TECHNICAL FACT SHEET

March 27, 2024

Purpose and Summary

The Michigan Department of Environment, Great Lakes, and Energy (EGLE), Air Quality Division (AQD), is proposing to act on Permit to Install (PTI) application No. APP-2023-0209 from Lansing Board of Water & Light (LBWL). The permit application is for the proposed installation and operation of a new reciprocating internal combustion engine (RICE) plant consisting of six natural gas-fired engines and other miscellaneous equipment. The proposed project is subject to permitting requirements of the Department's Rules for Air Pollution Control and the State and federal Prevention of Significant Deterioration (PSD) regulations. Before acting on this application, the AQD is holding a public comment period and a virtual public hearing, if requested in writing, to allow all interested parties the opportunity to comment on the proposed PTI. All relevant information received during the comment period and virtual hearing, if held, will be considered by the decision maker before taking final action on the application.

Background Information

The existing LBWL Erickson Power Station is located at 3725 South Canal Road, Lansing, Michigan. The company operates the Erickson Station and the Delta Energy Park at the same location under Renewable Operating Permit (ROP) No. MI-ROP-B4001-2024. The coal-fired boiler associated with the Erickson Station was decommissioned and permanently shut down in November 2022. The Delta Energy Park currently operates as a natural gas-fired combustion turbine power plant used to provide power to the electric grid for Lansing and the surrounding communities.

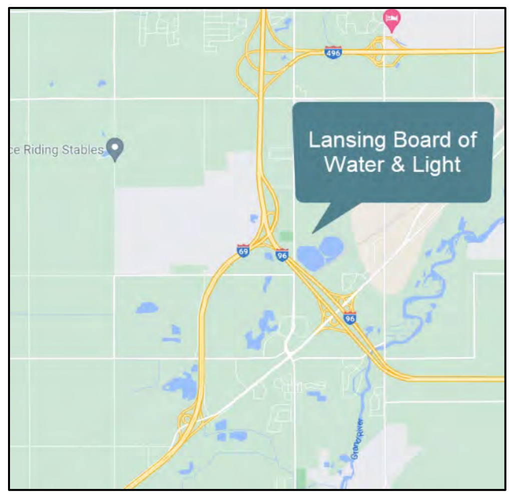


Figure 1: Location of Lansing Board of Water & Light

Proposed Facility and Present Air Quality

LBWL is proposing to install the following equipment at the Erickson Power Station:

- Six natural gas-fired RICE to produce electrical power, each with a horsepower (hp) rating of 29,147 hp.
- Two diesel-fired emergency engines. One will be used to power a generator, and one will be used to power a fire pump.
- One dew point heater to be used to warm the natural gas to prevent moisture from entering the equipment.
- Various natural gas-fired space heaters to be used for comfort heating.

Appendix 1 below shows the proposed site plan for the RICE plant.

The facility is in Eaton County, which is currently in attainment with the National Ambient Air Quality Standards (NAAQS) for all pollutants. The NAAQS establishes standards for several pollutants and are designed to protect public health, including the health of sensitive populations. The pollutants include particulate matter less than or equal to 10 microns in diameter (PM10), particulate matter less than or equal to 2.5 microns in diameter (PM2.5), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone, and lead.

Pollutant Emissions

LBWL is requesting to install the new equipment at a facility that is currently classified as an existing major source under the PSD regulations. Any modification at a PSD major source where the emissions of a regulated pollutant increase by more than the Significant Emission Rate (SER) results in the modification being subject to the PSD regulations for that pollutant. Emissions from the proposed RICE plant will be above the SER for several regulated pollutants; therefore, the project is subject to the PSD Regulations in Part 18 of the Michigan Air Pollution Control Rules and 40 CFR 52.21.

The following table provides the estimated emissions for each criteria pollutant:

Table 1: Project Potential Emissions Summary

Pollutant	Estimated Emissions Increase, tons per year (tpy)	PSD Significant Emission Rate, tons per year (tpy)	Subject to PSD?
NO_x	853	40	**Yes**
CO	513	100	**Yes**
Particulate Matter (PM)	56	25	**Yes**
PM10	112	15	**Yes**
PM2.5	112	10	**Yes**
SO_2	13	40	No
Lead	3.2×10^{-5}	0.6	No
Volatile Organic Compounds (VOCs)	538	40	**Yes**
Sulfuric acid mist (H_2SO_4)	3	7	No
Greenhouse gases (GHGs) as carbon dioxide equivalents (CO_2e)	549,536	100,000	**Yes**

The proposed RICE units are intended to be operated to support intermittent renewable power systems and will be required to start up and shut down depending on demand requirements. There is the potential for NO_x and CO emissions to temporarily increase during startup and shutdown. To calculate emissions from the proposed RICE plant, LBWL divided startups into three categories:

- Hot Start: RICE has been shut down for less than 6 hours
- Warm Start: RICE has been shut down for more than 6 hours but less than 48 hours
- Cold Start: RICE has been shut down for more than 48 hours.

Potential emissions associated with startup and shutdown of the RICE were calculated using vendor-supplied information. In all startup scenarios (hot, warm, and cold starts), NO_x and CO emissions are "self-correcting" on an annual basis. Self-correcting means that the emissions for each startup and shutdown sequence, incorporating the minimum downtime required to define each type of startup, are less than the corresponding steady-state emission rate on an annual basis. This means that steady-state operations are the worst-case scenario on an annual basis. PM/PM10/PM2.5 and SO_2 emissions are the result of fuel consumption, and since fuel consumption during startup and shutdown is less than at full load steady-state operations, these pollutants are also self-correcting for all types of startups.

Key Permit Review Issues

Staff evaluated the proposed project to identify all state rules and federal regulations which are, or may be, applicable. The tables in Appendix 2 summarize these rules and regulations.

- **Minor/Major Modification Determination for Attainment Pollutants**
  The facility is an existing PSD major stationary source. A modification at the facility where the emissions of any regulated pollutant will increase by more than the SER for that pollutant results in the modification being subject to PSD requirements for that pollutant. LBWL is located in Eaton County which is currently in attainment for all regulated pollutants. The proposed project is subject to PSD for NO_x, CO, PM, PM10, PM2.5, VOCs, and GHGs because the emission increase for each regulated pollutant is more than the SER for that pollutant. See Table 1 above for a summary of the proposed emissions of each regulated pollutant. Review under the PSD regulations requires Best Available Control Technology (BACT), a source impact analysis, an air quality impact analysis, and an additional impact analysis for each regulated air pollutant for which the project will result in significant emissions.

- **Federal NSPS Regulations**
  New Source Performance Standards (NSPS) were established under Title 40 of the Code of Federal Regulations (40 CFR) Part 60. The six natural gas-fired RICE are subject to NSPS Subpart JJJJ for Stationary Spark Ignition Internal Combustion Engines. Additionally, the two diesel-fired emergency engines are subject to NSPS Subpart IIII for Stationary Compression Ignition Internal Combustion Engines.

- **Federal NESHAP Regulations**
  National Emission Standards for Hazardous Air Pollutants (NESHAP) were established under 40 CFR Part 61 or Part 63. The proposed natural gas and diesel fired RICE are all subject to the NESHAP for Stationary Reciprocating Internal Combustion Engines, 40 CFR Part 63 Subpart ZZZZ.

- **Rule 224 TBACT Analysis**
  Rule 224 requires Best Available Control Technology for toxic air contaminants (TAC) (T-BACT). Per Rule 224, VOC and particulate TACs that are subject to BACT requirements are not subject to T-BACT. Additionally, T-BACT does not apply to any process subject to a federal NESHAP. The proposed RICE are subject to NESHAP Subpart ZZZZ and are not subject to T-BACT; all other equipment underwent a top-down BACT analysis for particulate and volatile TACs, and the only TACs that are subject to T-BACT for this project are ammonia and sulfuric acid.

  Ammonia emissions will occur as a result of the installation and utilization of selective catalytic reduction (SCR) to control NO_x emissions from the six RICE units. Ammonia is injected into the exhaust gas stream and reacts with NO_x in the presence of a catalyst; however, injection of too much ammonia (or urea, which breaks down into ammonia) results in ammonia slip, which is when unreacted ammonia exhausts to the atmosphere. It can also emit through damaged seals within the SCR reactor. T-BACT for reduction of ammonia slip is an efficiently designed and managed SCR system via work practice standards.

Sulfuric acid is formed as a result of the reaction of sulfur trioxide with water, either in the exhaust gas stream or in the atmosphere after discharge. Control technologies used to control sulfur compounds will also control sulfuric acid. However, control is not feasible or effective on natural gas or diesel units due to the low levels of sulfur in the fuel and exhaust gas. The use of natural gas and ultra-low sulfur diesel reduces sulfuric acid emissions and is considered T-BACT for the process.

- **Rule 225 Toxics Analysis**
  Rule 225 requires the emission of individual TACs to be compared against their respective health-based screening levels. These screening levels are defined as concentrations measured in micrograms per cubic meter ($\mu g/m^3$) and include both short-term (1-hour, 8-hour, 24-hour) and long-term (annual) averaging times. AQD staff reviewed LBWL's TAC analysis, including air quality modeling, for all TACs proposed to be emitted. The review found that all TACs show impacts below their respective screening levels and will comply with the requirements of Rule 225. Other than formaldehyde, no other modeled TAC had impacts greater than 30% of its respective screening level.

  Formaldehyde required the use of the Secondary Risk Screening Level (SRSL) to meet its screening levels. When reviewing the SRSL, emissions from the entire facility must be included in the dispersion modeling analysis. When emissions from the entire facility (including the existing Delta Energy Park natural gas-fired combustion turbine power plant) were included, formaldehyde impacts passed at 63% of the SRSL. Per AQD guidance, any TAC that requires the use of the SRSL to meet its health-based standards generally requires an emission limit. Based on the results of the TAC analysis, an emission limit for formaldehyde was included for the natural gas-fired RICE.

- **Rule 702 VOC Emissions**
  Rule 702 requires an evaluation of the following four items to determine what will result in the lowest maximum allowable emission rate of VOCs:

  a) BACT or a limit listed by the department on its own initiative
  b) New Source Performance Standards
  c) VOC emission rate specified in another permit
  d) VOC emission rate specified in the Part 6 rules for existing sources

  VOC emissions are also subject to PSD review for this project. In this case, a top-down BACT analysis was performed under the PSD regulations for all emission units that have the potential to emit VOCs. The six RICE units will be equipped with an oxidation catalyst to control VOC emissions. A more detailed explanation of the PSD BACT review can be found below in Appendix 3 of this document. The PSD BACT determinations satisfy the Rule 702 BACT requirements per Rule 702(a).

  The diesel-fired emergency engines will have emission limits for NO_x and non-methane hydrocarbons (NMHC) as a requirement to comply with NSPS Subpart IIII. The NSPS value coincides with VOC BACT for the emergency engines.

- **Criteria Pollutants Modeling Analysis**

Air dispersion modeling was performed to evaluate the potential impacts of NO_x (as nitrogen dioxide, NO_2), CO, PM10, and PM2.5. Emissions from the facility were compared to both the NAAQS and the PSD Increment. The NAAQS were established to protect public health, while the PSD Increment allows for industrial growth in an area while ensuring the area will continue to meet the NAAQS.

To determine predicted impacts, the modeling reviewed the worst-case impacts for each averaging time for each criteria pollutant. For the natural gas-fired RICE, this includes the worst-case startup and shutdown scenario for NO_x and CO. For the emergency engines, worst-case impacts are based on the United States Environmental Protection Agency (USEPA) restriction of 500 hours of operation per year, with no restriction on short-term usage.

After the predicted impacts from the proposed project have been determined, they are first compared to the respective Significant Impact Limits (SILs). If the predicted impacts from the project are less than the SIL, no further modeling analysis is required. Table 2 below lists the maximum predicted impacts for NO_x, CO, PM10, and PM2.5, along with their respective SILs for each averaging time.

Table 2: Significant Impact Levels (SIL)

Pollutant	Averaging Period	SIL (µg/m³)	Total Maximum Impact (µg/m³)	Below SIL?
NO_2	1-Hour	7.5	115.73	**No**
	Annual	1	4.91	**No**
CO	1-Hour	2,000	567.67	Yes
	8-Hour	500	340.35	Yes
PM10	24-Hour	5	8.25	**No**
	Annual	1	0.83	Yes
PM2.5	24-Hour	1.2	6.79	**No**
	Annual	0.2	0.75	**No**

CO (1-hour and 8-hour) and PM10 (annual) emissions meet their respective SILs and do not require additional modeling. All other pollutants have emissions exceeding the SILs and required additional modeling to compare to the respective NAAQS and PSD Increments. Unlike the SIL, the NAAQS and PSD Increment analyses includes emissions from the entire facility, as well as emissions from offsite sources. Tables 3 and 4 show the results of the potential impacts compared to the NAAQS and PSD Increment as a percentage. If modeling results show any percentage is over 100, the pollutant would not be considered to have met the thresholds. For this proposed project, all potential impacts for each pollutant will meet both the NAAQS and PSD Increment thresholds.

Table 3: PSD Increment Modeling Impacts

Pollutant	Averaging Period	PSD Increment (µg/m³)	Total Maximum Impact (µg/m³)	Percent of PSD Increment (%)	PSD Increment Met
NO_2	Annual	25	10.93	43.7%	Yes
PM10	24-Hour	30	8.80	29.3%	Yes
	Annual	17	1.20	7.1%	Yes
PM2.5	24-Hour	9	8.91	99.0%	Yes
	Annual	4	1.20	30.1%	Yes

Table 4: NAAQS Modeling Impacts

Pollutant	Averaging Time	NAAQS ($\mu g/m^3$)	Predicted Impact ($\mu g/m^3$)	Percent of NAAQS (%)	NAAQS Met
NO_2	1-Hour	188	183.55	97.6%	Yes
	Annual	100	23.18	23.2%	Yes
PM10	24-Hour	150	44.98	30.0%	Yes
PM2.5	24-Hour	35	25.79	73.7%	Yes
	Annual	9	8.47	94.1%	Yes

A secondary formation assessment of PM2.5 and ozone were performed as required by the USEPA for PSD applications. Secondary formation of PM2.5 and ozone can occur from emissions of SO_2, NO_x, and VOC as these criteria pollutants are considered precursors. The secondary analysis followed the methodology presented in the USEPA's Guidance for Ozone and Fine Particulate Matter Permit Modeling (7/29/22) and Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program (April 30, 2019). The Tier 1 methodology used in this assessment added the calculated secondary PM2.5 impact caused by emissions of SO_2 and NO_x to the primary PM2.5 PSD and NAAQS modeled impacts. This ensures the combination of primary and secondary impacts still meet the PSD and NAAQS impacts of PM2.5, shown in Tables 3 and 4 above.

There is an 8-hour NAAQS for ozone, but no PSD Increment. Ground-level ozone concentrations are the result of photochemical reactions among various chemical species. The chemical species that contribute to ozone formation, referred to as ozone precursors, include NO_x and VOC emissions from both anthropogenic (e.g., mobile and stationary sources) and natural sources (e.g., vegetation). The facility will emit NO_x at levels greater than 40 tpy, thus triggering the ozone ambient impact analysis requirements of Michigan Air Pollution Control Rule R 336.2809 and 40 CFR 51.166.

The secondary formation of ozone, or conversion of the precursors, is not instantaneous; it happens over time and is highly dependent upon weather conditions. Therefore, the conversion is often completed after the precursors have been dispersed away from the immediate area. Ozone formation is recognized as a long-range transport issue. As a result, there is no effective modeling method for ozone for single sources: the ozone modeling programs address larger areas of land and air movements and therefore must include many sources.

To address if a project may cause or contribute to a violation of the ozone NAAQS, the ozone precursors, NO_x and VOC are evaluated. LBWL followed guidance defined in the USEPA guidelines on Air Quality Models for addressing single source impacts of secondary pollutants. Specifically, LBWL used the methodology provided in the USEPA guidance memo, Guidance for Ozone and Fine Particulate Matter Permit Modeling (7/29/22) and Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program (April 30, 2019), to determine the secondary pollutant impact resulting from their proposed project. The secondary ozone impact, resulting from the proposed project, was 1.76 parts per billion (ppb) which was added to the area ozone Design Value. The summed impact was less than the 70 ppb 8-hour NAAQS standard and is therefore not expected to cause or contribute to any violation of the ozone standard.

The USEPA guidance also requires permit applicants to perform modeling for primary emissions of PM2.5, include ambient background concentrations, and add calculated contributions from precursor emissions to demonstrate NAAQS compliance. As a measure of conservatism, LBWL performed a modeling analysis assuming primary PM2.5 emissions would occur at the same time and place as secondary PM2.5; in reality, secondary PM2.5 emissions are formed downwind from the source. With the secondary PM2.5 emissions included in the analysis, impacts from the proposed project are able to meet both the NAAQS and PSD Increment standards (see Tables 3 and 4 above).

Preconstruction monitoring is required for at least one year for each criteria pollutant proposed to be emitted that triggers PSD review. Through guidance, the USEPA allows the use of existing regional data, if representative, as an alternative to the preconstruction monitoring. LBWL requested to use existing data and to receive a waiver from preconstruction monitoring. The AQD determined that the data is representative and granted the waiver request.

- **Additional Impact Analysis**
  An additional impact analysis is required for new or modified PSD major sources pursuant to 40 CFR 52.21(o) and Michigan Air Pollution Control Rule 336.2815. This analysis is necessary to evaluate the impacts of the proposed project on soils, vegetation, visibility, and growth. LBWL's proposed project is not anticipated to have a negative impact on soils, vegetation, wildlife, or visibility. Additionally, the project is anticipated to have a minimal impact on growth.

Soils, Vegetation, and Wildlife
The secondary NAAQS have been determined by the USEPA to be protective of soils, vegetation, and wildlife. LBWL performed dispersion modeling to compare potential impacts to the secondary NAAQS. All PSD pollutants with secondary NAAQS were able to meet their respective standards. Although VOCs do not have a specific secondary NAAQS, LBWL performed a secondary ozone analysis and determined that the proposed project will not cause or contribute to a violation of the NAAQS ozone standard, and the AQD confirmed their results. Therefore, potential emissions are not anticipated to have a negative impact on soils, vegetation, or wildlife.

Visibility
Assessments for visibility impacts are required only for Class I areas. The nearest Class I area is in Seney, Michigan, which is located approximately 400 kilometers away from LBWL. The source is sufficiently far away that USEPA does not require further analysis as no impairment to visibility in the Class I area is expected to occur.

Growth
The growth analysis is a projection of the commercial, residential, industrial, and other growth that will occur in the area due to the construction and operation of the proposed source. Construction will lead to a temporary increase in employment, but this will likely come from area residents. Additionally, permanent employment at the facility is projected to be very small. Therefore, the proposed project is expected to have a minimal impact on commercial and residential growth.

Key Aspects of Proposed Permit Conditions

- **Emission Limits (By Pollutant)**
  The proposed permit includes emission limits for NO_x, CO, VOCs, PM, PM10, PM2.5, GHGs as carbon dioxide equivalents (CO_2e), and formaldehyde for the new natural gas-fired RICE. The draft permit requires the six RICE units to be operated with SCR to limit NO_x emissions, as well as an oxidation catalyst to limit VOC and CO emissions.

  The proposed permit also has NO_x + NMHC, CO, and PM limits on the emergency engines consistent with the requirements of NSPS Subpart IIII. These engines also have PM10, PM2.5, and GHG as CO_2e limits based on the PSD BACT review.

- **Usage Limits**
  The proposed permit only allows the combustion of natural gas in the RICE units, the dew point heater, and the space heaters. Additionally, the proposed permit only allows ultra-low sulfur diesel fuel to be burned in the emergency engines. The maximum sulfur content of the diesel fuel cannot exceed 15 parts per million (ppm) sulfur, equivalent to 0.0015% sulfur by weight.

- **Process/Operational Restrictions**
  The proposed permit requires LBWL to implement and maintain a Malfunction Abatement Plan (MAP) for the natural gas-fired RICE. This plan requires a description of the corrective actions that will be taken in the event of a malfunction or failure to achieve compliance with the associated emission limits. LBWL will also be required to implement an additional plan that describes how they plan to minimize emissions during startup and shutdown operations. This plan will incorporate procedures recommended by the equipment manufacturer as well as incorporating standard industry practices.

- **Emission Control Device Requirements**
  The proposed permit includes emission control device requirements.

  The proposed six natural gas-fired RICE units will be required to control the following:

  – NO_x emissions through selective catalytic reduction

  – CO and VOC emissions through an oxidation catalyst

  LBWL will not be allowed to operate any of the RICE units unless both control technologies are installed, maintained, and operated according to the MAP.

- **Testing & Monitoring Requirements**
  The proposed permit includes the following requirements for the natural gas-fired RICE units:

  – Verify NO_x, CO, PM, PM10, PM2.5, VOC, and formaldehyde emission rates through performance testing.

  – Install Continuous Parameter Monitoring Systems (CPMS) that will collect the temperature of the oxidation catalyst at least once every 15 minutes.

- **Federal Regulations**
  The proposed natural gas-fired RICE units are subject to the NSPS for Stationary Spark Ignition Internal Combustion Engines, 40 CFR Part 60 Subpart JJJJ. The RICE are also

subject to the NESHAP for Stationary Reciprocating Internal Combustion Engines, 40 CFR Part 63 Subpart ZZZZ. Permit conditions require compliance with the NSPS and NESHAP through required emission limits, operational restrictions, testing or certification, monitoring and recordkeeping, notifications, and reporting.

- 40 CFR Part 60 Subpart JJJJ – NSPS for Stationary Spark Ignition Internal Combustion Engines

- 40 CFR Part 63 Subpart ZZZZ – NESHAP for Stationary Reciprocating Internal Combustion Engines

The proposed emergency engines are subject to the NSPS for Stationary Compression Ignition Internal Combustion Engines, 40 CFR Part 60 Subpart IIII and NESHAP Subpart ZZZZ. Permit conditions require compliance with the NSPS and NESHAP similar to the conditions for the natural gas-fired RICE.

- 40 CFR Part 60 Subpart IIII – NSPS for Stationary Compression Ignition Internal Combustion Engines

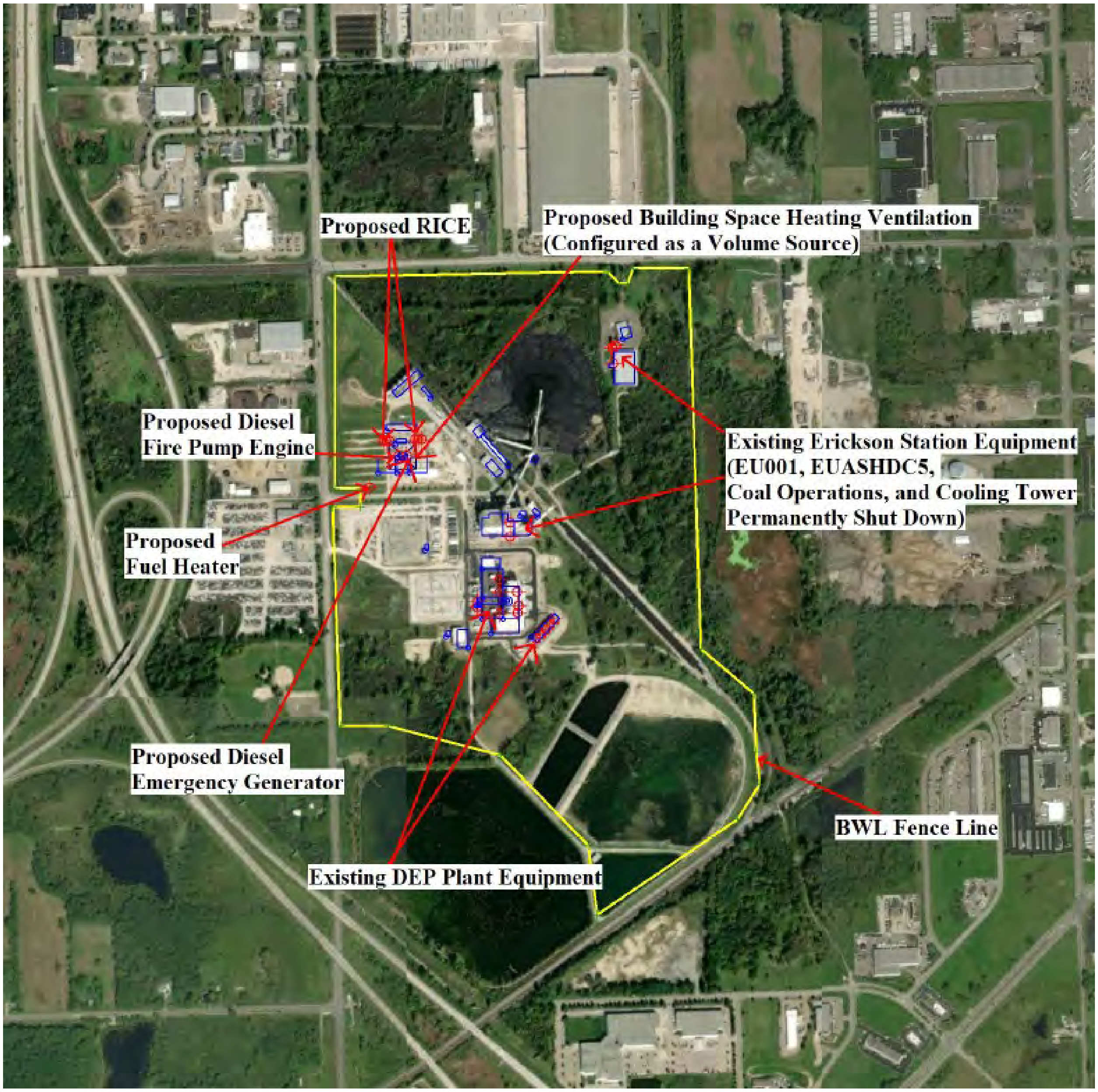
Conclusion

Based on the analyses conducted to date, AQD staff concluded that the proposed project will comply with all applicable state and federal air quality requirements. Also, the project, as proposed, will not violate the federal NAAQS and/or the state and federal PSD Increments.

Based on these conclusions, proposed permit terms and conditions were developed which would ensure the facility design and operation are enforceable and sufficient monitoring, recordkeeping, and reporting would be performed by LBWL to determine compliance with these terms and conditions. If the permit application is deemed approvable, the delegated decision maker may determine a need for additional or revised conditions to address issues raised during the public participation process.

If you would like additional information about this proposal, please contact Thomas Hercula, AQD, at 517-275-2912 or HerculaT@Michigan.gov.

Appendix 1
LBWL Proposed Site Plan



Appendix 2
STATE AIR REGULATIONS

State Rule	Description of State Air Regulations
R 336.1201	Requires an Air Use Permit for new or modified equipment that emits, or could emit, an air pollutant or contaminant. However, there are other rules that allow smaller emission sources to be installed without a permit (see Rules 336.1279 through 336.1290 below). Rule 336.1201 also states that the Department can add conditions to a permit to assure the air laws are met.
R 336.1205	Outlines the permit conditions that are required by the federal Prevention of Significant Deterioration (PSD) Regulations and/or Section 112 of the Clean Air Act. Also, the same types of conditions are added to their permit when a plant is limiting their air emissions to legally avoid these federal requirements. (See the Federal Regulations table for more details on PSD.)
R 336.1224	New or modified equipment that emits toxic air contaminants must use the Best Available Control Technology for Toxics (T-BACT). The T-BACT review determines what control technology must be applied to the equipment. A T-BACT review considers energy needs, environmental and economic impacts, and other costs. T-BACT may include a change in the raw materials used, the design of the process, or add-on air pollution control equipment. This rule also includes a list of instances where other regulations apply and T-BACT is not required.
R 336.1225 to R 336.1232	The ambient air concentration of each toxic air contaminant emitted from the project must not exceed health-based screening levels. Initial Risk Screening Levels (IRSL) apply to cancer-causing effects of air contaminants and Initial Threshold Screening Levels (ITSL) apply to non-cancer effects of air contaminants. These screening levels, designed to protect public health and the environment, are developed by Air Quality Division toxicologists following methods in the rules and U.S. EPA risk assessment guidance.
R 336.1279 to R 336.1291	These rules list equipment to processes that have very low emissions and do not need to get an Air Use permit. However, these sources must meet all requirements identified in the specific rule and other rules that apply.
R 336.1301	Limits how air emissions are allowed to look at the end of a stack. The color and intensity of the color of the emissions is called opacity.
R 336.1331	The particulate emission limits for certain sources are listed. These limits apply to both new and existing equipment.
R 336.1370	Material collected by air pollution control equipment, such as dust, must be disposed of in a manner, which does not cause more air emissions.
R 336.1401 and R 336.1402	Limit the sulfur dioxide emissions from power plants and other fuel burning equipment.
R 336.1601 to R 336.1651	Volatile organic compounds (VOCs) are a group of chemicals found in such things as paint solvents, degreasing materials, and gasoline. VOCs contribute to the formation of smog. The rules set VOC limits or work practice standards for existing equipment. The limits are based upon Reasonably Available Control Technology (RACT). RACT is required for all equipment listed in Rules 336.1601 through 336.1651.
R 336.1702	New equipment that emits VOCs is required to install the Best Available Control Technology (BACT). The technology is reviewed on a case-by-case basis. The VOC limits and/or work practice standards set for a particular piece of new equipment cannot be less restrictive than the Reasonably Available Control Technology limits for existing equipment outlined in Rules 336.1601 through 336.1651.
R 336.1801	Nitrogen oxide emission limits for larger boilers and stationary internal combustion engines are listed.

State Rule	Description of State Air Regulations
R 336.1901	Prohibits the emission of an air contaminant in quantities that cause injurious effects to human health and welfare, or prevent the comfortable enjoyment of life and property. As an example, a violation may be cited if excessive amounts of odor emissions were found to be preventing residents from enjoying outdoor activities.
R 336.1910	Air pollution control equipment must be installed, maintained, and operated properly.
R 336.1911	When requested by the Department, a facility must develop and submit a malfunction abatement plan (MAP). This plan is to prevent, detect, and correct malfunctions and equipment failures.
R 336.1912	A facility is required to notify the Department if a condition arises which causes emissions that exceed the allowable emission rate in a rule and/or permit.
R 336.2001 to R 336.2060	Allow the Department to request that a facility test its emissions and to approve the protocol used for these tests.
R 336.2801 to R 336.2804 Prevention of Significant Deterioration (PSD) Regulations **Best Available Control Technology (BACT)**	The PSD rules allow the installation and operation of large, new sources and the modification of existing large sources in areas that are meeting the National Ambient Air Quality Standards (NAAQS). The regulations define what is considered a large or significant source, or modification. In order to assure that the area will continue to meet the NAAQS, the permit applicant must demonstrate that it is installing the BACT. By law, BACT must consider the economic, environmental, and energy impacts of each installation on a case-by-case basis. As a result, BACT can be different for similar facilities. In its permit application, the applicant identifies all air pollution control options available, the feasibility of these options, the effectiveness of each option, and why the option proposed represents BACT. As part of its evaluation, the Air Quality Division verifies the applicant's determination and reviews BACT determinations made for similar facilities in Michigan and throughout the nation.
R 336.2901 to R 336.2903 and R 336.2908	Applies to new "major stationary sources" and "major modifications" as defined in R 336.2901. These rules contain the permitting requirements for sources located in nonattainment areas that have the potential to emit large amounts of air pollutants. To help the area meet the NAAQS, the applicant must install equipment that achieves the Lowest Achievable Emission Rate (LAER). LAER is the lowest emission rate required by a federal rule, state rule, or by a previously issued construction permit. The applicant must also provide emission offsets, which means the applicant must remove more pollutants from the air than the proposed equipment will emit. This can be done by reducing emissions at other existing facilities. As part of its evaluation, the AQD verifies that no other similar equipment throughout the nation is required to meet a lower emission rate and verifies that proposed emission offsets are permanent and enforceable.

FEDERAL AIR REGULATIONS

Citation	Description of Federal Air Regulations or Requirements
Section 109 of the Clean Air Act – National Ambient Air Quality Standards (NAAQS)	The United States Environmental Protection Agency has set maximum permissible levels for seven pollutants. These NAAQS are designed to protect the public health of everyone, including the most susceptible individuals, children, the elderly, and those with chronic respiratory ailments. The seven pollutants, called the criteria pollutants, are carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter less than 10 microns (PM10), particulate matter less than 2.5 microns (PM2.5), and sulfur dioxide (SO_2). Portions of Michigan are currently non-attainment for either ozone or SO_2. Further, in Michigan, State Rules 336.1225 to 336.1232 are used to ensure the public health is protected from other compounds.

Citation	Description of Federal Air Regulations or Requirements
40 CFR 52.21 – Prevention of Significant Deterioration (PSD) Regulations **Best Available Control Technology (BACT)**	The PSD regulations allow the installation and operation of large, new sources and the modification of existing large sources in areas that are meeting the NAAQS. The regulations define what is considered a large or significant source, or modification. In order to assure that the area will continue to meet the NAAQS, the permit applicant must demonstrate that it is installing BACT. By law, BACT must consider the economic, environmental, and energy impacts of each installation on a case-by-case basis. As a result, BACT can be different for similar facilities. In its permit application, the applicant identifies all air pollution control options available, the feasibility of these options, the effectiveness of each option, and why the option proposed represents BACT. As part of its evaluation, the Air Quality Division verifies the applicant's determination and reviews BACT determinations made for similar facilities in Michigan and throughout the nation.
40 CFR 60 – New Source Performance Standards (NSPS)	The United States Environmental Protection Agency has set national standards for specific sources of pollutants. These New Source Performance Standards (NSPS) apply to new or modified equipment in a particular industrial category. These NSPS set emission limits or work practice standards for over 60 categories of sources.
Section 112 of the Clean Air Act **Maximum Achievable Control Technology (MACT)** **Section 112g**	In the Clean Air Act, Congress listed 189 compounds as Hazardous Air Pollutants (HAPS). For facilities which emit, or could emit, HAPS above a certain level, one of the following two requirements must be met: 1) The United States Environmental Protection Agency has established standards for specific types of sources. These Maximum Achievable Control Technology (MACT) standards are based upon the best-demonstrated control technology or practices found in similar sources. 2) For sources where a MACT standard has not been established, the level of control technology required is determined on a case-by-case basis.

Notes: An "Air Use Permit," sometimes called a "Permit to Install," provides permission to emit air contaminants up to certain specified levels. These levels are set by state and federal law, and are set to protect health and welfare. By staying within the levels set by the permit, a facility is operating lawfully, and public health and air quality are protected.

The Air Quality Division does not have the authority to regulate noise, local zoning, property values, off-site truck traffic, or lighting.

These tables list the most frequently applied state and federal regulations. Not all regulations listed may be applicable in each case. Please refer to the draft permit conditions provided to determine which regulations apply.

Appendix 3
Best Available Control Technology Analysis (BACT)
(Michigan Rule 336.2810 and 40 CFR 52.21(j))

A requirement of PSD New Source Review is a BACT analysis. The top-down BACT approach, per the USEPA DRAFT New Source Review Workshop Manual (October 1990), was utilized by LBWL. The top-down approach considers all available emission reduction options and proceeds in a five-step process as follows:

1. Identify all control technologies;
2. Eliminate technically infeasible options;
3. Rank the remaining control technologies by control effectiveness;
4. Evaluate the most effective controls and document the results;
5. Select BACT (e.g., the most effective option not rejected is BACT).

The proposed project is subject to a BACT analysis for NO_x, CO, VOCs, PM, PM10, PM2.5, and GHGs as CO_2e. The following is a summary of the BACT analysis for LBWL's proposed natural gas-fired RICE plant.

BACT for six (6) Natural Gas-Fired RICE Units

It should be noted that CO and VOC have an inverse relationship to NO_x in terms of potential emissions. A higher combustion temperature in the RICE will result in better combustion, and subsequently, lower CO and VOC emissions. However, this will also increase the amount of NO_x that is produced. Conversely, a lower combustion temperature will reduce NO_x emissions, but it will decrease combustion efficiency and increase CO and VOC emissions. LBWL proposed control technologies that intend to limit CO, VOC, and NO_x emissions without causing a sharp increase in the inverse pollutant's emissions.

BACT for NO_x

NO_x is emitted due to dissociation of nitrogen and subsequent combining with oxygen in the combustion air at the high temperature flame pockets of the combustion zone (referred to as thermal NO_x). Negligible amounts of NO_x can be formed as a result of reactions of nitrogen molecules in the combustion air with hydrocarbon radicals from fuel (prompt NO_x), as well as nitrogen in the fuel being oxidized (fuel NO_x). Most of the NO_x formed from natural gas combustion is thermal NO_x. The following control technologies were identified and evaluated:

Combustion and Post Combustion Controls	• Pre-Stratified Charge (PSC) • Lean Burn Combustion • Selective Catalytic Reduction (SCR) • Non-selective Catalytic Reduction (NSCR) • Selective Non-Catalytic Reduction (SNCR)

The review of these technologies is summarized below.

- Pre-Stratified charge (PSC) is a pre-combustion system that involves injecting air into the intake manifold prior to a fuel-rich mixture. The fuel-rich mixture near the spark plug allows for quick, accurate ignition, while the fuel mixture away from the spark plug is fuel-lean to allow for a lower combustion temperature reducing the formation of NOx. PSC can only be used on rich-burn engines and, therefore, is not applicable to the RICE proposed for this project.

- Natural gas-fired RICE that operate with a lean air-to-fuel ratio (i.e: combust fuel with excess air) are considered lean burn RICE. Most natural gas RICE are equipped with the ability to control the air-to-fuel ratio and better control the NO_x emissions. LBWL is proposing to install lean burn RICE.

- SCR is a process that reduces the concentration of NO_x in the flue gas through a chemical reaction. Ammonia (NH_3) or urea (which breaks down to form ammonia at high heat) is introduced into the flue gas stream and reacts with NO_x in the presence of a catalyst, usually a precious metal (platinum or rhodium) or metal oxide (titanium oxide or vanadium oxide). Challenges of using SCR include monitoring and replacing the catalyst, ammonia transport and handling, and ensuring excess ammonia or urea is not injected into the system. SCR is a feasible option for LBWL.

- NSCR is a process that reduces NO_x emissions from the flue gas through use of a three-way catalytic converter. No chemical injection is necessary as the technology uses unburned hydrocarbons as the NO_x reducing agent. The exhaust gas passes over a catalyst, usually a noble metal, which reduces the NO_x to nitrogen. The reactions occur with flue gas that contains a minimal oxygen content. The flue gas from natural gas-fired RICE will have a higher oxygen content, so NSCR is not considered a technically feasible control technology.

- SNCR is a process that reduces emissions of NO_x by injecting NH_3 or urea into combustion flue gases without a catalyst present. Typical exhaust parameters for effective removal of NO_x are a temperature of 1,600 to 2,100 degrees Fahrenheit. The higher temperatures are required because SNCR does not utilize a catalyst to promote NO_x reduction. Typical flue gas temperatures from the RICE range from 500 to 800 degrees Fahrenheit, which is much lower than the required temperatures for SNCR. Therefore, this control technology is not technically feasible for this project.

It is proposed that BACT for NO_x is the use of SCR technology along with lean burn combustion in order to achieve the greatest reduction of NO_x emissions. The proposed permit requires continuous (at least once every 15 minutes) monitoring of SCR operating parameters to ensure proper operation of the control device.

During normal operation, the proposed BACT emission limit is 0.5 grams per horsepower-hour (g/hp-hr), based on the average of three stack test runs per the applicable method requirements. In reviewing the USEPA's RACT BACT LAER Clearinghouse (RBLC) database, comparable gas-fired RICE have BACT limits ranging from 0.084 g/hp-hr to 0.7 g/hp-hr. The proposed limit for LBWL is on the higher end of the RBLC database range. This is because the RICE plant will not be operated as a baseload plant at a consistent, single load continuously. Rather, LBWL's proposed RICE will be operated to support intermittent renewable power systems and will be required to respond to electric load demand and short-term production swings in solar generation, which is often intermittent. Engines that operate at a consistent load are generally more efficient and have lower emissions than those that run intermittently. During startup and shutdown of the RICE, it is anticipated that NO_x emissions will be greater than emissions during steady-state operation. To account for the increase during startup and shutdown, an hourly BACT limit of 49.7 pounds per hour (pph) was included for NO_x emissions. This limit will only apply during an hourly period when a startup or shutdown occurs. There are very few entries in the RBLC database that contain emission limits for startup and shutdown conditions, and there are none for engines of the size LBWL is proposing.

Because of the nature of operation for the proposed RICE, BACT limits were proposed that take into account the worst-case operations of the RICE while still complying with BACT. The AQD reviewed the information and agreed that the proposed BACT limit for NO_x is acceptable for this project.

BACT for CO and VOCs

CO and VOCs are emitted from the natural gas-fired RICE as a result of incomplete combustion of the fuel. Factors affecting the formation of CO and VOCs include the air-to-fuel ratio, combustion temperature, residence time, and turbulence (mixing) of the combustion gases. LBWL reviewed the following control technologies:

Combustion and Post Combustion Controls	• Catalytic Oxidation • Thermal Oxidation • Non-Selective Catalytic Reduction (NSCR) • Good Combustion Practices

- Catalytic oxidation treats exhaust gases from a combustion device using a catalyst bed, which is typically a media-supported film of precious metals where oxidation of CO or CO_2 takes place. It can also be used in a similar way to control VOC emissions. The reaction can occur over a wide range of temperatures from 450 to 1200 degrees Fahrenheit. This is a technically feasible control option based on the exhaust temperature of the flue gas from the proposed RICE.

- Thermal oxidation uses a thermal oxidizer to increase the flue gas temperature above the auto-ignition temperature of CO, which is 1300 degrees Fahrenheit, to induce combustion. This technology is best used for exhaust streams that have a high concentration of CO and VOCs, which allows the exhaust stream to provide some of the fuel requirements. The exhaust streams from the RICE will have a relatively low concentration of CO and VOCs, so thermal oxidation is not a technically feasible control strategy for the proposed RICE.

- NSCR was discussed in the BACT section for NO_x and would operate similarly here. The low oxygen content makes NSCR a technically infeasible option.

- Good combustion practices must be carefully balanced as NO_x emissions will increase with a higher combustion efficiency. Modern combustion controls are generally able to balance this relationship to limit CO and VOC emissions without significantly increasing NO_x emissions.

As discussed above, thermal oxidation and NSCR are not technically feasible options for the proposed RICE. LBWL proposed BACT for CO and VOCs to be a combination of catalytic oxidation and good combustion practices.

Under steady-state operation, BACT for CO is a limit of 0.3 g/hp-hr, based on the average of three stack test runs per the applicable method requirements. This is within the range of comparable sources listed in the RBLC database, which vary from 0.08 g/hp-hr to 0.55 g/hp-hr. BACT for VOC is a limit of 20 pph, which equates to approximately 0.3 g/hp-hr, based on the average of three stack test runs per the applicable method requirements. Although the pounds per hour value is high compared to other entries in the RBLC database, it should be noted that the proposed RICE for this project are much larger than other engines from comparable projects.

Like NO_x, CO and VOC emissions are expected to fluctuate because the proposed RICE will be operating intermittently depending on the electric load demand. Engines that operate continuously at normal operation will have lower CO and VOC emissions than those that operate intermittently. Because of the intermittent nature of the operations, there will be periods of startup and shutdown for each RICE. It is anticipated that CO emissions from the RICE during startup and shutdown will be greater than emissions during steady-state operation. To account for the increase during startup and shutdown, an hourly BACT limit of 36.9 pph was included for CO emissions. This limit will only apply during an hourly period when a startup or shutdown occurs. There are very few entries in the RBLC database that contain emission limits for startup and shutdown conditions, and there are none for engines of the size LBWL is proposing. The BACT limit for VOC is inclusive of startup and shutdown operations, so a separate BACT limit is not required.

Based on the provided information, the AQD concurs with the proposed BACT and BACT limits for CO and VOCs.

BACT for PM, PM10, and PM2.5

Particulate matter may be emitted either as a solid or as a condensable material and can be formed from sulfur in the fuel, as well as the products of incomplete combustion and potential metallic oxides from degradation of internal engine components. PM includes “filterable” or “front-half” particulate, which is particulate that exists as a solid or liquid even at high temperatures. PM10 and PM2.5 includes both “filterable” and “condensable” particulates. “Condensable” or “back-half” particulates exists as a vapor during combustion but form a solid or liquid when the temperature is cooled to ambient conditions. Condensable particulates are composed primarily of nitrogen and sulfur compounds.

Possible control technologies for PM, PM10, and PM2.5 include pretreatment collection (e.g: cyclones, flue gas conditioning) and post-combustion control (e.g: electrostatic precipitator, fabric filter, wet scrubber, incineration). Additionally, because particulate emissions from natural gas combustion consist of heavier weight hydrocarbons that are not fully combusted, proper combustion techniques can be utilized to reduce emissions. A brief description of the proposed control technologies is discussed below.

- Cyclones use inertia to collect particulate from exhaust gas streams. Exhaust gas is spun inside the cyclone using centrifugal force, and the force of the stream forces particulate toward the cyclone walls. Gravity causes the particles to travel down the cyclone and into a hopper. Cyclones are generally used for large particulate matter (greater than 10 microns) and the control efficiency drops significantly as the particle size decreases. Additionally, cyclones only collect filterable particulate and do not collect particulate in condensable form. Natural gas combustion does not contain ash or other large particles, and the majority of particulate exists in the condensable form, so a cyclone would not be able to obtain a high level of efficiency for the proposed RICE.

- Fabric filtration, often referred to as a baghouse, utilizes a filter to remove particles from a contaminated gas stream by depositing the particles on fabric material. Over time, particulate builds up on the fabric material and forms a “dust cake” that acts as an additional filtration device. To avoid excessively high pressure drops, the filter material is cleaned periodically. There are three common methods to cleaning fabric filters:

  - Shaker fabric filters clean the bags by gently shaking them. Dislodged dust falls into a hopper and is removed from the collector.

- Reverse-air fabric filters collect dust on the inside of the bag, as opposed to the outside with other fabric filters. Under normal flow, the bags gently inflate because of the air flow through them. When the filters require cleaning, the air flow is reversed, the bags partially collapse, and the dust cake is removed and falls into the hopper.
- Pulse jet fabric filters utilize short pulses of compressed air to remove dust cakes from the outside of bags. The compressed air can be directed to one or multiple rows of bags, so the collector does not have to completely shut down while cleaning is occurring.

Fabric filtration can achieve levels of PM, PM10, and PM2.5 control greater than 99% (as high as 99.9+%) on a mass basis of filterable particulate, and they are generally considered to be the best technology for capturing fine filterable particulate. However, as mentioned above, the majority of particulate from natural gas combustion exist as condensable particulate, so this high level of control would most likely not be reached.

- An electrostatic precipitator (ESP) removes particles from a gas stream by using electrical energy to charge particles and attract them to a surface. An ESP is a large enclosure filled with a series of fields that consist of negatively charged discharge electrodes and positively charged collection plates. The discharge electrodes negatively charge the particles in the gas stream which migrate to the positively charged plates. Over time, the particulate that collects on the plates must be removed. Factors affecting particulate collection efficiency of an ESP include gas flow rate through the ESP, total plate area, particulate resistivity, voltage, and the structure of the ESP. The smaller the collection area of the ESP, the narrower the acceptable resistivity range becomes. To optimize particulate resistivity and maximize collection efficiency, sulfur trioxide is injected to condition the particulate and reduce resistivity; this injection process is known as flue gas conditioning. A properly operated ESP can achieve control efficiencies of greater than 99 percent. Additionally, ESPs have lower pressure drops across the control device than fabric filter baghouses, which saves energy by reducing fan horsepower requirements, and therefore, the parasitic load on the generating unit. However, there is an increase in capital cost due to the significant additional electrical infrastructure required to support its operation. There are two types of ESPs that can be utilized.

  - In a dry ESP, rappers are used to contact the plates and cause the collected particulate to drop into hoppers at the bottom of the ESP.
  - In a wet ESP, the flue gas is cooled below the dew point, and particulate matter may be present as either solid or liquid particles. Water droplets, other condensable particulate (e.g: sulfuric acid), and fine particulate matter can be collected by the charged fields. The electrodes are flushed with water to remove collected materials. Wet ESPs require an additional electrical supply, water supply, and wastewater treatment infrastructure.

- Venturi scrubbers remove particulate using several mechanisms, including condensation, inertial impaction of particulate with water droplets, and reactions of particulate and particulate precursors with the scrubber reagents. Venturi scrubbers would require an additional electrical, water supply, and wastewater treatment infrastructures. Particulate control efficiency in a venturi scrubber is variable depending on the scrubber design, particulate size, and particulate loading but control efficiency can be greater than 90 percent.

Pretreatment systems and post-combustion controls are generally not applied to RICE units because they are typically not considered effective control. These systems are typically used on boilers when combusting fuels with higher solid constituents, like coal or fuel oil. Coal and fuel oil both contain ash, which is not associated with natural gas. LBWL stated that the control technologies mentioned above are not technically feasible for the proposed project; however, the facility also provided an economic analysis for each control technology to demonstrate that add-on control would not be economically feasible. The cost analysis conservatively assumed a 99.9 control efficiency of PM10, and it assumed PM10 emissions equaled PM2.5 emissions. Fabric filtration was evaluated as the same capture efficiency, even though they would be less efficient with condensable particulate capture. The total cost effectiveness, in dollars per ton of particulate removed, for each control technology are listed below:

- Pulse Jet Fabric Filter: $201,366 per ton removed
- Mechanical Shaker Fabric Filter: $223,570 per ton removed
- Reverse-Air Fabric Filter: $263,324 per ton removed
- Dry Electrostatic Precipitator (Wire-Plate Type): $264,493 per ton removed
- Dry Electrostatic Precipitator (Wire-Pipe Type): $167,825 per ton removed
- Wet Electrostatic Precipitator (Wire-Plate Type): $318,605 per ton removed
- Wet Electrostatic Precipitator (Wire-Pipe Type): $243,083 per ton removed
- Venturi Scrubber: $798,532 per ton removed

Based on the values calculated, additional particulate control for the proposed RICE was determined to be economically infeasible. Based on the above information, LBWL proposed the use of natural gas as well as good combustion practices as BACT for PM, PM10, and PM2.5

During normal operation, LBWL proposed a PM emission limit of 2 pph, and a PM10 and PM2.5 limit of 4 pph each. Compliance with these emission limits will be demonstrated via stack testing. Several entries in the RBLC database have PM, PM10, and PM2.5 limits that are less than the ones proposed by LBWL. However, the size of the proposed RICE for LBWL are significantly larger than any other RICE listed in the RBLC database. Additionally, the intermittent operation of the engines will cause fluctuations in the emissions and may result in higher particulate emissions than engines that run continuously at full capacity. Several of the BACT limits in the database are 3-hour or 24-hour averages, which allow for more flexibility than the hourly limit for LBWL. Based on the information provided, the AQD concurs with the proposed BACT and BACT limits for particulate matter.

BACT for Greenhouse Gases (GHGs)
GHGs are produced as a result of the chemical reaction between fuel and oxygen in a combustion reaction. GHGs are regulated as a single air pollutant defined as the aggregate combination of six GHGs, which are: Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Because some GHGs have a higher global warming potential than others, they are all converted to carbon dioxide equivalents (CO_2e) by using the gases' global warming potential and adding together the CO_2e emissions of all six pollutants. For natural gas combustion, almost all fuel is converted to CO_2, with trace amounts of CH_4 and N_2O as well. HFCs, PFCs, and SF_6 are not produced with combustion of natural gas. LBWL identified several potential control technologies for controlling or reducing GHG emissions:

Combustion and Post Combustion Controls	• Low-Carbon Fuel • Energy Efficiency Measures • Carbon Capture and Sequestration

- The use of a low-carbon fuel reduces the amount of GHGs produced during combustion. Natural gas has a carbon content of 34 pounds carbon per million British thermal units (MMBtu), whereas the carbon content of fuel oil is 48 pounds per MMBtu, and the carbon content of ash-free coal is 66 pounds per MMBtu. Natural gas has the lowest carbon content of any commercially available fuel and is best suited to minimize GHG emissions from the proposed RICE.

- Energy efficiency includes efficient combustion practices and proper maintenance and tuning of equipment. Efficient combustion involves increasing energy efficiency and simultaneously reducing emissions of combustion-related pollutants, including CO_2. Energy efficiency measures include following vendor-recommended maintenance practices, maintaining proper insulation, and using automated instrumentation and controls for efficient combustion. LBWL will install and maintain efficient natural gas-fired RICE.

- Carbon capture and sequestration (CCS) is a multiple-step process: capture of the CO_2 from the flue gas, transportation of CO_2 emissions, and long-term storage of the captured CO_2, or sequestration. Capture and sequestration are evaluated separately to determine feasible solutions for each step of the CCS process. Each step of the process is described in detail below.

  – **Carbon Capture**
  Carbon capture is the separation of CO_2 from the flue gas before it is emitted through the exhaust stack from the facility. Capture systems being developed are expected to collect up to 90 percent of flue gas CO_2. Currently, absorption technology is the most feasible technology for carbon capture and is considered an available technology. The most developed is the amine and ammonia-based absorption technologies. However, the process of separating CO_2 from the flue gas has high energy demand and is cost intensive. Therefore, the addition of a carbon capture system would increase the energy needed to operate the proposed facility.

  An amine-based CO_2 stripping process is a commonly evaluated capture system; it is composed of three main functional areas: flue gas pretreatment (cooling/polishing scrubber), CO_2 absorption/stripping, and CO_2 compression. The following sections briefly describe each of these process steps.

  Flue Gas Pretreatment
  In the pretreatment step, flue gas leaves the RICE and is directed through a cooler/polishing scrubber to reduce the gas temperature and remove residual acid gases and particulate that are contaminants to the overall process. The flue gas temperature is lowered to approximately 120°F, or less, for proper operation of the amine absorber. The residual acid gases are removed to minimize degradation of the amine solvent, and particulates need to be removed to prevent the plugging of packed beds and heat exchanger surfaces.

  It is anticipated that flue gas booster fans would be required to pressurize the flue gas to overcome added pressure loss as the flue gas passes through the pretreatment and absorption processes of the CCS system and interconnecting ductwork.

  CO_2 Absorption/Stripping
  In the absorption/stripping process, CO_2 is removed from the flue gas in the absorber by the amine solvent. The absorbers would likely have packed beds to enhance removal performance. Lean amine solvent enters the top of the CO_2 absorber. As the amine solvent flows through the packed beds of the absorber, it contacts the counter-current flowing flue gas. CO_2 is absorbed by the amine solvent which is collected in the bottom

of the CO_2 absorber. The CO_2-rich amine solvent is heated and pumped to the CO_2 stripper for regeneration. The flue gas leaves the CO_2 absorber and is discharged through the exhaust stack. A key concern is that losses of amine solvent as carryover from the absorber in the flue gas be minimized.

CO_2 is separated from rich amine solvent in the CO_2 regenerators, which are steam stripping towers, containing packed beds. The CO_2-rich solvent flows from the top of the regenerator to the bottom and is contacted with steam, releasing CO_2 into the gas phase. The top bed of the regenerator is washed using water to remove entrained amine solvent from the exiting CO_2/steam mixture. The lean amine solvent, collected in the bottom of the CO_2 regenerator is cooled through a heat exchanger and returned to the CO_2 absorber.

CO_2 Compression
Captured CO_2 that is exhausted from the CO_2 stripper/solvent regeneration towers is compressed to high pressure (approximately 1,500 pounds per square inch gauge, or psig) by staged compressors with interstage cooling/drying. The compressed CO_2 is then further pressurized via high pressure pumps to 2,200 psig or greater for pipeline transport to a sequestration site for injection.

– **Transportation of CO_2 emissions**
  Captured CO_2 emissions would have to be transported to a storage site via a pipeline.

– **Carbon Sequestration**
  Sequestration is the long-term isolation of CO_2 from the atmosphere through physical, chemical, biological, or engineered processes. Geological sequestration is a sequestration technique involving the storage of captured CO_2 in a location where it will not readily escape into the atmosphere. Current technology involves the use of deep underground rock formations where the extreme pressure and temperatures cause the CO_2 to enter the liquid phase and can be used for enhanced oil recovery. Injected CO_2 occupies pore spaces in the surrounding rock. Saline water residing in the pore space will be displaced by the CO_2. The CO_2 also dissolves in water and chemical reactions between the dissolved CO_2 and rock create solid carbonate minerals which trap CO_2.

CCS requires a significant amount of energy and would also create a significant amount of liquefied CO_2 which would have to be sequestered in a secure geologic formation. Although carbon capture technologies have been demonstrated to be technically feasible on small commercial operations, they have not been proven to be economically feasible at full scale. Additionally, the USEPA has stated that CCS has been applied primarily to gas streams with a high concentration of CO_2 (such as a coal-fired combustion unit). The concentration of CO_2 in a coal-fired unit is normally about four times higher than the concentration of CO_2 in a natural gas-fired unit.

As an additional measure, LBWL provided a full cost analysis detailing the total cost of installing a CCS, including the capital cost of the carbon capture system, cost of installing the pipeline, and operations and maintenance (O&M) costs. The values used in the calculations were taken from multiple papers composed by the National Energy Research Laboratory. Based on the calculations, LBWL estimates that the capital cost of the project will be $120.8 million, which includes $40 million to construct a pipeline, assuming the closest sequestering site is 100 miles away from the RICE plant (the closest site is located in Otsego County, which is greater than 100 miles away from the proposed plant). The estimated cost is more than the estimated cost of the proposed plant. Therefore, per USEPA guidance which states that it is appropriate in some cases to assess the cost-effectiveness in a less detailed manner when there is an extremely high capital cost that makes the control technology cost prohibitive, CCS was determined to be economically infeasible for the proposed project.

LBWL selected the use of natural gas as fuel, good combustion practices, and current energy efficiency measures as GHG BACT for the proposed project. Efficiency will be based on implementing vendor-recommended maintenance, efficient generator design, insulation to reduce heat loss, and automated instrumentation and controls for efficient combustion. LBWL also proposed a BACT limit of 90,268 tpy CO_2e for each RICE installed. Although this value is greater than most entries in the RBLC database, the value is proportional to engines of smaller sizes with 12-month rolling GHG emission limits. Therefore, the AQD determined that the proposed limit was acceptable for the proposed project. Compliance with this limit will be met by keeping records of the amount of fuel used as well as monthly records of the total CO_2e mass emissions for each RICE.

BACT for Startup and Shutdown of RICE

BACT applies at all times and during all periods of operation, including periods of startup and shutdown. However, during startup and shutdown periods, emissions of certain pollutants may be elevated as the units are operating at low load levels where the units are less efficient, and the control technologies are not yet fully engaged. In order to minimize emissions during startup and shutdown, LBWL proposed to utilize good combustion practices according to manufacturer's recommendations, as well as good work practices that include a startup and shutdown plan to minimize time spent at idle. Additionally, the AQD proposed short-term emission limits for both NO_x and CO because of the potential for short-term emissions to increase during startup and shutdown events.

BACT Emission Limit Summary

The table below lists the proposed BACT limits for each pollutant subject to PSD BACT review:

Pollutant	Emission limit, per RICE	Units	Averaging Time
NO_x	0.5	g/bhp-hr	Hourly
	49.7	pph	Hourly, during startup or shutdown
CO	0.3	g/bhp-hr	Hourly
	36.9	pph	Hourly, during startup or shutdown
PM	2	pph	Hourly
PM10	4	pph	Hourly
PM2.5	4	pph	Hourly
VOC	20	pph	Hourly
GHGs as CO_2e	90,268	tpy	12-month rolling average

BACT for Emergency Engines

BACT for NO_x

NO_x is emitted as a result of nitrogen in the fuel being oxidized as well as from disassociation of diatomic nitrogen and subsequent combining with oxygen in the combustion air at the high temperatures of the combustion zone. LBWL identified the following potential control technologies:

Combustion and Post Combustion Controls	• Selective Catalytic Reduction (SCR) • Non-selective Catalytic Reduction (NSCR) • Selective Non-Catalytic Reduction (SNCR)

All of the above control technologies are discussed above in the BACT section for the proposed natural gas-fired RICE.

- SCR is intended for use on combustion equipment operating under continuous steady-state conditions and is not feasible on emergency equipment as the engines will operate on an infrequent and as-needed, emergency, or maintenance basis.
- NSCR is not a technically feasible option for lean-burn engines as the exhaust gas contains a higher oxygen content than what is required for effective removal of NO_x emissions.
- SNCR is not technically feasible as, like the natural gas-fired RICE, the exhaust temperature of the engines will not be high enough to effectively control emissions.

LBWL proposed to comply with NO_x BACT for the emergency engines by complying with the emission limits in NSPS Subpart IIII. Compliance will be verified through vendor documentation (e.g: engine certificate) and meeting the requirements of NSPS IIII. The limits are consistent with numerous other emergency engines listed in the RBLC database and the AQD concurs that they represent BACT.

BACT for CO and VOC
CO is emitted from the emergency engines as a result of incomplete combustion of the fuel. Factors affecting the formation of CO include the air-fuel ratio, combustion temperature, residence time, and turbulence (mixing) of the combustion gases. LBWL identified the following control technologies for CO emissions:

Combustion and Post Combustion Controls	• Catalytic Oxidation • Thermal Oxidation • Non-selective Catalytic Reduction (NSCR)

These technologies are discussed in detail above in the BACT analysis for the natural gas-fired RICE.

- Catalytic oxidation is a feasible technology based on the temperature of the exhaust gas being within the range described above, 450-1200 degrees Fahrenheit.
- Thermal oxidation is best used on exhaust streams that have a high concentration of VOCs, such as paint booths and ovens. The VOC concentration of the exhaust from the engines is very low, so thermal oxidation is not a technically feasible control.
- As discussed in the BACT section for NO_x, NSCR is not a technically feasible control because the exhaust gas contains a higher oxygen concentration than what is required for effective NSCR control.

LBWL performed an economic analysis on catalytic oxidation for the engines based on values from the USEPA's Air Pollution Control Cost Manual. The cost effectiveness of catalytic oxidation was estimated to be $49,834/ton removed for the emergency generator engine, and $202,759/ton removed for the fire pump engine. These values are greater than what the AQD considers to be economically feasible. Therefore, LBWL proposed good combustion practices as BACT for both CO and VOC. For CO emissions, BACT limits were based on NSPS Subpart IIII limits, which is consistent with other emergency engines in the RBLC database. For VOC emissions, compliance with the NO_x + NMHC limit in NSPS Subpart IIII will demonstrate BACT for the emergency engines.

BACT for PM, PM10, and PM2.5

Particulate matter may be emitted as a solid or as a condensable material. Solid emissions are considered filterable particulate that consist of various quantities of materials found in diesel fuel. Condensable particulate is formed as a result of incomplete combustion of heavier hydrocarbons.

LBWL identified the same control technologies as for the natural gas-fired RICE, along with the use of ultra-low sulfur diesel (ULSD) in the emergency equipment. Pretreatment systems (cyclones, flue gas conditioning) and post-combustion controls (filtration, venturi scrubber, ESP) are typically not applied to diesel-fired engines. These systems are typically used on boilers with fuels that have higher solid constituents, such as coal. Additional control technology would not be feasible on these engines given the type of fuel burned as well as the limited time the engines would be in use.

LBWL proposed to use ULSD as well as good combustion practices to limit emissions of PM, PM10, and PM2.5. This is consistent with other diesel-fired emergency equipment in the RBLC database. The proposed emission limits for PM are equivalent to the limits in NSPS Subpart IIII and will be verified with vendor documentation. The proposed limits for PM10 and PM2.5 are comparable to other values listed in the RBLC database. The AQD determined that the proposed limits are representative of BACT and are acceptable for the proposed project.

BACT for Greenhouse Gases (GHGs)

GHG emissions are produced as a result of the chemical reaction between fuel and oxygen in combustion. LBWL proposed CCS and energy efficiency measures as two potential control technologies for GHG emissions.

CCS is discussed in detail above in the GHG BACT section for the natural gas-fired RICE units. In addition to the cost prohibitive nature of CCS, the emergency engines will not be running on a regular basis, and using CCS on these engines would be impractical based on the limited hours of operation. Therefore, CCS is not technically or economically feasible for the emergency engines. LBWL is proposing to implement energy efficiency measures similar to the ones used for the natural gas-fired RICE units. The facility will show compliance with the proposed emission limits by keeping monthly records of the amount of fuel used as well as emission calculations of GHGs as CO_2e. The AQD determined that LBWL's proposal is BACT.

BACT Emission Limit Summary

The table below lists the proposed BACT limits for the emergency engines.

Pollutant	Emission Limit, Generator Engine	Emission Limit, Fire Pump Engine	Averaging Time
NO_x + NMHC	6.4 g/bkW-hr	4.0 g/bKw-hr	Hourly
CO	3.5 g/bKw-hr	3.5 g/bKw-hr	Hourly
PM	0.2 g/bKw-hr	0.2 g/bKw-hr	Hourly
PM10	0.3 pph	1.1 pph	Hourly
PM2.5	0.3 pph	1.1 pph	Hourly
GHGs as CO_2e	205 tpy	27 tpy	12-month rolling average

BACT for Natural Gas-Fired Heating Equipment

The AQD reviewed potential control for the dew point heater and the various space heaters to be installed at the facility. LBWL discussed the same control technologies as those suggested for the natural gas-fired RICE units. However, due to the small size and design of the equipment, additional control is not technically or economically feasible. LBWL proposed to burn only natural gas as fuel as well as to restrict the heat input capacity of the emission units (5 MMBtu/hr for the dew point heater, 10 MMBtu/hr for all space heaters combined).