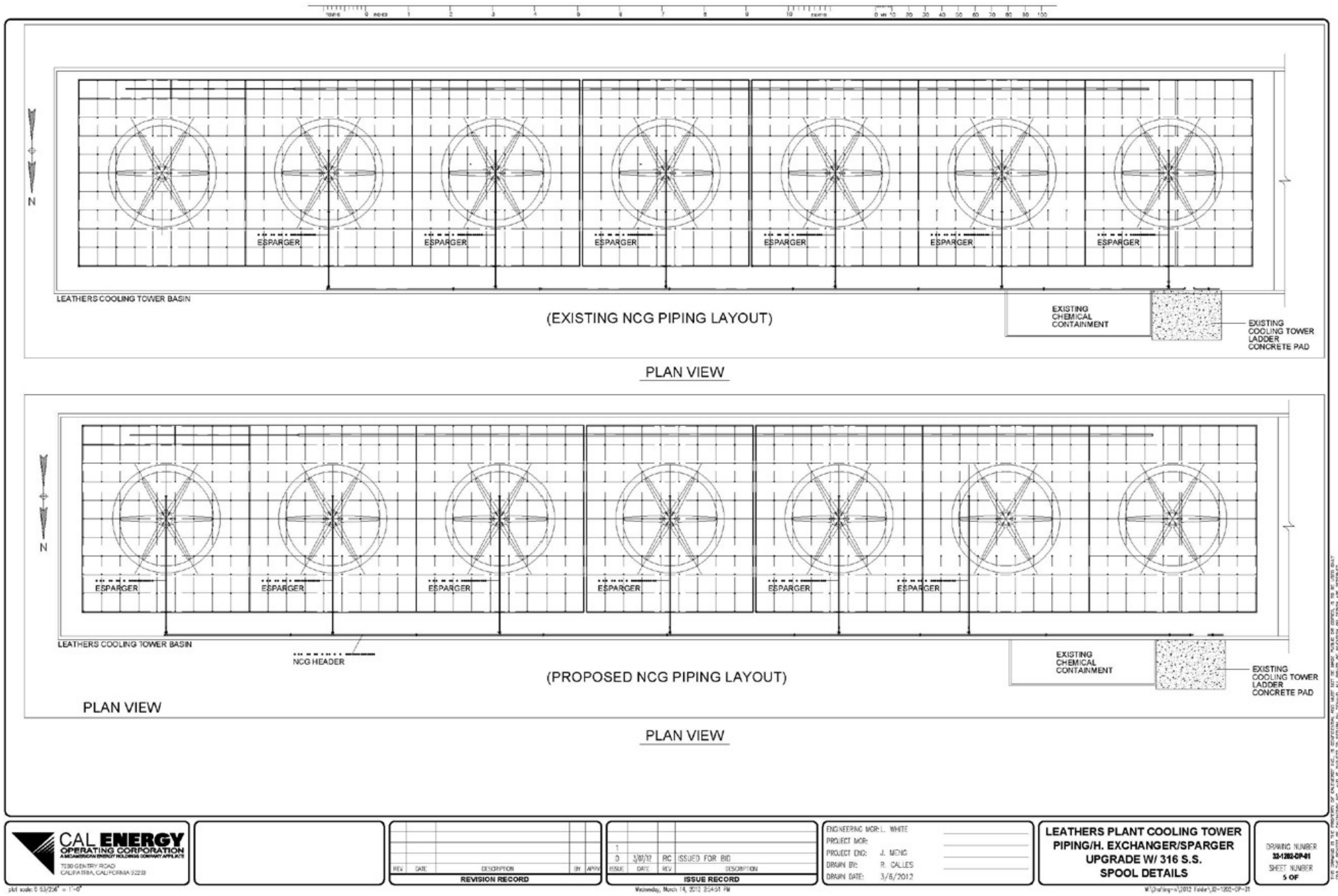
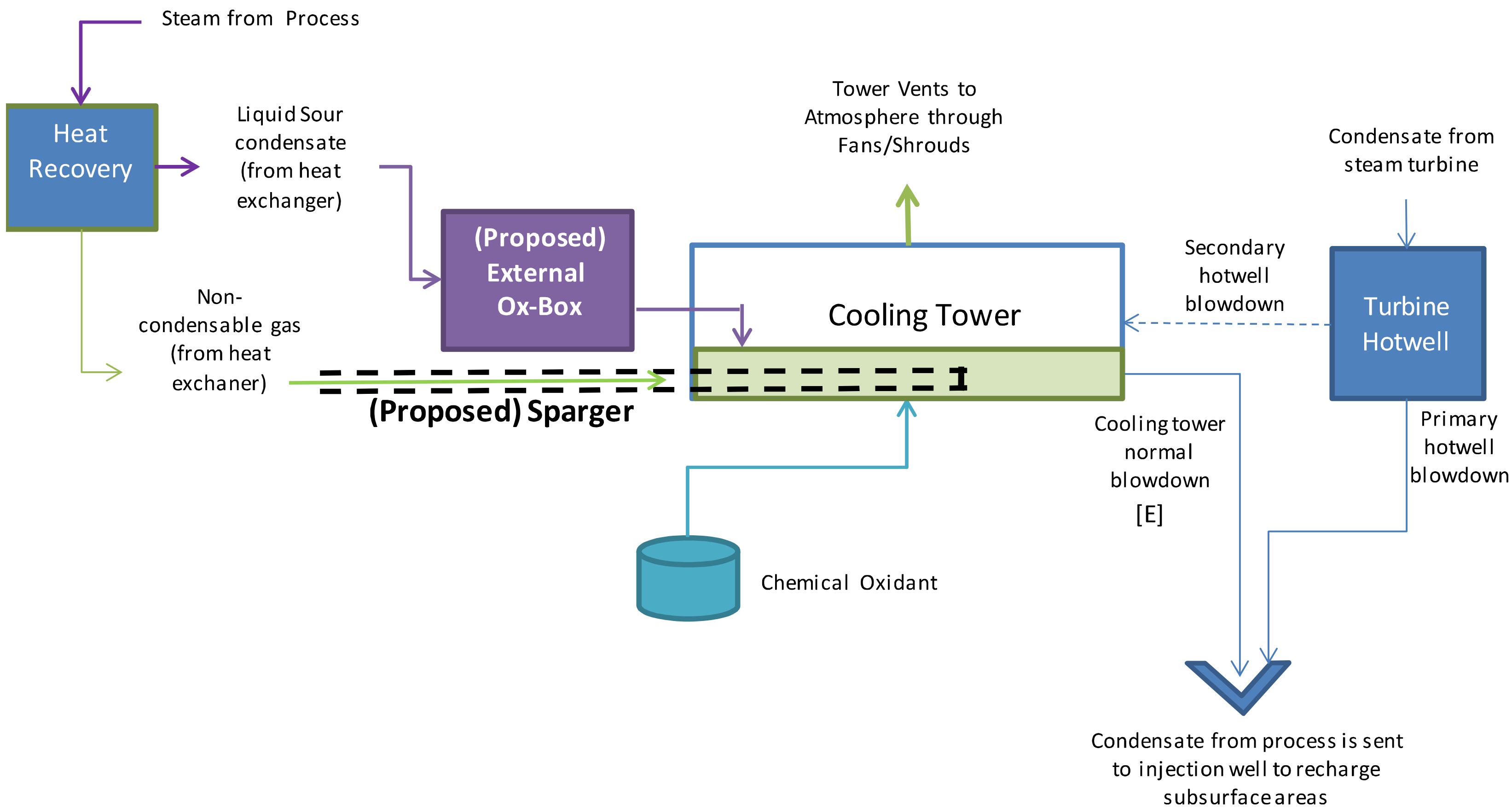


Figure B.6 - Conceptual Arrangement of Proposed External Ox-Box and Sparger for H2S Abatement at Elmore



Note that during short-duration maintenance of the Ox-box, condensate will be routed to the cooling tower basin for abatement, and additional chemicals will be used to control emissions (as described in the application letter dated 1/3/17).

The final design information will be provided prior to the issuance of a permit to operate.

Appendix 5.9A
Operational Health Risk Assessment

Morton Bay Geothermal Project

Morton Bay Health Risk Assessment

Sensitive Receptors

April 2023

Morton Bay Nearby Sensitive Receptors

Receptor Number	Receptor Description	X Coordinate	Y Coordinate
5,622	Residence	630,020	3,666,838
5,623	Residence	630,812	3,666,941
5,624	Residence	632,437	3,665,342
5,625	Residence	634,165	3,665,327
5,626	Residence	633,274	3,668,579
5,627	Residence	635,720	3,668,695
5,628	Residence	635,683	3,667,001
5,629	Residence	636,085	3,666,125
5,630	Residence	629,091	3,671,844
5,631	Residence	629,311	3,674,439
5,632	Residence	633,189	3,676,633
5,633	Residence	638,071	3,677,428
5,634	Residence	637,938	3,674,194
5,635	Residence	638,180	3,672,664

Note: Coordinates presented are UTM NAD83 Zone 11, meters

Morton Bay Geothermal Project

Morton Bay Health Risk Assessment

Census Receptors

April 2023

Morton Bay Nearby Census Receptors

Receptor Number	Receptor Description	X Coordinate	Y Coordinate	Population
5,636	Census Receptor	636,696	3,682,655	0
5,637	Census Receptor	639,583	3,680,189	10
5,638	Census Receptor	639,097	3,679,648	0
5,639	Census Receptor	638,074	3,681,572	9
5,640	Census Receptor	637,148	3,680,807	8
5,641	Census Receptor	634,352	3,682,677	0
5,642	Census Receptor	638,931	3,678,995	0
5,643	Census Receptor	639,067	3,678,887	0
5,644	Census Receptor	640,169	3,679,097	0
5,645	Census Receptor	639,498	3,679,201	0
5,646	Census Receptor	639,393	3,679,082	0
5,647	Census Receptor	639,870	3,678,354	0
5,648	Census Receptor	640,402	3,677,816	0
5,649	Census Receptor	639,301	3,677,890	2
5,650	Census Receptor	638,695	3,677,882	0
5,651	Census Receptor	638,213	3,677,815	0
5,652	Census Receptor	638,074	3,678,120	2
5,653	Census Receptor	638,189	3,677,074	29
5,654	Census Receptor	638,695	3,677,075	4
5,655	Census Receptor	639,308	3,677,086	0
5,656	Census Receptor	641,647	3,675,511	0
5,657	Census Receptor	640,815	3,677,106	0
5,658	Census Receptor	640,001	3,677,095	0
5,659	Census Receptor	640,011	3,676,301	0
5,660	Census Receptor	640,823	3,676,301	0
5,661	Census Receptor	639,315	3,676,283	0
5,662	Census Receptor	638,918	3,676,278	0
5,663	Census Receptor	638,413	3,676,270	0
5,664	Census Receptor	638,426	3,675,466	0
5,665	Census Receptor	638,929	3,675,477	0
5,666	Census Receptor	639,327	3,675,478	0
5,667	Census Receptor	640,025	3,675,488	0
5,668	Census Receptor	640,007	3,675,899	0
5,669	Census Receptor	639,739	3,674,673	0
5,670	Census Receptor	638,536	3,674,661	4
5,671	Census Receptor	638,542	3,673,854	0
5,672	Census Receptor	639,744	3,673,867	0
5,673	Census Receptor	641,259	3,673,906	0
5,674	Census Receptor	641,245	3,674,697	0
5,675	Census Receptor	640,838	3,675,495	0

Morton Bay Geothermal Project

Morton Bay Health Risk Assessment Census Receptors

April 2023

Morton Bay Nearby Census Receptors

Receptor Number	Receptor Description	X Coordinate	Y Coordinate	Population
5,676	Census Receptor	638,551	3,673,051	2
5,677	Census Receptor	641,272	3,673,091	0
5,678	Census Receptor	641,324	3,673,509	0
5,679	Census Receptor	639,768	3,673,452	0
5,680	Census Receptor	639,755	3,673,051	0
5,681	Census Receptor	639,764	3,672,265	0
5,682	Census Receptor	641,298	3,672,674	0
5,683	Census Receptor	641,284	3,672,272	0
5,684	Census Receptor	639,793	3,671,453	0
5,685	Census Receptor	639,076	3,671,543	0
5,686	Census Receptor	638,568	3,671,445	0
5,687	Census Receptor	638,559	3,672,249	0
5,688	Census Receptor	638,577	3,670,618	0
5,689	Census Receptor	639,070	3,670,642	0
5,690	Census Receptor	639,729	3,671,031	0
5,691	Census Receptor	639,789	3,670,631	0
5,692	Census Receptor	640,113	3,669,851	0
5,693	Census Receptor	639,389	3,669,839	0
5,694	Census Receptor	639,835	3,669,432	0
5,695	Census Receptor	638,591	3,669,028	0
5,696	Census Receptor	638,584	3,669,813	0
5,697	Census Receptor	638,599	3,668,237	3
5,698	Census Receptor	638,614	3,667,822	0
5,699	Census Receptor	632,342	3,683,811	0
5,700	Census Receptor	637,060	3,679,948	0
5,701	Census Receptor	637,914	3,679,393	0
5,702	Census Receptor	627,051	3,678,982	0
5,703	Census Receptor	627,155	3,670,991	0
5,704	Census Receptor	629,644	3,677,138	0
5,705	Census Receptor	629,375	3,675,191	0
5,706	Census Receptor	630,177	3,673,064	3
5,707	Census Receptor	628,027	3,671,919	0
5,708	Census Receptor	626,742	3,670,099	0
5,709	Census Receptor	628,778	3,672,116	4
5,710	Census Receptor	631,617	3,679,429	1
5,711	Census Receptor	632,857	3,682,234	11
5,712	Census Receptor	633,792	3,680,585	1
5,713	Census Receptor	636,113	3,680,114	1
5,714	Census Receptor	633,929	3,679,444	0
5,715	Census Receptor	634,004	3,679,853	0

Morton Bay Geothermal Project

Morton Bay Health Risk Assessment

Census Receptors

April 2023

Morton Bay Nearby Census Receptors

Receptor Number	Receptor Description	X Coordinate	Y Coordinate	Population
5,716	Census Receptor	631,160	3,672,764	0
5,717	Census Receptor	632,345	3,672,252	0
5,718	Census Receptor	633,050	3,672,205	0
5,719	Census Receptor	632,951	3,672,989	0
5,720	Census Receptor	634,606	3,673,010	0
5,721	Census Receptor	636,856	3,673,417	0
5,722	Census Receptor	636,839	3,673,832	3
5,723	Census Receptor	636,828	3,674,639	0
5,724	Census Receptor	636,750	3,675,052	0
5,725	Census Receptor	633,987	3,675,392	0
5,726	Census Receptor	633,951	3,675,796	0
5,727	Census Receptor	634,129	3,675,823	0
5,728	Census Receptor	636,812	3,676,259	4
5,729	Census Receptor	636,846	3,676,664	0
5,730	Census Receptor	636,792	3,677,065	0
5,731	Census Receptor	636,376	3,677,850	0
5,732	Census Receptor	637,378	3,677,866	10
5,733	Census Receptor	636,612	3,678,699	2
5,734	Census Receptor	637,561	3,679,218	0
5,735	Census Receptor	636,504	3,679,466	0
5,736	Census Receptor	636,969	3,679,089	0
5,737	Census Receptor	634,020	3,679,035	0
5,738	Census Receptor	633,936	3,678,623	6
5,739	Census Receptor	633,952	3,677,824	0
5,740	Census Receptor	633,871	3,677,409	0
5,741	Census Receptor	633,961	3,677,017	1
5,742	Census Receptor	633,920	3,676,628	0
5,743	Census Receptor	633,974	3,676,224	0
5,744	Census Receptor	638,254	3,679,066	53
5,745	Census Receptor	638,326	3,679,178	89
5,746	Census Receptor	638,603	3,679,174	0
5,747	Census Receptor	638,599	3,679,049	0
5,748	Census Receptor	637,927	3,679,151	0
5,749	Census Receptor	638,072	3,678,960	39
5,750	Census Receptor	638,265	3,678,995	27
5,751	Census Receptor	638,465	3,679,003	13
5,752	Census Receptor	638,669	3,678,967	44
5,753	Census Receptor	638,623	3,678,874	13
5,754	Census Receptor	638,664	3,678,835	14
5,755	Census Receptor	638,739	3,678,822	2

Morton Bay Geothermal Project

Morton Bay Health Risk Assessment

Census Receptors

April 2023

Morton Bay Nearby Census Receptors

Receptor Number	Receptor Description	X Coordinate	Y Coordinate	Population
5,756	Census Receptor	638,858	3,678,844	39
5,757	Census Receptor	638,975	3,678,592	0
5,758	Census Receptor	638,859	3,678,720	35
5,759	Census Receptor	638,694	3,678,712	19
5,760	Census Receptor	638,605	3,678,739	0
5,761	Census Receptor	638,471	3,678,717	34
5,762	Census Receptor	638,471	3,678,809	11
5,763	Census Receptor	638,467	3,678,870	26
5,764	Census Receptor	638,468	3,678,940	10
5,765	Census Receptor	638,266	3,678,932	21
5,766	Census Receptor	638,269	3,678,838	37
5,767	Census Receptor	638,074	3,678,835	27
5,768	Census Receptor	638,075	3,678,711	32
5,769	Census Receptor	638,271	3,678,746	29
5,770	Census Receptor	638,271	3,678,683	38
5,771	Census Receptor	637,570	3,678,465	114
5,772	Census Receptor	638,075	3,678,590	0
5,773	Census Receptor	638,245	3,678,624	19
5,774	Census Receptor	638,345	3,678,593	7
5,775	Census Receptor	638,451	3,678,601	21
5,776	Census Receptor	638,542	3,678,575	34
5,777	Census Receptor	638,674	3,678,597	42
5,778	Census Receptor	638,860	3,678,599	14
5,779	Census Receptor	638,862	3,678,477	14
5,780	Census Receptor	638,676	3,678,475	39
5,781	Census Receptor	638,499	3,678,466	21
5,782	Census Receptor	638,410	3,678,492	0
5,783	Census Receptor	638,275	3,678,471	39
5,784	Census Receptor	638,245	3,678,566	16
5,785	Census Receptor	638,477	3,678,345	27
5,786	Census Receptor	638,678	3,678,349	17
5,787	Census Receptor	638,863	3,678,351	15
5,788	Census Receptor	638,344	3,678,322	0
5,789	Census Receptor	638,253	3,678,350	11
5,790	Census Receptor	638,078	3,678,341	16
5,791	Census Receptor	638,077	3,678,470	0
5,792	Census Receptor	636,532	3,675,859	0
5,793	Census Receptor	636,835	3,675,830	0
5,794	Census Receptor	636,816	3,675,438	0
5,795	Census Receptor	634,819	3,672,601	0

Morton Bay Geothermal Project

Morton Bay Health Risk Assessment

Census Receptors

April 2023

Morton Bay Nearby Census Receptors

Receptor Number	Receptor Description	X Coordinate	Y Coordinate	Population
5,796	Census Receptor	633,796	3,672,577	0
5,797	Census Receptor	633,792	3,672,178	0
5,798	Census Receptor	634,821	3,672,191	0
5,799	Census Receptor	636,049	3,672,217	0
5,800	Census Receptor	637,257	3,672,232	0
5,801	Census Receptor	636,875	3,672,640	0
5,802	Census Receptor	636,848	3,673,028	0
5,803	Census Receptor	633,737	3,669,371	5
5,804	Census Receptor	634,842	3,671,398	0
5,805	Census Receptor	633,485	3,667,547	3
5,806	Census Receptor	632,737	3,670,848	0
5,807	Census Receptor	632,036	3,670,146	0
5,808	Census Receptor	631,227	3,670,139	0
5,809	Census Receptor	630,421	3,670,531	0
5,810	Census Receptor	629,595	3,671,722	0
5,811	Census Receptor	629,583	3,672,126	0
5,812	Census Receptor	632,822	3,669,354	0
5,813	Census Receptor	632,860	3,667,743	0
5,814	Census Receptor	632,061	3,667,730	0
5,815	Census Receptor	631,636	3,670,034	0
5,816	Census Receptor	630,015	3,670,414	0
5,817	Census Receptor	629,606	3,670,518	0
5,818	Census Receptor	629,209	3,670,508	0
5,819	Census Receptor	628,787	3,671,309	0
5,820	Census Receptor	628,735	3,671,709	0
5,821	Census Receptor	628,001	3,671,301	0
5,822	Census Receptor	630,028	3,668,910	0
5,823	Census Receptor	630,444	3,668,917	0
5,824	Census Receptor	630,825	3,669,939	0
5,825	Census Receptor	631,254	3,667,719	6
5,826	Census Receptor	630,461	3,667,712	2
5,827	Census Receptor	630,059	3,667,697	0
5,828	Census Receptor	630,033	3,667,752	0
5,829	Census Receptor	629,631	3,667,698	0
5,830	Census Receptor	629,612	3,668,907	0
5,831	Census Receptor	628,826	3,669,705	0
5,832	Census Receptor	628,423	3,669,766	0
5,833	Census Receptor	628,403	3,669,528	0
5,834	Census Receptor	628,006	3,669,690	0
5,835	Census Receptor	627,221	3,669,280	0

Morton Bay Geothermal Project

Morton Bay Health Risk Assessment

Census Receptors

April 2023

Morton Bay Nearby Census Receptors

Receptor Number	Receptor Description	X Coordinate	Y Coordinate	Population
5,836	Census Receptor	626,409	3,669,252	0
5,837	Census Receptor	625,523	3,667,969	0
5,838	Census Receptor	626,424	3,667,658	0
5,839	Census Receptor	627,235	3,667,667	0
5,840	Census Receptor	628,040	3,667,675	0
5,841	Census Receptor	628,840	3,667,688	0
5,842	Census Receptor	628,869	3,666,079	0
5,843	Census Receptor	629,659	3,666,492	6
5,844	Census Receptor	630,463	3,666,502	0
5,845	Census Receptor	631,270	3,666,513	0
5,846	Census Receptor	632,077	3,666,524	0
5,847	Census Receptor	632,877	3,666,536	0
5,848	Census Receptor	633,381	3,666,693	0
5,849	Census Receptor	633,748	3,666,514	0
5,850	Census Receptor	633,798	3,667,999	0
5,851	Census Receptor	633,964	3,667,348	0
5,852	Census Receptor	632,087	3,665,722	7
5,853	Census Receptor	631,282	3,665,711	0
5,854	Census Receptor	630,474	3,665,699	0
5,855	Census Receptor	629,668	3,665,686	0
5,856	Census Receptor	634,471	3,668,168	0
5,857	Census Receptor	636,877	3,668,613	0
5,858	Census Receptor	636,908	3,669,008	13
5,859	Census Receptor	636,892	3,669,806	0
5,860	Census Receptor	637,006	3,670,197	0
5,861	Census Receptor	636,883	3,670,600	0
5,862	Census Receptor	636,922	3,671,004	0
5,863	Census Receptor	636,802	3,671,026	0
5,864	Census Receptor	636,873	3,671,431	0
5,865	Census Receptor	634,083	3,670,160	0
5,866	Census Receptor	634,856	3,670,576	0
5,867	Census Receptor	634,850	3,670,978	0
5,868	Census Receptor	634,876	3,668,982	0
5,869	Census Receptor	634,867	3,669,372	0
5,870	Census Receptor	634,880	3,669,774	0
5,871	Census Receptor	636,858	3,669,418	0
5,872	Census Receptor	636,791	3,669,394	0
5,873	Census Receptor	634,868	3,668,588	0
5,874	Census Receptor	633,318	3,665,283	0
5,875	Census Receptor	633,498	3,665,497	0

Morton Bay Geothermal Project

Morton Bay Health Risk Assessment

Census Receptors

April 2023

Morton Bay Nearby Census Receptors

Receptor Number	Receptor Description	X Coordinate	Y Coordinate	Population
5,876	Census Receptor	632,888	3,665,731	0
5,877	Census Receptor	634,902	3,665,939	2
5,878	Census Receptor	634,917	3,666,145	0
5,879	Census Receptor	634,907	3,666,562	0
5,880	Census Receptor	634,899	3,667,364	8
5,881	Census Receptor	635,285	3,668,170	0
5,882	Census Receptor	635,714	3,668,169	0
5,883	Census Receptor	635,724	3,665,953	0
5,884	Census Receptor	635,934	3,666,157	0
5,885	Census Receptor	635,937	3,666,182	0
5,886	Census Receptor	636,136	3,666,582	39
5,887	Census Receptor	636,992	3,667,380	6
5,888	Census Receptor	636,917	3,667,810	0
5,889	Census Receptor	636,923	3,668,213	0
5,890	Census Receptor	638,142	3,667,859	0
5,891	Census Receptor	633,744	3,665,781	8
5,892	Census Receptor	636,341	3,666,162	0
5,893	Census Receptor	637,140	3,666,593	21
5,894	Census Receptor	636,737	3,666,586	15
5,895	Census Receptor	628,430	3,666,853	0
5,896	Census Receptor	628,071	3,666,052	0
5,897	Census Receptor	633,993	3,674,612	1
5,898	Census Receptor	634,210	3,674,214	0
5,899	Census Receptor	634,584	3,673,807	1
5,900	Census Receptor	637,783	3,677,869	50

Note: Coordinates presented are UTM NAD83 Zone 11, meters

Morton Bay Geothermal Project

Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year With Startups and Shutdowns

April 2023

Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
CT	7439921	Lead	1.11E-02	1.46E-06
FPUMP	7439921	Lead	0.00E+00	0.00E+00
G1	7439921	Lead	0.00E+00	0.00E+00
G2	7439921	Lead	0.00E+00	0.00E+00
G3	7439921	Lead	0.00E+00	0.00E+00
G4	7439921	Lead	0.00E+00	0.00E+00
G5	7439921	Lead	0.00E+00	0.00E+00
PTU	7439921	Lead	0.00E+00	0.00E+00
RMP	7439921	Lead	0.00E+00	0.00E+00
CT	7439976	Mercury	8.39E-03	1.10E-06
FPUMP	7439976	Mercury	0.00E+00	0.00E+00
G1	7439976	Mercury	0.00E+00	0.00E+00
G2	7439976	Mercury	0.00E+00	0.00E+00
G3	7439976	Mercury	0.00E+00	0.00E+00
G4	7439976	Mercury	0.00E+00	0.00E+00
G5	7439976	Mercury	0.00E+00	0.00E+00
PTU	7439976	Mercury	5.32E-02	0.00E+00
RMP	7439976	Mercury	5.58E-01	0.00E+00
CT	71432	Benzene	2.41E+02	3.20E-02
FPUMP	71432	Benzene	0.00E+00	0.00E+00
G1	71432	Benzene	0.00E+00	0.00E+00
G2	71432	Benzene	0.00E+00	0.00E+00
G3	71432	Benzene	0.00E+00	0.00E+00
G4	71432	Benzene	0.00E+00	0.00E+00
G5	71432	Benzene	0.00E+00	0.00E+00
PTU	71432	Benzene	2.55E+01	0.00E+00
RMP	71432	Benzene	2.68E+02	0.00E+00
CT	108883	Toluene	1.57E+00	2.08E-04
FPUMP	108883	Toluene	0.00E+00	0.00E+00
G1	108883	Toluene	0.00E+00	0.00E+00
G2	108883	Toluene	0.00E+00	0.00E+00
G3	108883	Toluene	0.00E+00	0.00E+00
G4	108883	Toluene	0.00E+00	0.00E+00
G5	108883	Toluene	0.00E+00	0.00E+00
PTU	108883	Toluene	1.36E-01	0.00E+00
RMP	108883	Toluene	1.43E+00	0.00E+00
CT	100414	Ethylbenzene	1.35E+00	1.79E-04
FPUMP	100414	Ethylbenzene	0.00E+00	0.00E+00
G1	100414	Ethylbenzene	0.00E+00	0.00E+00
G2	100414	Ethylbenzene	0.00E+00	0.00E+00
G3	100414	Ethylbenzene	0.00E+00	0.00E+00
G4	100414	Ethylbenzene	0.00E+00	0.00E+00
G5	100414	Ethylbenzene	0.00E+00	0.00E+00

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Source Emission Rates: Routine Operating Year With Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
PTU	100414	Ethylbenzene	1.13E-01	0.00E+00
RMP	100414	Ethylbenzene	1.18E+00	0.00E+00
CT	1330207	Xylenes	1.64E+00	2.17E-04
FPUMP	1330207	Xylenes	0.00E+00	0.00E+00
G1	1330207	Xylenes	0.00E+00	0.00E+00
G2	1330207	Xylenes	0.00E+00	0.00E+00
G3	1330207	Xylenes	0.00E+00	0.00E+00
G4	1330207	Xylenes	0.00E+00	0.00E+00
G5	1330207	Xylenes	0.00E+00	0.00E+00
PTU	1330207	Xylenes	1.13E-01	0.00E+00
RMP	1330207	Xylenes	1.18E+00	0.00E+00
CT	7429905	Aluminum	1.57E-02	2.06E-06
FPUMP	7429905	Aluminum	0.00E+00	0.00E+00
G1	7429905	Aluminum	0.00E+00	0.00E+00
G2	7429905	Aluminum	0.00E+00	0.00E+00
G3	7429905	Aluminum	0.00E+00	0.00E+00
G4	7429905	Aluminum	0.00E+00	0.00E+00
G5	7429905	Aluminum	0.00E+00	0.00E+00
PTU	7429905	Aluminum	0.00E+00	0.00E+00
RMP	7429905	Aluminum	0.00E+00	0.00E+00
CT	7440360	Antimony	2.35E-03	3.08E-07
FPUMP	7440360	Antimony	0.00E+00	0.00E+00
G1	7440360	Antimony	0.00E+00	0.00E+00
G2	7440360	Antimony	0.00E+00	0.00E+00
G3	7440360	Antimony	0.00E+00	0.00E+00
G4	7440360	Antimony	0.00E+00	0.00E+00
G5	7440360	Antimony	0.00E+00	0.00E+00
PTU	7440360	Antimony	0.00E+00	0.00E+00
RMP	7440360	Antimony	0.00E+00	0.00E+00
CT	7440393	Barium	7.53E-02	9.87E-06
FPUMP	7440393	Barium	0.00E+00	0.00E+00
G1	7440393	Barium	0.00E+00	0.00E+00
G2	7440393	Barium	0.00E+00	0.00E+00
G3	7440393	Barium	0.00E+00	0.00E+00
G4	7440393	Barium	0.00E+00	0.00E+00
G5	7440393	Barium	0.00E+00	0.00E+00
PTU	7440393	Barium	0.00E+00	0.00E+00
RMP	7440393	Barium	0.00E+00	0.00E+00
CT	7440417	Beryllium	1.57E-04	2.06E-08
FPUMP	7440417	Beryllium	0.00E+00	0.00E+00
G1	7440417	Beryllium	0.00E+00	0.00E+00
G2	7440417	Beryllium	0.00E+00	0.00E+00
G3	7440417	Beryllium	0.00E+00	0.00E+00

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Source Emission Rates: Routine Operating Year With Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G4	7440417	Beryllium	0.00E+00	0.00E+00
G5	7440417	Beryllium	0.00E+00	0.00E+00
PTU	7440417	Beryllium	0.00E+00	0.00E+00
RMP	7440417	Beryllium	0.00E+00	0.00E+00
CT	7440439	Cadmium	4.70E-04	6.17E-08
FPUMP	7440439	Cadmium	0.00E+00	0.00E+00
G1	7440439	Cadmium	0.00E+00	0.00E+00
G2	7440439	Cadmium	0.00E+00	0.00E+00
G3	7440439	Cadmium	0.00E+00	0.00E+00
G4	7440439	Cadmium	0.00E+00	0.00E+00
G5	7440439	Cadmium	0.00E+00	0.00E+00
PTU	7440439	Cadmium	0.00E+00	0.00E+00
RMP	7440439	Cadmium	0.00E+00	0.00E+00
CT	7440473	Chromium	7.84E-04	1.03E-07
FPUMP	7440473	Chromium	0.00E+00	0.00E+00
G1	7440473	Chromium	0.00E+00	0.00E+00
G2	7440473	Chromium	0.00E+00	0.00E+00
G3	7440473	Chromium	0.00E+00	0.00E+00
G4	7440473	Chromium	0.00E+00	0.00E+00
G5	7440473	Chromium	0.00E+00	0.00E+00
PTU	7440473	Chromium	0.00E+00	0.00E+00
RMP	7440473	Chromium	0.00E+00	0.00E+00
CT	7440508	Copper	7.53E-03	9.87E-07
FPUMP	7440508	Copper	0.00E+00	0.00E+00
G1	7440508	Copper	0.00E+00	0.00E+00
G2	7440508	Copper	0.00E+00	0.00E+00
G3	7440508	Copper	0.00E+00	0.00E+00
G4	7440508	Copper	0.00E+00	0.00E+00
G5	7440508	Copper	0.00E+00	0.00E+00
PTU	7440508	Copper	0.00E+00	0.00E+00
RMP	7440508	Copper	0.00E+00	0.00E+00
CT	7439965	Manganese	7.21E-01	9.46E-05
FPUMP	7439965	Manganese	0.00E+00	0.00E+00
G1	7439965	Manganese	0.00E+00	0.00E+00
G2	7439965	Manganese	0.00E+00	0.00E+00
G3	7439965	Manganese	0.00E+00	0.00E+00
G4	7439965	Manganese	0.00E+00	0.00E+00
G5	7439965	Manganese	0.00E+00	0.00E+00
PTU	7439965	Manganese	0.00E+00	0.00E+00
RMP	7439965	Manganese	0.00E+00	0.00E+00
CT	7440020	Nickel	1.91E-03	2.51E-07
FPUMP	7440020	Nickel	0.00E+00	0.00E+00
G1	7440020	Nickel	0.00E+00	0.00E+00

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Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year With Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G2	7440020	Nickel	0.00E+00	0.00E+00
G3	7440020	Nickel	0.00E+00	0.00E+00
G4	7440020	Nickel	0.00E+00	0.00E+00
G5	7440020	Nickel	0.00E+00	0.00E+00
PTU	7440020	Nickel	0.00E+00	0.00E+00
RMP	7440020	Nickel	0.00E+00	0.00E+00
CT	7782492	Selenium	2.48E-02	3.25E-06
FPUMP	7782492	Selenium	0.00E+00	0.00E+00
G1	7782492	Selenium	0.00E+00	0.00E+00
G2	7782492	Selenium	0.00E+00	0.00E+00
G3	7782492	Selenium	0.00E+00	0.00E+00
G4	7782492	Selenium	0.00E+00	0.00E+00
G5	7782492	Selenium	0.00E+00	0.00E+00
PTU	7782492	Selenium	0.00E+00	0.00E+00
RMP	7782492	Selenium	0.00E+00	0.00E+00
CT	1175	Silica, Crystln	7.84E-01	1.03E-04
FPUMP	1175	Silica, Crystln	0.00E+00	0.00E+00
G1	1175	Silica, Crystln	0.00E+00	0.00E+00
G2	1175	Silica, Crystln	0.00E+00	0.00E+00
G3	1175	Silica, Crystln	0.00E+00	0.00E+00
G4	1175	Silica, Crystln	0.00E+00	0.00E+00
G5	1175	Silica, Crystln	0.00E+00	0.00E+00
PTU	1175	Silica, Crystln	0.00E+00	0.00E+00
RMP	1175	Silica, Crystln	0.00E+00	0.00E+00
CT	7440224	Silver	7.84E-04	1.03E-07
FPUMP	7440224	Silver	0.00E+00	0.00E+00
G1	7440224	Silver	0.00E+00	0.00E+00
G2	7440224	Silver	0.00E+00	0.00E+00
G3	7440224	Silver	0.00E+00	0.00E+00
G4	7440224	Silver	0.00E+00	0.00E+00
G5	7440224	Silver	0.00E+00	0.00E+00
PTU	7440224	Silver	0.00E+00	0.00E+00
RMP	7440224	Silver	0.00E+00	0.00E+00
CT	7440666	Zinc	4.47E-01	5.86E-05
FPUMP	7440666	Zinc	0.00E+00	0.00E+00
G1	7440666	Zinc	0.00E+00	0.00E+00
G2	7440666	Zinc	0.00E+00	0.00E+00
G3	7440666	Zinc	0.00E+00	0.00E+00
G4	7440666	Zinc	0.00E+00	0.00E+00
G5	7440666	Zinc	0.00E+00	0.00E+00
PTU	7440666	Zinc	0.00E+00	0.00E+00
RMP	7440666	Zinc	0.00E+00	0.00E+00
CT	9901	DieselExhPM	0.00E+00	0.00E+00

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Source Emission Rates: Routine Operating Year With Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
FPUMP	9901	DieselExhPM	2.86E+00	5.72E-02
G1	9901	DieselExhPM	8.93E+00	1.79E-01
G2	9901	DieselExhPM	1.15E+01	2.31E-01
G3	9901	DieselExhPM	1.15E+01	2.31E-01
G4	9901	DieselExhPM	1.15E+01	2.31E-01
G5	9901	DieselExhPM	1.15E+01	2.31E-01
PTU	9901	DieselExhPM	0.00E+00	0.00E+00
RMP	9901	DieselExhPM	0.00E+00	0.00E+00
CT	67663	Chloroform	0.00E+00	0.00E+00
FPUMP	67663	Chloroform	0.00E+00	0.00E+00
G1	67663	Chloroform	0.00E+00	0.00E+00
G2	67663	Chloroform	0.00E+00	0.00E+00
G3	67663	Chloroform	0.00E+00	0.00E+00
G4	67663	Chloroform	0.00E+00	0.00E+00
G5	67663	Chloroform	0.00E+00	0.00E+00
PTU	67663	Chloroform	0.00E+00	0.00E+00
RMP	67663	Chloroform	0.00E+00	0.00E+00
CT	50000	Formaldehyde	0.00E+00	0.00E+00
FPUMP	50000	Formaldehyde	0.00E+00	0.00E+00
G1	50000	Formaldehyde	0.00E+00	0.00E+00
G2	50000	Formaldehyde	0.00E+00	0.00E+00
G3	50000	Formaldehyde	0.00E+00	0.00E+00
G4	50000	Formaldehyde	0.00E+00	0.00E+00
G5	50000	Formaldehyde	0.00E+00	0.00E+00
PTU	50000	Formaldehyde	0.00E+00	0.00E+00
RMP	50000	Formaldehyde	0.00E+00	0.00E+00
CT	1150	PAHs-w/	0.00E+00	0.00E+00
FPUMP	1150	PAHs-w/	0.00E+00	0.00E+00
G1	1150	PAHs-w/	0.00E+00	0.00E+00
G2	1150	PAHs-w/	0.00E+00	0.00E+00
G3	1150	PAHs-w/	0.00E+00	0.00E+00
G4	1150	PAHs-w/	0.00E+00	0.00E+00
G5	1150	PAHs-w/	0.00E+00	0.00E+00
PTU	1150	PAHs-w/	0.00E+00	0.00E+00
RMP	1150	PAHs-w/	0.00E+00	0.00E+00
CT	91203	Naphthalene	0.00E+00	0.00E+00
FPUMP	91203	Naphthalene	0.00E+00	0.00E+00
G1	91203	Naphthalene	0.00E+00	0.00E+00
G2	91203	Naphthalene	0.00E+00	0.00E+00
G3	91203	Naphthalene	0.00E+00	0.00E+00
G4	91203	Naphthalene	0.00E+00	0.00E+00
G5	91203	Naphthalene	0.00E+00	0.00E+00
PTU	91203	Naphthalene	0.00E+00	0.00E+00

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Source Emission Rates: Routine Operating Year With Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
RMP	91203	Naphthalene	0.00E+00	0.00E+00
CT	75070	Acetaldehyde	0.00E+00	0.00E+00
FPUMP	75070	Acetaldehyde	0.00E+00	0.00E+00
G1	75070	Acetaldehyde	0.00E+00	0.00E+00
G2	75070	Acetaldehyde	0.00E+00	0.00E+00
G3	75070	Acetaldehyde	0.00E+00	0.00E+00
G4	75070	Acetaldehyde	0.00E+00	0.00E+00
G5	75070	Acetaldehyde	0.00E+00	0.00E+00
PTU	75070	Acetaldehyde	0.00E+00	0.00E+00
RMP	75070	Acetaldehyde	0.00E+00	0.00E+00
CT	107028	Acrolein	0.00E+00	0.00E+00
FPUMP	107028	Acrolein	0.00E+00	0.00E+00
G1	107028	Acrolein	0.00E+00	0.00E+00
G2	107028	Acrolein	0.00E+00	0.00E+00
G3	107028	Acrolein	0.00E+00	0.00E+00
G4	107028	Acrolein	0.00E+00	0.00E+00
G5	107028	Acrolein	0.00E+00	0.00E+00
PTU	107028	Acrolein	0.00E+00	0.00E+00
RMP	107028	Acrolein	0.00E+00	0.00E+00
CT	115071	Propylene	0.00E+00	0.00E+00
FPUMP	115071	Propylene	0.00E+00	0.00E+00
G1	115071	Propylene	0.00E+00	0.00E+00
G2	115071	Propylene	0.00E+00	0.00E+00
G3	115071	Propylene	0.00E+00	0.00E+00
G4	115071	Propylene	0.00E+00	0.00E+00
G5	115071	Propylene	0.00E+00	0.00E+00
PTU	115071	Propylene	0.00E+00	0.00E+00
RMP	115071	Propylene	0.00E+00	0.00E+00
CT	110543	Hexane	0.00E+00	0.00E+00
FPUMP	110543	Hexane	0.00E+00	0.00E+00
G1	110543	Hexane	0.00E+00	0.00E+00
G2	110543	Hexane	0.00E+00	0.00E+00
G3	110543	Hexane	0.00E+00	0.00E+00
G4	110543	Hexane	0.00E+00	0.00E+00
G5	110543	Hexane	0.00E+00	0.00E+00
PTU	110543	Hexane	0.00E+00	0.00E+00
RMP	110543	Hexane	0.00E+00	0.00E+00
CT	1166	Radon	1.40E+03	9.29E-05
FPUMP	1166	Radon	0.00E+00	0.00E+00
G1	1166	Radon	0.00E+00	0.00E+00
G2	1166	Radon	0.00E+00	0.00E+00
G3	1166	Radon	0.00E+00	0.00E+00
G4	1166	Radon	0.00E+00	0.00E+00

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Source Emission Rates: Routine Operating Year With Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G5	1166	Radon	0.00E+00	0.00E+00
PTU	1166	Radon	1.48E+02	0.00E+00
RMP	1166	Radon	1.56E+03	0.00E+00
CT	208968	Acenaphthylene	0.00E+00	0.00E+00
FPUMP	208968	Acenaphthylene	0.00E+00	0.00E+00
G1	208968	Acenaphthylene	0.00E+00	0.00E+00
G2	208968	Acenaphthylene	0.00E+00	0.00E+00
G3	208968	Acenaphthylene	0.00E+00	0.00E+00
G4	208968	Acenaphthylene	0.00E+00	0.00E+00
G5	208968	Acenaphthylene	0.00E+00	0.00E+00
PTU	208968	Acenaphthylene	0.00E+00	0.00E+00
RMP	208968	Acenaphthylene	0.00E+00	0.00E+00
CT	83329	Acenaphthene	0.00E+00	0.00E+00
FPUMP	83329	Acenaphthene	0.00E+00	0.00E+00
G1	83329	Acenaphthene	0.00E+00	0.00E+00
G2	83329	Acenaphthene	0.00E+00	0.00E+00
G3	83329	Acenaphthene	0.00E+00	0.00E+00
G4	83329	Acenaphthene	0.00E+00	0.00E+00
G5	83329	Acenaphthene	0.00E+00	0.00E+00
PTU	83329	Acenaphthene	0.00E+00	0.00E+00
RMP	83329	Acenaphthene	0.00E+00	0.00E+00
CT	86737	Fluorene	0.00E+00	0.00E+00
FPUMP	86737	Fluorene	0.00E+00	0.00E+00
G1	86737	Fluorene	0.00E+00	0.00E+00
G2	86737	Fluorene	0.00E+00	0.00E+00
G3	86737	Fluorene	0.00E+00	0.00E+00
G4	86737	Fluorene	0.00E+00	0.00E+00
G5	86737	Fluorene	0.00E+00	0.00E+00
PTU	86737	Fluorene	0.00E+00	0.00E+00
RMP	86737	Fluorene	0.00E+00	0.00E+00
CT	85018	Phenanthrene	0.00E+00	0.00E+00
FPUMP	85018	Phenanthrene	0.00E+00	0.00E+00
G1	85018	Phenanthrene	0.00E+00	0.00E+00
G2	85018	Phenanthrene	0.00E+00	0.00E+00
G3	85018	Phenanthrene	0.00E+00	0.00E+00
G4	85018	Phenanthrene	0.00E+00	0.00E+00
G5	85018	Phenanthrene	0.00E+00	0.00E+00
PTU	85018	Phenanthrene	0.00E+00	0.00E+00
RMP	85018	Phenanthrene	0.00E+00	0.00E+00
CT	120127	Anthracene	0.00E+00	0.00E+00
FPUMP	120127	Anthracene	0.00E+00	0.00E+00
G1	120127	Anthracene	0.00E+00	0.00E+00
G2	120127	Anthracene	0.00E+00	0.00E+00

Morton Bay Geothermal Project

Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year With Startups and Shutdowns

April 2023

Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G3	120127	Anthracene	0.00E+00	0.00E+00
G4	120127	Anthracene	0.00E+00	0.00E+00
G5	120127	Anthracene	0.00E+00	0.00E+00
PTU	120127	Anthracene	0.00E+00	0.00E+00
RMP	120127	Anthracene	0.00E+00	0.00E+00
CT	206440	Fluoranthene	0.00E+00	0.00E+00
FPUMP	206440	Fluoranthene	0.00E+00	0.00E+00
G1	206440	Fluoranthene	0.00E+00	0.00E+00
G2	206440	Fluoranthene	0.00E+00	0.00E+00
G3	206440	Fluoranthene	0.00E+00	0.00E+00
G4	206440	Fluoranthene	0.00E+00	0.00E+00
G5	206440	Fluoranthene	0.00E+00	0.00E+00
PTU	206440	Fluoranthene	0.00E+00	0.00E+00
RMP	206440	Fluoranthene	0.00E+00	0.00E+00
CT	129000	Pyrene	0.00E+00	0.00E+00
FPUMP	129000	Pyrene	0.00E+00	0.00E+00
G1	129000	Pyrene	0.00E+00	0.00E+00
G2	129000	Pyrene	0.00E+00	0.00E+00
G3	129000	Pyrene	0.00E+00	0.00E+00
G4	129000	Pyrene	0.00E+00	0.00E+00
G5	129000	Pyrene	0.00E+00	0.00E+00
PTU	129000	Pyrene	0.00E+00	0.00E+00
RMP	129000	Pyrene	0.00E+00	0.00E+00
CT	56553	Benz[a]anthracene	0.00E+00	0.00E+00
FPUMP	56553	Benz[a]anthracene	0.00E+00	0.00E+00
G1	56553	Benz[a]anthracene	0.00E+00	0.00E+00
G2	56553	Benz[a]anthracene	0.00E+00	0.00E+00
G3	56553	Benz[a]anthracene	0.00E+00	0.00E+00
G4	56553	Benz[a]anthracene	0.00E+00	0.00E+00
G5	56553	Benz[a]anthracene	0.00E+00	0.00E+00
PTU	56553	Benz[a]anthracene	0.00E+00	0.00E+00
RMP	56553	Benz[a]anthracene	0.00E+00	0.00E+00
CT	218019	Chrysene	0.00E+00	0.00E+00
FPUMP	218019	Chrysene	0.00E+00	0.00E+00
G1	218019	Chrysene	0.00E+00	0.00E+00
G2	218019	Chrysene	0.00E+00	0.00E+00
G3	218019	Chrysene	0.00E+00	0.00E+00
G4	218019	Chrysene	0.00E+00	0.00E+00
G5	218019	Chrysene	0.00E+00	0.00E+00
PTU	218019	Chrysene	0.00E+00	0.00E+00
RMP	218019	Chrysene	0.00E+00	0.00E+00
CT	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
FPUMP	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00

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Source Emission Rates: Routine Operating Year With Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G1	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
G2	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
G3	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
G4	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
G5	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
PTU	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
RMP	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
CT	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
FPUMP	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
G1	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
G2	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
G3	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
G4	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
G5	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
PTU	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
RMP	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
CT	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
FPUMP	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
G1	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
G2	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
G3	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
G4	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
G5	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
PTU	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
RMP	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
CT	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
FPUMP	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
G1	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
G2	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
G3	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
G4	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
G5	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
PTU	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
RMP	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
CT	53703	D[a,h]anthracen	0.00E+00	0.00E+00
FPUMP	53703	D[a,h]anthracen	0.00E+00	0.00E+00
G1	53703	D[a,h]anthracen	0.00E+00	0.00E+00
G2	53703	D[a,h]anthracen	0.00E+00	0.00E+00
G3	53703	D[a,h]anthracen	0.00E+00	0.00E+00
G4	53703	D[a,h]anthracen	0.00E+00	0.00E+00
G5	53703	D[a,h]anthracen	0.00E+00	0.00E+00
PTU	53703	D[a,h]anthracen	0.00E+00	0.00E+00
RMP	53703	D[a,h]anthracen	0.00E+00	0.00E+00

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Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year With Startups and Shutdowns

April 2023

Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
CT	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
FPUMP	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
G1	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
G2	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
G3	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
G4	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
G5	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
PTU	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
RMP	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
CT	7783064	H2S	0.00E+00	0.00E+00
FPUMP	7783064	H2S	0.00E+00	0.00E+00
G1	7783064	H2S	0.00E+00	0.00E+00
G2	7783064	H2S	0.00E+00	0.00E+00
G3	7783064	H2S	0.00E+00	0.00E+00
G4	7783064	H2S	0.00E+00	0.00E+00
G5	7783064	H2S	0.00E+00	0.00E+00
PTU	7783064	H2S	0.00E+00	0.00E+00
RMP	7783064	H2S	0.00E+00	0.00E+00
CT	7664417	NH3	7.15E+04	8.53E+00
FPUMP	7664417	NH3	0.00E+00	0.00E+00
G1	7664417	NH3	1.39E+01	2.77E-01
G2	7664417	NH3	1.69E+01	3.37E-01
G3	7664417	NH3	1.69E+01	3.37E-01
G4	7664417	NH3	1.69E+01	3.37E-01
G5	7664417	NH3	1.69E+01	3.37E-01
PTU	7664417	NH3	7.75E+01	0.00E+00
RMP	7664417	NH3	8.12E+02	0.00E+00
CT	124389	CO2	8.21E+06	1.09E+03
FPUMP	124389	CO2	0.00E+00	0.00E+00
G1	124389	CO2	0.00E+00	0.00E+00
G2	124389	CO2	0.00E+00	0.00E+00
G3	124389	CO2	0.00E+00	0.00E+00
G4	124389	CO2	0.00E+00	0.00E+00
G5	124389	CO2	0.00E+00	0.00E+00
PTU	124389	CO2	8.71E+05	0.00E+00
RMP	124389	CO2	9.13E+06	0.00E+00
CT	74828	CH4	2.05E+04	2.72E+00
FPUMP	74828	CH4	0.00E+00	0.00E+00
G1	74828	CH4	0.00E+00	0.00E+00
G2	74828	CH4	0.00E+00	0.00E+00
G3	74828	CH4	0.00E+00	0.00E+00
G4	74828	CH4	0.00E+00	0.00E+00
G5	74828	CH4	0.00E+00	0.00E+00

Morton Bay Geothermal Project

Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year With Startups and Shutdowns

April 2023

Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
PTU	74828	CH4	2.18E+03	0.00E+00
RMP	74828	CH4	2.28E+04	0.00E+00
CT	10024972	Nitrous Oxide	0.00E+00	0.00E+00
FPUMP	10024972	Nitrous Oxide	0.00E+00	0.00E+00
G1	10024972	Nitrous Oxide	0.00E+00	0.00E+00
G2	10024972	Nitrous Oxide	0.00E+00	0.00E+00
G3	10024972	Nitrous Oxide	0.00E+00	0.00E+00
G4	10024972	Nitrous Oxide	0.00E+00	0.00E+00
G5	10024972	Nitrous Oxide	0.00E+00	0.00E+00
PTU	10024972	Nitrous Oxide	0.00E+00	0.00E+00
RMP	10024972	Nitrous Oxide	0.00E+00	0.00E+00
CT	7440382	Arsenic	1.48E-01	1.93E-05
FPUMP	7440382	Arsenic	0.00E+00	0.00E+00
G1	7440382	Arsenic	0.00E+00	0.00E+00
G2	7440382	Arsenic	0.00E+00	0.00E+00
G3	7440382	Arsenic	0.00E+00	0.00E+00
G4	7440382	Arsenic	0.00E+00	0.00E+00
G5	7440382	Arsenic	0.00E+00	0.00E+00
PTU	7440382	Arsenic	3.26E-02	0.00E+00
RMP	7440382	Arsenic	3.42E-01	0.00E+00
CT	106990	1,3-Butadiene	0.00E+00	0.00E+00
FPUMP	106990	1,3-Butadiene	0.00E+00	0.00E+00
G1	106990	1,3-Butadiene	0.00E+00	0.00E+00
G2	106990	1,3-Butadiene	0.00E+00	0.00E+00
G3	106990	1,3-Butadiene	0.00E+00	0.00E+00
G4	106990	1,3-Butadiene	0.00E+00	0.00E+00
G5	106990	1,3-Butadiene	0.00E+00	0.00E+00
PTU	106990	1,3-Butadiene	0.00E+00	0.00E+00
RMP	106990	1,3-Butadiene	0.00E+00	0.00E+00
CT	7440484	Cobalt	1.57E-04	2.06E-08
FPUMP	7440484	Cobalt	0.00E+00	0.00E+00
G1	7440484	Cobalt	0.00E+00	0.00E+00
G2	7440484	Cobalt	0.00E+00	0.00E+00
G3	7440484	Cobalt	0.00E+00	0.00E+00
G4	7440484	Cobalt	0.00E+00	0.00E+00
G5	7440484	Cobalt	0.00E+00	0.00E+00
PTU	7440484	Cobalt	0.00E+00	0.00E+00
RMP	7440484	Cobalt	0.00E+00	0.00E+00
CT	7440622	Vanadium (fume or dust)	7.84E-04	1.03E-07
FPUMP	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
G1	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
G2	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
G3	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00

Morton Bay Geothermal Project

Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year With Startups and Shutdowns

April 2023

Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year With Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G4	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
G5	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
PTU	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
RMP	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00

[a] The CT source group includes emissions associated with a single cooling tower cell.

[b] Radon emissions are presented in units of curies per time period. These emission do not match and are higher than those presented in Appendix 5.1A based upon final Applicant requested reivsions. The associated health risk modeling was not updated as radon does not have any health risk related values in the HARP2 database and does impact results presented in Section 5.9.

[c] CARB/OEHHA-developed health risk assessment criteria for DPM includes risks and estimates of all speciated emissions. Therefore, only DPM is modeled from diesel combustion sources including the emergency generators and fire water pump.

lbs/yr = pound(s) per year

lbs/hr = pound(s) per hour

Morton Bay Geothermal Project

Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

April 2023

Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
CT	7439921	Lead	1.28E-02	1.46E-06
FPUMP	7439921	Lead	0.00E+00	0.00E+00
G1	7439921	Lead	0.00E+00	0.00E+00
G2	7439921	Lead	0.00E+00	0.00E+00
G3	7439921	Lead	0.00E+00	0.00E+00
G4	7439921	Lead	0.00E+00	0.00E+00
G5	7439921	Lead	0.00E+00	0.00E+00
PTU	7439921	Lead	0.00E+00	0.00E+00
RMP	7439921	Lead	0.00E+00	0.00E+00
CT	7439976	Mercury	9.64E-03	1.10E-06
FPUMP	7439976	Mercury	0.00E+00	0.00E+00
G1	7439976	Mercury	0.00E+00	0.00E+00
G2	7439976	Mercury	0.00E+00	0.00E+00
G3	7439976	Mercury	0.00E+00	0.00E+00
G4	7439976	Mercury	0.00E+00	0.00E+00
G5	7439976	Mercury	0.00E+00	0.00E+00
PTU	7439976	Mercury	0.00E+00	0.00E+00
RMP	7439976	Mercury	0.00E+00	0.00E+00
CT	71432	Benzene	2.80E+02	3.20E-02
FPUMP	71432	Benzene	0.00E+00	0.00E+00
G1	71432	Benzene	0.00E+00	0.00E+00
G2	71432	Benzene	0.00E+00	0.00E+00
G3	71432	Benzene	0.00E+00	0.00E+00
G4	71432	Benzene	0.00E+00	0.00E+00
G5	71432	Benzene	0.00E+00	0.00E+00
PTU	71432	Benzene	0.00E+00	0.00E+00
RMP	71432	Benzene	0.00E+00	0.00E+00
CT	108883	Toluene	1.83E+00	2.08E-04
FPUMP	108883	Toluene	0.00E+00	0.00E+00
G1	108883	Toluene	0.00E+00	0.00E+00
G2	108883	Toluene	0.00E+00	0.00E+00
G3	108883	Toluene	0.00E+00	0.00E+00
G4	108883	Toluene	0.00E+00	0.00E+00
G5	108883	Toluene	0.00E+00	0.00E+00
PTU	108883	Toluene	0.00E+00	0.00E+00
RMP	108883	Toluene	0.00E+00	0.00E+00
CT	100414	Ethylbenzene	1.57E+00	1.79E-04
FPUMP	100414	Ethylbenzene	0.00E+00	0.00E+00
G1	100414	Ethylbenzene	0.00E+00	0.00E+00
G2	100414	Ethylbenzene	0.00E+00	0.00E+00
G3	100414	Ethylbenzene	0.00E+00	0.00E+00
G4	100414	Ethylbenzene	0.00E+00	0.00E+00
G5	100414	Ethylbenzene	0.00E+00	0.00E+00

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Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
PTU	100414	Ethylbenzene	0.00E+00	0.00E+00
RMP	100414	Ethylbenzene	0.00E+00	0.00E+00
CT	1330207	Xylenes	1.90E+00	2.17E-04
FPUMP	1330207	Xylenes	0.00E+00	0.00E+00
G1	1330207	Xylenes	0.00E+00	0.00E+00
G2	1330207	Xylenes	0.00E+00	0.00E+00
G3	1330207	Xylenes	0.00E+00	0.00E+00
G4	1330207	Xylenes	0.00E+00	0.00E+00
G5	1330207	Xylenes	0.00E+00	0.00E+00
PTU	1330207	Xylenes	0.00E+00	0.00E+00
RMP	1330207	Xylenes	0.00E+00	0.00E+00
CT	7429905	Aluminum	1.80E-02	2.06E-06
FPUMP	7429905	Aluminum	0.00E+00	0.00E+00
G1	7429905	Aluminum	0.00E+00	0.00E+00
G2	7429905	Aluminum	0.00E+00	0.00E+00
G3	7429905	Aluminum	0.00E+00	0.00E+00
G4	7429905	Aluminum	0.00E+00	0.00E+00
G5	7429905	Aluminum	0.00E+00	0.00E+00
PTU	7429905	Aluminum	0.00E+00	0.00E+00
RMP	7429905	Aluminum	0.00E+00	0.00E+00
CT	7440360	Antimony	2.70E-03	3.08E-07
FPUMP	7440360	Antimony	0.00E+00	0.00E+00
G1	7440360	Antimony	0.00E+00	0.00E+00
G2	7440360	Antimony	0.00E+00	0.00E+00
G3	7440360	Antimony	0.00E+00	0.00E+00
G4	7440360	Antimony	0.00E+00	0.00E+00
G5	7440360	Antimony	0.00E+00	0.00E+00
PTU	7440360	Antimony	0.00E+00	0.00E+00
RMP	7440360	Antimony	0.00E+00	0.00E+00
CT	7440393	Barium	8.65E-02	9.87E-06
FPUMP	7440393	Barium	0.00E+00	0.00E+00
G1	7440393	Barium	0.00E+00	0.00E+00
G2	7440393	Barium	0.00E+00	0.00E+00
G3	7440393	Barium	0.00E+00	0.00E+00
G4	7440393	Barium	0.00E+00	0.00E+00
G5	7440393	Barium	0.00E+00	0.00E+00
PTU	7440393	Barium	0.00E+00	0.00E+00
RMP	7440393	Barium	0.00E+00	0.00E+00
CT	7440417	Beryllium	1.80E-04	2.06E-08
FPUMP	7440417	Beryllium	0.00E+00	0.00E+00
G1	7440417	Beryllium	0.00E+00	0.00E+00
G2	7440417	Beryllium	0.00E+00	0.00E+00
G3	7440417	Beryllium	0.00E+00	0.00E+00

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Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G4	7440417	Beryllium	0.00E+00	0.00E+00
G5	7440417	Beryllium	0.00E+00	0.00E+00
PTU	7440417	Beryllium	0.00E+00	0.00E+00
RMP	7440417	Beryllium	0.00E+00	0.00E+00
CT	7440439	Cadmium	5.40E-04	6.17E-08
FPUMP	7440439	Cadmium	0.00E+00	0.00E+00
G1	7440439	Cadmium	0.00E+00	0.00E+00
G2	7440439	Cadmium	0.00E+00	0.00E+00
G3	7440439	Cadmium	0.00E+00	0.00E+00
G4	7440439	Cadmium	0.00E+00	0.00E+00
G5	7440439	Cadmium	0.00E+00	0.00E+00
PTU	7440439	Cadmium	0.00E+00	0.00E+00
RMP	7440439	Cadmium	0.00E+00	0.00E+00
CT	7440473	Chromium	9.01E-04	1.03E-07
FPUMP	7440473	Chromium	0.00E+00	0.00E+00
G1	7440473	Chromium	0.00E+00	0.00E+00
G2	7440473	Chromium	0.00E+00	0.00E+00
G3	7440473	Chromium	0.00E+00	0.00E+00
G4	7440473	Chromium	0.00E+00	0.00E+00
G5	7440473	Chromium	0.00E+00	0.00E+00
PTU	7440473	Chromium	0.00E+00	0.00E+00
RMP	7440473	Chromium	0.00E+00	0.00E+00
CT	7440508	Copper	8.65E-03	9.87E-07
FPUMP	7440508	Copper	0.00E+00	0.00E+00
G1	7440508	Copper	0.00E+00	0.00E+00
G2	7440508	Copper	0.00E+00	0.00E+00
G3	7440508	Copper	0.00E+00	0.00E+00
G4	7440508	Copper	0.00E+00	0.00E+00
G5	7440508	Copper	0.00E+00	0.00E+00
PTU	7440508	Copper	0.00E+00	0.00E+00
RMP	7440508	Copper	0.00E+00	0.00E+00
CT	7439965	Manganese	8.29E-01	9.46E-05
FPUMP	7439965	Manganese	0.00E+00	0.00E+00
G1	7439965	Manganese	0.00E+00	0.00E+00
G2	7439965	Manganese	0.00E+00	0.00E+00
G3	7439965	Manganese	0.00E+00	0.00E+00
G4	7439965	Manganese	0.00E+00	0.00E+00
G5	7439965	Manganese	0.00E+00	0.00E+00
PTU	7439965	Manganese	0.00E+00	0.00E+00
RMP	7439965	Manganese	0.00E+00	0.00E+00
CT	7440020	Nickel	2.20E-03	2.51E-07
FPUMP	7440020	Nickel	0.00E+00	0.00E+00
G1	7440020	Nickel	0.00E+00	0.00E+00

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Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G2	7440020	Nickel	0.00E+00	0.00E+00
G3	7440020	Nickel	0.00E+00	0.00E+00
G4	7440020	Nickel	0.00E+00	0.00E+00
G5	7440020	Nickel	0.00E+00	0.00E+00
PTU	7440020	Nickel	0.00E+00	0.00E+00
RMP	7440020	Nickel	0.00E+00	0.00E+00
CT	7782492	Selenium	2.85E-02	3.25E-06
FPUMP	7782492	Selenium	0.00E+00	0.00E+00
G1	7782492	Selenium	0.00E+00	0.00E+00
G2	7782492	Selenium	0.00E+00	0.00E+00
G3	7782492	Selenium	0.00E+00	0.00E+00
G4	7782492	Selenium	0.00E+00	0.00E+00
G5	7782492	Selenium	0.00E+00	0.00E+00
PTU	7782492	Selenium	0.00E+00	0.00E+00
RMP	7782492	Selenium	0.00E+00	0.00E+00
CT	1175	Silica, Crystln	9.01E-01	1.03E-04
FPUMP	1175	Silica, Crystln	0.00E+00	0.00E+00
G1	1175	Silica, Crystln	0.00E+00	0.00E+00
G2	1175	Silica, Crystln	0.00E+00	0.00E+00
G3	1175	Silica, Crystln	0.00E+00	0.00E+00
G4	1175	Silica, Crystln	0.00E+00	0.00E+00
G5	1175	Silica, Crystln	0.00E+00	0.00E+00
PTU	1175	Silica, Crystln	0.00E+00	0.00E+00
RMP	1175	Silica, Crystln	0.00E+00	0.00E+00
CT	7440224	Silver	9.01E-04	1.03E-07
FPUMP	7440224	Silver	0.00E+00	0.00E+00
G1	7440224	Silver	0.00E+00	0.00E+00
G2	7440224	Silver	0.00E+00	0.00E+00
G3	7440224	Silver	0.00E+00	0.00E+00
G4	7440224	Silver	0.00E+00	0.00E+00
G5	7440224	Silver	0.00E+00	0.00E+00
PTU	7440224	Silver	0.00E+00	0.00E+00
RMP	7440224	Silver	0.00E+00	0.00E+00
CT	7440666	Zinc	5.13E-01	5.86E-05
FPUMP	7440666	Zinc	0.00E+00	0.00E+00
G1	7440666	Zinc	0.00E+00	0.00E+00
G2	7440666	Zinc	0.00E+00	0.00E+00
G3	7440666	Zinc	0.00E+00	0.00E+00
G4	7440666	Zinc	0.00E+00	0.00E+00
G5	7440666	Zinc	0.00E+00	0.00E+00
PTU	7440666	Zinc	0.00E+00	0.00E+00
RMP	7440666	Zinc	0.00E+00	0.00E+00
CT	9901	DieselExhPM	0.00E+00	0.00E+00

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Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
FPUMP	9901	DieselExhPM	2.86E+00	5.72E-02
G1	9901	DieselExhPM	8.93E+00	1.79E-01
G2	9901	DieselExhPM	1.15E+01	2.31E-01
G3	9901	DieselExhPM	1.15E+01	2.31E-01
G4	9901	DieselExhPM	1.15E+01	2.31E-01
G5	9901	DieselExhPM	1.15E+01	2.31E-01
PTU	9901	DieselExhPM	0.00E+00	0.00E+00
RMP	9901	DieselExhPM	0.00E+00	0.00E+00
CT	67663	Chloroform	0.00E+00	0.00E+00
FPUMP	67663	Chloroform	0.00E+00	0.00E+00
G1	67663	Chloroform	0.00E+00	0.00E+00
G2	67663	Chloroform	0.00E+00	0.00E+00
G3	67663	Chloroform	0.00E+00	0.00E+00
G4	67663	Chloroform	0.00E+00	0.00E+00
G5	67663	Chloroform	0.00E+00	0.00E+00
PTU	67663	Chloroform	0.00E+00	0.00E+00
RMP	67663	Chloroform	0.00E+00	0.00E+00
CT	50000	Formaldehyde	0.00E+00	0.00E+00
FPUMP	50000	Formaldehyde	0.00E+00	0.00E+00
G1	50000	Formaldehyde	0.00E+00	0.00E+00
G2	50000	Formaldehyde	0.00E+00	0.00E+00
G3	50000	Formaldehyde	0.00E+00	0.00E+00
G4	50000	Formaldehyde	0.00E+00	0.00E+00
G5	50000	Formaldehyde	0.00E+00	0.00E+00
PTU	50000	Formaldehyde	0.00E+00	0.00E+00
RMP	50000	Formaldehyde	0.00E+00	0.00E+00
CT	1150	PAHs-w/	0.00E+00	0.00E+00
FPUMP	1150	PAHs-w/	0.00E+00	0.00E+00
G1	1150	PAHs-w/	0.00E+00	0.00E+00
G2	1150	PAHs-w/	0.00E+00	0.00E+00
G3	1150	PAHs-w/	0.00E+00	0.00E+00
G4	1150	PAHs-w/	0.00E+00	0.00E+00
G5	1150	PAHs-w/	0.00E+00	0.00E+00
PTU	1150	PAHs-w/	0.00E+00	0.00E+00
RMP	1150	PAHs-w/	0.00E+00	0.00E+00
CT	91203	Naphthalene	0.00E+00	0.00E+00
FPUMP	91203	Naphthalene	0.00E+00	0.00E+00
G1	91203	Naphthalene	0.00E+00	0.00E+00
G2	91203	Naphthalene	0.00E+00	0.00E+00
G3	91203	Naphthalene	0.00E+00	0.00E+00
G4	91203	Naphthalene	0.00E+00	0.00E+00
G5	91203	Naphthalene	0.00E+00	0.00E+00
PTU	91203	Naphthalene	0.00E+00	0.00E+00

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Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
RMP	91203	Naphthalene	0.00E+00	0.00E+00
CT	75070	Acetaldehyde	0.00E+00	0.00E+00
FPUMP	75070	Acetaldehyde	0.00E+00	0.00E+00
G1	75070	Acetaldehyde	0.00E+00	0.00E+00
G2	75070	Acetaldehyde	0.00E+00	0.00E+00
G3	75070	Acetaldehyde	0.00E+00	0.00E+00
G4	75070	Acetaldehyde	0.00E+00	0.00E+00
G5	75070	Acetaldehyde	0.00E+00	0.00E+00
PTU	75070	Acetaldehyde	0.00E+00	0.00E+00
RMP	75070	Acetaldehyde	0.00E+00	0.00E+00
CT	107028	Acrolein	0.00E+00	0.00E+00
FPUMP	107028	Acrolein	0.00E+00	0.00E+00
G1	107028	Acrolein	0.00E+00	0.00E+00
G2	107028	Acrolein	0.00E+00	0.00E+00
G3	107028	Acrolein	0.00E+00	0.00E+00
G4	107028	Acrolein	0.00E+00	0.00E+00
G5	107028	Acrolein	0.00E+00	0.00E+00
PTU	107028	Acrolein	0.00E+00	0.00E+00
RMP	107028	Acrolein	0.00E+00	0.00E+00
CT	115071	Propylene	0.00E+00	0.00E+00
FPUMP	115071	Propylene	0.00E+00	0.00E+00
G1	115071	Propylene	0.00E+00	0.00E+00
G2	115071	Propylene	0.00E+00	0.00E+00
G3	115071	Propylene	0.00E+00	0.00E+00
G4	115071	Propylene	0.00E+00	0.00E+00
G5	115071	Propylene	0.00E+00	0.00E+00
PTU	115071	Propylene	0.00E+00	0.00E+00
RMP	115071	Propylene	0.00E+00	0.00E+00
CT	110543	Hexane	0.00E+00	0.00E+00
FPUMP	110543	Hexane	0.00E+00	0.00E+00
G1	110543	Hexane	0.00E+00	0.00E+00
G2	110543	Hexane	0.00E+00	0.00E+00
G3	110543	Hexane	0.00E+00	0.00E+00
G4	110543	Hexane	0.00E+00	0.00E+00
G5	110543	Hexane	0.00E+00	0.00E+00
PTU	110543	Hexane	0.00E+00	0.00E+00
RMP	110543	Hexane	0.00E+00	0.00E+00
CT	1166	Radon	8.14E-01	9.29E-05
FPUMP	1166	Radon	0.00E+00	0.00E+00
G1	1166	Radon	0.00E+00	0.00E+00
G2	1166	Radon	0.00E+00	0.00E+00
G3	1166	Radon	0.00E+00	0.00E+00
G4	1166	Radon	0.00E+00	0.00E+00

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Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G5	1166	Radon	0.00E+00	0.00E+00
PTU	1166	Radon	0.00E+00	0.00E+00
RMP	1166	Radon	0.00E+00	0.00E+00
CT	208968	Acenaphthylene	0.00E+00	0.00E+00
FPUMP	208968	Acenaphthylene	0.00E+00	0.00E+00
G1	208968	Acenaphthylene	0.00E+00	0.00E+00
G2	208968	Acenaphthylene	0.00E+00	0.00E+00
G3	208968	Acenaphthylene	0.00E+00	0.00E+00
G4	208968	Acenaphthylene	0.00E+00	0.00E+00
G5	208968	Acenaphthylene	0.00E+00	0.00E+00
PTU	208968	Acenaphthylene	0.00E+00	0.00E+00
RMP	208968	Acenaphthylene	0.00E+00	0.00E+00
CT	83329	Acenaphthene	0.00E+00	0.00E+00
FPUMP	83329	Acenaphthene	0.00E+00	0.00E+00
G1	83329	Acenaphthene	0.00E+00	0.00E+00
G2	83329	Acenaphthene	0.00E+00	0.00E+00
G3	83329	Acenaphthene	0.00E+00	0.00E+00
G4	83329	Acenaphthene	0.00E+00	0.00E+00
G5	83329	Acenaphthene	0.00E+00	0.00E+00
PTU	83329	Acenaphthene	0.00E+00	0.00E+00
RMP	83329	Acenaphthene	0.00E+00	0.00E+00
CT	86737	Fluorene	0.00E+00	0.00E+00
FPUMP	86737	Fluorene	0.00E+00	0.00E+00
G1	86737	Fluorene	0.00E+00	0.00E+00
G2	86737	Fluorene	0.00E+00	0.00E+00
G3	86737	Fluorene	0.00E+00	0.00E+00
G4	86737	Fluorene	0.00E+00	0.00E+00
G5	86737	Fluorene	0.00E+00	0.00E+00
PTU	86737	Fluorene	0.00E+00	0.00E+00
RMP	86737	Fluorene	0.00E+00	0.00E+00
CT	85018	Phenanthrene	0.00E+00	0.00E+00
FPUMP	85018	Phenanthrene	0.00E+00	0.00E+00
G1	85018	Phenanthrene	0.00E+00	0.00E+00
G2	85018	Phenanthrene	0.00E+00	0.00E+00
G3	85018	Phenanthrene	0.00E+00	0.00E+00
G4	85018	Phenanthrene	0.00E+00	0.00E+00
G5	85018	Phenanthrene	0.00E+00	0.00E+00
PTU	85018	Phenanthrene	0.00E+00	0.00E+00
RMP	85018	Phenanthrene	0.00E+00	0.00E+00
CT	120127	Anthracene	0.00E+00	0.00E+00
FPUMP	120127	Anthracene	0.00E+00	0.00E+00
G1	120127	Anthracene	0.00E+00	0.00E+00
G2	120127	Anthracene	0.00E+00	0.00E+00

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Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G3	120127	Anthracene	0.00E+00	0.00E+00
G4	120127	Anthracene	0.00E+00	0.00E+00
G5	120127	Anthracene	0.00E+00	0.00E+00
PTU	120127	Anthracene	0.00E+00	0.00E+00
RMP	120127	Anthracene	0.00E+00	0.00E+00
CT	206440	Fluoranthene	0.00E+00	0.00E+00
FPUMP	206440	Fluoranthene	0.00E+00	0.00E+00
G1	206440	Fluoranthene	0.00E+00	0.00E+00
G2	206440	Fluoranthene	0.00E+00	0.00E+00
G3	206440	Fluoranthene	0.00E+00	0.00E+00
G4	206440	Fluoranthene	0.00E+00	0.00E+00
G5	206440	Fluoranthene	0.00E+00	0.00E+00
PTU	206440	Fluoranthene	0.00E+00	0.00E+00
RMP	206440	Fluoranthene	0.00E+00	0.00E+00
CT	129000	Pyrene	0.00E+00	0.00E+00
FPUMP	129000	Pyrene	0.00E+00	0.00E+00
G1	129000	Pyrene	0.00E+00	0.00E+00
G2	129000	Pyrene	0.00E+00	0.00E+00
G3	129000	Pyrene	0.00E+00	0.00E+00
G4	129000	Pyrene	0.00E+00	0.00E+00
G5	129000	Pyrene	0.00E+00	0.00E+00
PTU	129000	Pyrene	0.00E+00	0.00E+00
RMP	129000	Pyrene	0.00E+00	0.00E+00
CT	56553	Benz[a]anthracene	0.00E+00	0.00E+00
FPUMP	56553	Benz[a]anthracene	0.00E+00	0.00E+00
G1	56553	Benz[a]anthracene	0.00E+00	0.00E+00
G2	56553	Benz[a]anthracene	0.00E+00	0.00E+00
G3	56553	Benz[a]anthracene	0.00E+00	0.00E+00
G4	56553	Benz[a]anthracene	0.00E+00	0.00E+00
G5	56553	Benz[a]anthracene	0.00E+00	0.00E+00
PTU	56553	Benz[a]anthracene	0.00E+00	0.00E+00
RMP	56553	Benz[a]anthracene	0.00E+00	0.00E+00
CT	218019	Chrysene	0.00E+00	0.00E+00
FPUMP	218019	Chrysene	0.00E+00	0.00E+00
G1	218019	Chrysene	0.00E+00	0.00E+00
G2	218019	Chrysene	0.00E+00	0.00E+00
G3	218019	Chrysene	0.00E+00	0.00E+00
G4	218019	Chrysene	0.00E+00	0.00E+00
G5	218019	Chrysene	0.00E+00	0.00E+00
PTU	218019	Chrysene	0.00E+00	0.00E+00
RMP	218019	Chrysene	0.00E+00	0.00E+00
CT	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
FPUMP	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00

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Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G1	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
G2	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
G3	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
G4	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
G5	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
PTU	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
RMP	205992	Benzo[b]fluoranthene	0.00E+00	0.00E+00
CT	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
FPUMP	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
G1	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
G2	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
G3	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
G4	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
G5	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
PTU	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
RMP	207089	Benzo[k]fluoranthene	0.00E+00	0.00E+00
CT	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
FPUMP	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
G1	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
G2	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
G3	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
G4	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
G5	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
PTU	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
RMP	50328	Benzo[a]pyrene	0.00E+00	0.00E+00
CT	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
FPUMP	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
G1	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
G2	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
G3	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
G4	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
G5	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
PTU	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
RMP	193395	In[1,2,3-cd]pyr	0.00E+00	0.00E+00
CT	53703	D[a,h]anthracen	0.00E+00	0.00E+00
FPUMP	53703	D[a,h]anthracen	0.00E+00	0.00E+00
G1	53703	D[a,h]anthracen	0.00E+00	0.00E+00
G2	53703	D[a,h]anthracen	0.00E+00	0.00E+00
G3	53703	D[a,h]anthracen	0.00E+00	0.00E+00
G4	53703	D[a,h]anthracen	0.00E+00	0.00E+00
G5	53703	D[a,h]anthracen	0.00E+00	0.00E+00
PTU	53703	D[a,h]anthracen	0.00E+00	0.00E+00
RMP	53703	D[a,h]anthracen	0.00E+00	0.00E+00

Morton Bay Geothermal Project

Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

April 2023

Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
CT	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
FPUMP	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
G1	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
G2	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
G3	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
G4	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
G5	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
PTU	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
RMP	191242	B[g,h,i]perylen	0.00E+00	0.00E+00
CT	7783064	H2S	0.00E+00	0.00E+00
FPUMP	7783064	H2S	0.00E+00	0.00E+00
G1	7783064	H2S	0.00E+00	0.00E+00
G2	7783064	H2S	0.00E+00	0.00E+00
G3	7783064	H2S	0.00E+00	0.00E+00
G4	7783064	H2S	0.00E+00	0.00E+00
G5	7783064	H2S	0.00E+00	0.00E+00
PTU	7783064	H2S	0.00E+00	0.00E+00
RMP	7783064	H2S	0.00E+00	0.00E+00
CT	7664417	NH3	7.47E+04	8.53E+00
FPUMP	7664417	NH3	0.00E+00	0.00E+00
G1	7664417	NH3	1.39E+01	2.77E-01
G2	7664417	NH3	1.69E+01	3.37E-01
G3	7664417	NH3	1.69E+01	3.37E-01
G4	7664417	NH3	1.69E+01	3.37E-01
G5	7664417	NH3	1.69E+01	3.37E-01
PTU	7664417	NH3	0.00E+00	0.00E+00
RMP	7664417	NH3	0.00E+00	0.00E+00
CT	124389	CO2	9.54E+06	1.09E+03
FPUMP	124389	CO2	0.00E+00	0.00E+00
G1	124389	CO2	0.00E+00	0.00E+00
G2	124389	CO2	0.00E+00	0.00E+00
G3	124389	CO2	0.00E+00	0.00E+00
G4	124389	CO2	0.00E+00	0.00E+00
G5	124389	CO2	0.00E+00	0.00E+00
PTU	124389	CO2	0.00E+00	0.00E+00
RMP	124389	CO2	0.00E+00	0.00E+00
CT	74828	CH4	2.39E+04	2.72E+00
FPUMP	74828	CH4	0.00E+00	0.00E+00
G1	74828	CH4	0.00E+00	0.00E+00
G2	74828	CH4	0.00E+00	0.00E+00
G3	74828	CH4	0.00E+00	0.00E+00
G4	74828	CH4	0.00E+00	0.00E+00
G5	74828	CH4	0.00E+00	0.00E+00

Morton Bay Geothermal Project

Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

April 2023

Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
PTU	74828	CH4	0.00E+00	0.00E+00
RMP	74828	CH4	0.00E+00	0.00E+00
CT	10024972	Nitrous Oxide	0.00E+00	0.00E+00
FPUMP	10024972	Nitrous Oxide	0.00E+00	0.00E+00
G1	10024972	Nitrous Oxide	0.00E+00	0.00E+00
G2	10024972	Nitrous Oxide	0.00E+00	0.00E+00
G3	10024972	Nitrous Oxide	0.00E+00	0.00E+00
G4	10024972	Nitrous Oxide	0.00E+00	0.00E+00
G5	10024972	Nitrous Oxide	0.00E+00	0.00E+00
PTU	10024972	Nitrous Oxide	0.00E+00	0.00E+00
RMP	10024972	Nitrous Oxide	0.00E+00	0.00E+00
CT	7440382	Arsenic	1.70E-01	1.93E-05
FPUMP	7440382	Arsenic	0.00E+00	0.00E+00
G1	7440382	Arsenic	0.00E+00	0.00E+00
G2	7440382	Arsenic	0.00E+00	0.00E+00
G3	7440382	Arsenic	0.00E+00	0.00E+00
G4	7440382	Arsenic	0.00E+00	0.00E+00
G5	7440382	Arsenic	0.00E+00	0.00E+00
PTU	7440382	Arsenic	0.00E+00	0.00E+00
RMP	7440382	Arsenic	0.00E+00	0.00E+00
CT	106990	1,3-Butadiene	0.00E+00	0.00E+00
FPUMP	106990	1,3-Butadiene	0.00E+00	0.00E+00
G1	106990	1,3-Butadiene	0.00E+00	0.00E+00
G2	106990	1,3-Butadiene	0.00E+00	0.00E+00
G3	106990	1,3-Butadiene	0.00E+00	0.00E+00
G4	106990	1,3-Butadiene	0.00E+00	0.00E+00
G5	106990	1,3-Butadiene	0.00E+00	0.00E+00
PTU	106990	1,3-Butadiene	0.00E+00	0.00E+00
RMP	106990	1,3-Butadiene	0.00E+00	0.00E+00
CT	7440484	Cobalt	1.80E-04	2.06E-08
FPUMP	7440484	Cobalt	0.00E+00	0.00E+00
G1	7440484	Cobalt	0.00E+00	0.00E+00
G2	7440484	Cobalt	0.00E+00	0.00E+00
G3	7440484	Cobalt	0.00E+00	0.00E+00
G4	7440484	Cobalt	0.00E+00	0.00E+00
G5	7440484	Cobalt	0.00E+00	0.00E+00
PTU	7440484	Cobalt	0.00E+00	0.00E+00
RMP	7440484	Cobalt	0.00E+00	0.00E+00
CT	7440622	Vanadium (fume or dust)	9.01E-04	1.03E-07
FPUMP	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
G1	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
G2	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
G3	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00

Morton Bay Geothermal Project

Morton Bay Operational Health Risk Assessment

Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

April 2023

Morton Bay Operational Modeled Source Emission Rates: Routine Operating Year Without Startups and Shutdowns

Source ID [a]	CAS Number	Pollutant Name	Annual Emissions (lbs/yr) [b, c]	Hourly Emissions (lbs/hr) [b, c]
G4	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
G5	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
PTU	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00
RMP	7440622	Vanadium (fume or dust)	0.00E+00	0.00E+00

[a] The CT source group includes emissions associated with a single cooling tower cell.

[b] Radon emissions are presented in units of curies per time period. These emission do not match and are higher than those presented in Appendix 5.1A based upon final Applicant requested reivsions. The associated health risk modeling was not updated as radon does not have any health risk related values in the HARP2 database and does impact results presented in Section 5.9.

[c] CARB/OEHHA-developed health risk assessment criteria for DPM includes risks and estimates of all speciated emissions. Therefore, only DPM is modeled from diesel combustion sources including the emergency generators and fire water pump.

lbs/yr = pound(s) per year

lbs/hr = pound(s) per hour

Morton Bay Geothermal Project

Morton Bay

Operational Health Risk Assessment

Health Risk Assessment Results

April 2023

Morton Bay Operational Health Risk Assessment Results

Risk Type	Risk Analysis [a]	Receptor #	Easting [b]	Northing [b]	Risk [c]	Thresholds [d]
Facility Wide Impacts: Routine Operating Year with Startups and Shutdowns						
Cancer	PMI	51	632,334.06	3,674,763.22	14.66	--
	MEIR	5,634	637,938.41	3,674,194.07	0.46	10.00
	MEIW	51	632,334.06	3,674,763.22	0.65	10.00
	Maximally Exposed Sensitive Receptor	5,634	637,938.41	3,674,194.07	0.46	10.00
Non-Cancer Chronic	PMI	51	632,334.06	3,674,763.22	0.87	--
	MEIR	5,634	637,938.41	3,674,194.07	0.02	1.00
	MEIW	51	632,334.06	3,674,763.22	0.87	1.00
	Maximally Exposed Sensitive Receptor	5,634	637,938.41	3,674,194.07	0.02	1.00
Non-Cancer Acute	PMI	2,664	631,550.00	3,675,300.00	0.44	--
	MEIR	5,631	629,310.70	3,674,439.02	0.15	1.00
	MEIW	2,664	631,550.00	3,675,300.00	0.44	1.00
	Maximally Exposed Sensitive Receptor	5,631	629,310.70	3,674,439.02	0.15	1.00
Facility Wide Impacts: Routine Operating Year without Startups and Shutdowns						
Cancer	PMI	51	632,334.06	3,674,763.22	16.44	--
	MEIR	5,634	637,938.41	3,674,194.07	0.47	10.00
	MEIW	51	632,334.06	3,674,763.22	0.73	10.00
	Maximally Exposed Sensitive Receptor	5,634	637,938.41	3,674,194.07	0.47	10.00
Non-Cancer Chronic	PMI	51	632,334.06	3,674,763.22	0.97	--
	MEIR	5,634	637,938.41	3,674,194.07	0.02	1.00
	MEIW	51	632,334.06	3,674,763.22	0.97	1.00
	Maximally Exposed Sensitive Receptor	5,634	637,938.41	3,674,194.07	0.02	1.00
Non-Cancer Acute	PMI	2,664	631,550.00	3,675,300.00	0.44	--
	MEIR	5,631	629,310.70	3,674,439.02	0.15	1.00
	MEIW	2,664	631,550.00	3,675,300.00	0.44	1.00
	Maximally Exposed Sensitive Receptor	5,631	629,310.70	3,674,439.02	0.15	1.00

[a] There are no nearby sensitive receptors so the Project conservatively assumes all nearby residences are potential sensitive receptors. For all non-cancer MEIW locations, the MEIW is assumed equal to the PMI.

[b] Coordinates presented are UTM NAD 83 Zone 11, meters

[c] Health risk results presented in incidences per million for cancer risks and hazard indices (HI) for non-cancer chronic and acute risks.

[d] Thresholds presented in incidences per million for cancer risks and HI for non-cancer chronic and acute risks. In the absence of ICAPCD thresholds, facility total risk results are compared to the SCAQMD's CEQA significance thresholds.

Note: "-- = Not applicable per discussion in Section 5.9.

Appendix 5.9B
Construction Health Risk Assessment

Morton Bay Geothermal Project

Morton Bay Construction

Health Risk Assessment

Health Risk Assessment Results - Cancer

April 2023

Modeled Concentrations

Maximum annual impact of annualized project emissions

PMI	0.09058	μg/m^3	Diesel PM
MEIR	0.00323	μg/m^3	Diesel PM
Sensitive	0.00323	μg/m^3	Diesel PM
MEIW	0.09058	μg/m^3	Diesel PM

Construction HRA per the 2015 OEHHA Guidance

Residential Calculation Procedure for Cancer Risks

PMI

Year	0 (3rd tri)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Dose (mg/kg/day)	3.14E-05	9.48E-05	9.48E-05	7.49E-05	7.49E-05	7.49E-05	7.49E-05	7.49E-05	7.49E-05	6.48E-05	6.48E-05	6.48E-05	6.48E-05	6.48E-05	6.48E-05	6.48E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05	2.91E-05
Risk	1.05E-06	1.27E-05	1.27E-05	2.54E-06	2.54E-06	2.54E-06	2.54E-06	2.54E-06	2.54E-06	2.20E-06	2.20E-06	2.20E-06	2.20E-06	2.20E-06	2.20E-06	2.20E-06	3.34E-07	3.34E-07	3.34E-07	3.34E-07	3.34E-07	3.34E-07	3.34E-07	3.34E-07	3.34E-07	3.34E-07	3.34E-07	3.34E-07	3.34E-07	3.34E-07	3.34E-07
Rolling 3-yr Risk [a]				2.89E-05	1.77E-05	7.62E-06	7.62E-06	7.62E-06	7.62E-06	7.28E-06	6.94E-06	6.60E-06	6.60E-06	6.60E-06	6.60E-06	6.60E-06	4.73E-06	2.87E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
Risk per Million				28.91	17.74	7.62	7.62	7.62	7.62	7.28	6.94	6.60	6.60	6.60	6.60	6.60	4.73	2.87	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

MEIR

Year	0 (3rd tri)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Dose (mg/kg/day)	1.12E-06	3.38E-06	3.38E-06	2.67E-06	2.67E-06	2.67E-06	2.67E-06	2.67E-06	2.67E-06	2.31E-06	2.31E-06	2.31E-06	2.31E-06	2.31E-06	2.31E-06	2.31E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06
Risk	3.74E-08	4.51E-07	4.51E-07	9.06E-08	9.06E-08	9.06E-08	9.06E-08	9.06E-08	9.06E-08	7.84E-08	7.84E-08	7.84E-08	7.84E-08	7.84E-08	7.84E-08	7.84E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08
Rolling 3-yr Risk [a]				1.03E-06	6.33E-07	2.72E-07	2.72E-07	2.72E-07	2.72E-07	2.60E-07	2.47E-07	2.35E-07	2.35E-07	2.35E-07	2.35E-07	2.35E-07	1.69E-07	1.02E-07	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08
Risk per Million				1.03	0.63	0.27	0.27	0.27	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.24	0.17	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04

MESR

Year	0 (3rd tri)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Dose (mg/kg/day)	1.12E-06	3.38E-06	3.38E-06	2.67E-06	2.67E-06	2.67E-06	2.67E-06	2.67E-06	2.67E-06	2.31E-06	2.31E-06	2.31E-06	2.31E-06	2.31E-06	2.31E-06	2.31E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06	1.04E-06
Risk	3.74E-08	4.51E-07	4.51E-07	9.06E-08	9.06E-08	9.06E-08	9.06E-08	9.06E-08	9.06E-08	7.84E-08	7.84E-08	7.84E-08	7.84E-08	7.84E-08	7.84E-08	7.84E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08	1.19E-08
Rolling 3-yr Risk [a]				1.03E-06	6.33E-07	2.72E-07	2.72E-07	2.72E-07	2.72E-07	2.60E-07	2.47E-07	2.35E-07	2.35E-07	2.35E-07	2.35E-07	2.35E-07	1.69E-07	1.02E-07	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08	3.57E-08
Risk per Million				1.03	0.63	0.27	0.27	0.27	0.27	0.26	0.25	0.24	0.24	0.24	0.24	0.24	0.17	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04

Worker Calculation Procedure for Cancer Risks

MEIW

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Dose (mg/kg/day)	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05	1.42E-05
Risk	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07	2.23E-07
Rolling 3-yr Risk [a]			6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07	6.68E-07
Risk per Million			0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67	0.67

Note:

[a] Cancer risk was summed on a 3-year rolling basis to conservatively mirror the 29-month duration of Project construction.

Morton Bay Geothermal Project Construction
Health Risk Assessment Health Risk Assessment
Results - Chronic
April 2023

Construction HRA per the 2015 OEHHA Guidance
Calculation Procedure for Chronic Hazard Index

Receptor Type	Pollutant	Maximum Annual Modeled Concentration (µg/m^3) [a]	REL (µg/m^3) [b]	Chronic Hazard Index
PMI	Diesel PM	0.091	5.00	0.02
MEIR	Diesel PM	0.003	5.00	0.0006
MESR	Diesel PM	0.003	5.00	0.0006
MEIW	Diesel PM	0.091	5.00	0.02

Notes:
[a] Maximum Annual Modeled Concentrations taken from Appendix 5.9B, Modeled Concentrations Table.
[b] REL taken from the *Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values* (CARB 2022a).

Morton Bay Geothermal Project

Morton Bay Construction Health Risk Assessment

Health Risk Assessment Residential Cancer Risk Methodology

April 2023

Dose Constants

Year	0 (3rd tri)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
BR/BW	361	1,090	1,090	861	861	861	861	861	861	745	745	745	745	745	745	745	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335
A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
EF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Conversion	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06

Risk Constants

Year	0 (3rd tri)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
CPF (Diesel PM)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
ASF	10.0	10.0	10.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ED	0.25	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
AT	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
FAH	0.85	0.85	0.85	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73

Morton Bay Geothermal Project

Morton Bay Construction Health Risk Assessment
Health Risk Assessment Worker Cancer Risk Methodology
April 2023

Dose Constants

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
WAF [a]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BR/BW	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0	230.0
A	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
EF	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Conversion	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06

Risk Constants

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
CPF (Diesel PM)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
ASF	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
ED	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
AT	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70

Note:
[a] Conservatively assumes construction activities occur 24 hours per day, 7 days per week.