TECHNICAL EVALUATION

&

PRELIMINARY DETERMINATION

APPLICANT

Landfill Energy Systems Florida, LLC
4000 Knights Trail Road
Nokomis, FL 34275

Sarasota Landfill Gas-to-Energy
ARMS Facility ID No. 1150089

PROJECT

Draft Permit No. PSD-FL-422
Project No. 1150089-008-AC

Landfill Gas-to-Energy Project

COUNTY

Sarasota County, Florida

PERMITTING AUTHORITY

Florida Department of Environmental Protection
Division of Air Resource Management
Office of Permitting and Compliance
2600 Blair Stone Road, MS#5505
Tallahassee, Florida 32399-2400

October 31, 2013

1. GENERAL PROJECT INFORMATION

1.1. Facility Description and Location

Central County Solid Waste Disposal Complex (CCSWDC) is a Class I Municipal Solid Waste Landfill in Sarasota County at 4000 Knights Trail Road in Nokomis, Florida. The Class I disposal landfill currently consists of a Phase I area which began accepting waste on June 5, 1998, and a Phase II expansion area. This landfill has a permitted design capacity greater than 2.5 million megagrams (Mg) by mass and 2.5 million cubic meters by volume and is subject to the requirements of 40 Code of Federal Regulations (CFR) 60, Subpart WWW. Non-methane organic compounds (NMOC) are less than 50 Mg/year; therefore is not subject to the collection and control system requirements of 40 CFR 60, Subpart WWW. Methane-rich landfill gas (LFG) produced from the decomposition of disposed waste materials at both active and capped cells is being collected by a LFG collection system. LFG is directed to a 5,500 standard cubic feet per minute (scfm) open candlestick utility flare where methane, NMOC and hazardous air pollutants (HAP) contained in the gas are destroyed at high temperatures.

Landfill Energy Systems Florida, LLC is proposing to construct Sarasota LFG-to-energy plant on leased land adjacent to CCSWDC. Landfill Energy Systems Florida produces renewable energy from the recovery of methane from landfills. Landfill Energy Systems Florida intends to use LFG to fuel four reciprocating internal combustion engines (RICE)/electrical generator sets to produce 6.4 megawatts (MW) total of electricity for sale to the grid. The existing open flare will be used primarily as a backup control device to combust the LFG when the engines are unavailable or to control emissions when more LFG is generated than can be handled by the engines.

The facility will be an electrical services plant categorized under Standard Industrial Classification Code of SIC No. 4911. The facility will be located at 4000 Knights Trail Road, Nokomis, Florida. The UTM coordinates are Zone 17, 362.9 kilometers (km) East, and 3008.9 km North.

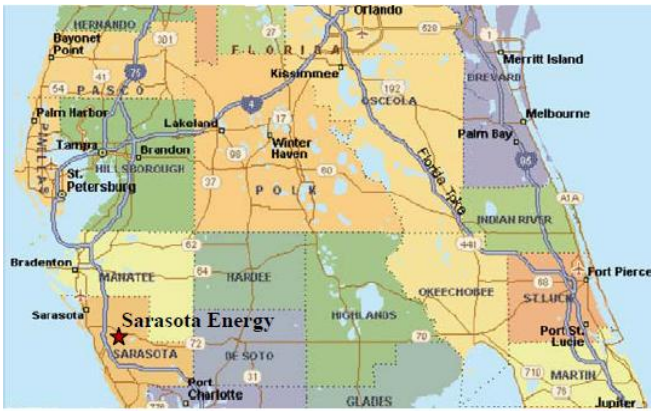

Figure 1: Proposed Location of Facility

Figure 2: Ariel View of Proposed Location

The nearest Prevention of Significant Deterioration (PSD) Class I area is Chassahowitzka National Wildlife Refuge, which is approximately 157 km from the proposed new facility.

1.2. Project Description

The proposed project will consist of Caterpillar (CAT) Model G3520C gas IC engines and electricity generators. The electricity generation plant will consist of:

1. LFG treatment equipment (gas dewatering, filtration and compression equipment and processes).
2. Four (4) lean-burn internal combustion (IC) engines that will be connected to individual electrical generators. Each gas engine will be connected to a 1,600 kilowatt (kW) electrical generator. The plant will have the potential to generate 6.4 MW of electricity under base load operating conditions and will be interconnected to a local utility company's distribution network through a nearby power line.

3. Ancillary equipment that supports the electricity generation operations will consist of fan-cooled radiators, drums for engine radiator coolant and lube oil tanks.

The proposed LFG fueled IC engine/electrical generator sets will be housed in a separate building in a leased area near the existing LFG collection system and flare. The existing flare will be retained and will be used as a backup control device or to control emissions when more LFG is generated than can be handled by the engines. Only treated LFG will be delivered to the engines; any excess LFG will not be treated, but directly routed to the flares. The proposed engines are scheduled to be installed in October 2013 and the approximate startup date is July 2014.

1.3. Process Description

The facility will utilize LFG generated from CCSWDC landfill. LFG will be transported through a gas transmission line that will be connected to the header of the existing LFG collection system. Dedicated gas blowers/compressors will be used to draw methane rich gas from the LFG collection system to a LFG treatment system. Only treated LFG will be delivered to the engines; any excess LFG will not be treated, but directly routed to the flare as shown in Figure 3 below.

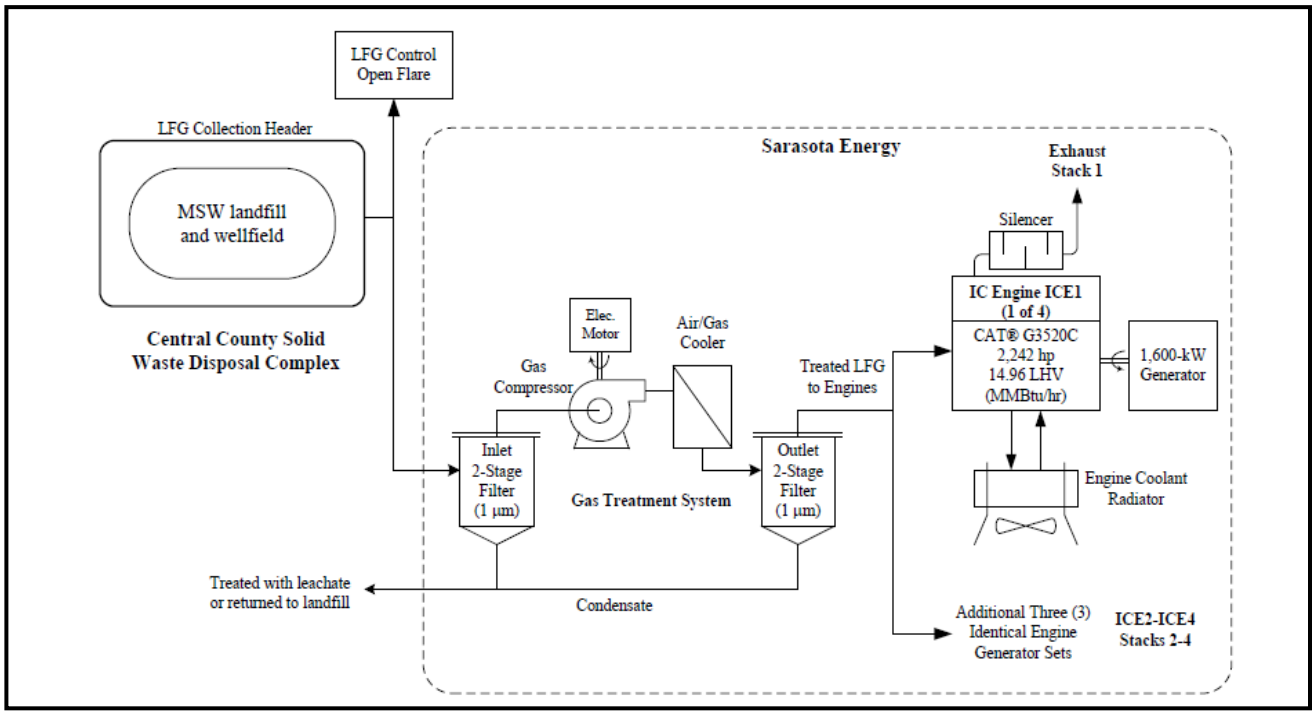

Figure 3: Sarasota LFG-to-Energy Process Flow Diagram

1.3.1. Landfill Gas Physical Properties

LFG production is the result of the degradation of solid wastes placed in a landfill. LFG is a mixture of different gases that are created by chemical reactions and microbes' acting upon waste as the waste begins to break down. The rate of production is affected by the composition of the waste placed in the landfill and site specific conditions. LFG primarily consist of approximately 50% methane the remainder being mostly carbon dioxide and varying amounts of nitrogen and oxygen. The applicant proposes to convert the methane gas emitted from the decomposing garbage to generate power. After the LFG has been treated and prior to be combusted in the engines the LFG lower heating value (LHV) is estimated to be 450 British thermal units/standard cubic foot (Btu/scf) with a higher heating value (HHV) of 500 Btu/scf.

1.3.2. Landfill Gas Availability

The CCSWDC landfill currently generates approximately 1,700 scfm of LFG, which is being controlled by an existing 5,500 scfm open flare. Each engine can fire approximately 554 scfm of LFG per engine for a total of

2,216 scfm for all four engines. This is approximately 6.8 million standard cubic feet per day (MMscf/day). The current LFG generating capacity is adequate to fuel three of the four engines proposed. The fourth engine will be installed when enough LFG is generated to accommodate the fourth engine, which is expected to be approximately 12 months after the first three engines are operating. The permittee will provide requests for permit extensions should they be determined to be necessary. The permittee has been made aware of the source obligation rule in 62-212.400(12)(a), F.A.C. Authorization to construct shall expire if construction is not commenced within 18 months after receipt of the permit or if construction is discontinued for a period of 18 months.

According to the LFG projection recovery model (gas curves), the future estimated landfill production rate is estimated to be 6,186 scfm by the year 2072.

1.3.3. Treatment of Landfill Gas

The equipment and processes used to treat (dewater, filter and compress) the collected LFG prior to its combustion as fuel in the proposed engines will consist of the following.

- Initially, LFG will pass through a two stage inlet gas dewatering/filter vessels. The vessel is composed of bottom chambers that are used for moisture knockout and the top chamber is equipped with coalescing filter media to remove gas particles down to 1 micron filters.
- LFG enters the blower, which supply the compressor. The heat of compression increases the temperature of the gas.
- LFG received from the compressor then enters the air-to-gas cooler, which reduces the elevated temperature of the LFG to approximately 10 degrees Fahrenheit (°F) above ambient temperatures.
- LFG will enter the final two stage outlet gas dewatering/filter vessels. The vessel is composed of bottom chambers that are used for moisture knockout and the top chamber is equipped with coalescing filter media to remove gas particles down to 1 micron filters.

Components of the LFG treatment system will not be equipped with atmospheric vents. Therefore, all of the LFG received by the system will be directed to the engines for use as fuel. LFG in excess of the engines design capacity bypasses the treatment system prior to being routed to the flare for destruction.

1.3.4. CAT G3520C Engines/Generator Specifications (EU 010 – EU 013)

Each of the four identical CAT Model G3520C engines/generators sets will have the following specifications:

- Each engine is designed to fire low-pressure, lean fuel mixtures (lean-burn) and produce low combustion by-product emissions. Each engine is equipped with an air-to-fuel ratio controller to monitor engine performance parameters and automatically adjust the air-to-fuel ratio and ignition timing to maintain efficient fuel combustion, which also minimizes air pollutant emissions.
- Each engine will be fired exclusively with LFG generated by and received from the CCSWDC landfill.
- Each engine will have power generation rating of 2,242 brake horsepower (bhp).
- Each engine will be connected to a 1,600 kW electrical generator.
- The maximum fuel consumption rate of each engine is 554 scfm or 33,240 scf per hour.
- Based on a LFG HHV of 500 Btu/scf, the maximum heat input rating for each engine is 16.61 million Btu per hour (MMBtu/hour) (14.96 MMBtu/hour LHV).

With all four engines operating, the proposed LFG project will have a total electrical generating capacity of 6.4 MW (1.6 MW per engine), nominal. Emissions produced by the combustion of LFG in the four engines will be exhausted to ambient air through individual stacks connected to the engine exhaust manifolds. A noise muffler will be installed on each engine exhaust stack. Each engine exhaust stack will be 1.5 feet in diameter with a volumetric flow rate of 13,700 actual cubic feet per minute (acfm). The fuel combustion system exhausts and noise mufflers will be located on the roof of the single building that houses the engines.

NSPS Provisions for the Engines

The LFG engines and generator sets are subject to applicable NSPS provisions in 40 CFR 60 for Subpart A (General Provisions) and Subpart JJJJ (Standards of Performance for Stationary Spark Ignition Internal Combustion Engines). These regulations establish operating limitations and emissions standards for carbon monoxide (CO), nitrogen oxide (NO_X) and volatile organic compound (VOC) as shown below in Table A for lean burn, spark-ignited engines firing LFG with a capacity of more than 500 hp manufactured after July 1, 2010. Therefore, the engines must meet the following emission standards required by 40 CFR 60.4233(e), as defined by Table 1 of this subpart.

Table A: NSPS Subpart JJJJ Emission Limits

Pollutant	Subpart JJJJ Standards
CO	5.0 g/bhp-hr
NO_X	2.0 g/bhp-hr
VOC	1.0 g/bhp-hr
*Grams per brake horse power-hour (g/bhp-hr)	

The LFG engines are subject to applicable NESHAP provisions in 40 CFR 63 for Subpart A (General Provisions) and Subpart ZZZZ (Reciprocating Internal Combustion Engines). Pursuant to 40 CFR 63.6590, these units comply with NESHAP Subpart ZZZZ by complying with NSPS Subpart JJJJ.

1.3.5. Ancillary Equipment

Each of the proposed IC engines will be equipped with a stand-alone fan-cooled radiator. Engine coolant for the radiators will be stored on-site in drum quantities. Engine lube oil (new and used) will be stored in the following above ground holding tanks:

- 2,000 gallon new lube oil storage tank
- 1,000 gallon used oil storage tank

The ancillary equipment will be located within the premises of the electrical generating plant.

1.3.6. Flare (EU-001)

The existing open candlestick utility flare was installed in 2010. The existing flare will be retained and located in the same position and consists of:

- A maximum volumetric flow rate to the flare of 5,500 scfm.
- A maximum heat input rate of 153 MMBtu/hour.
- The open flare stack is one foot in diameter with a height of 35 feet above ground.
- The flare is designed for an overall 98% destruction efficiency of total hydrocarbons at a design flow with a LFG methane content of 40% to 60%.
- The flare is equipped with a pilot flame fueled by propane/natural gas, a pilot monitoring thermocouple, a main flame monitoring thermocouple, an inlet flame arrestor, and a flame flashback indicator.

The flare will operate under the following scenarios: when the engines are not available because of downtime or maintenance; or when LFG is generated in excess of the design fuel requirements of the proposed engines. The LFG will not be treated when combusted in the flares.

NSPS Provisions for the Flare

The existing CCSWDC landfill is subject to the following applicable provisions: NSPS Subparts A (General Provisions) and WWW (Standards of Performance for Municipal Solid Waste Landfills) in 40 CFR 60. The existing flare has met the applicable requirements of these subparts. The draft permit will not change any currently applicable requirements with regard to these regulations.

1.4. Primary Regulatory Categories

- The facility will be a major source of hazardous air pollutants (HAP).
- The facility will have no units subject to the acid rain provisions of the Clean Air Act.
- The facility will be a Title V major source of air pollution in accordance with Chapter 62-213, F.A.C.
- The facility is subject to PSD preconstruction review in accordance with Rule 62-212.400, F.A.C.
- The facility will include units subject to applicable NSPS in Title 40, Part 60 of the Code of Federal Regulations.
- The facility will include units subject to applicable NESHAP in Title 40, Part 63 of the Code of Federal Regulations.

1.5. Processing Schedule

06/28/2013 Department received the application for an air pollution construction permit.

07/03/2013 Department requested additional information.

08/26/2013 Department received additional information; application complete.

2. APPLICABLE REGULATIONS

2.1. State Regulations

This project is subject to the applicable environmental laws specified in Section 403 of the Florida Statutes (F.S.). The Florida Statutes authorize the Department of Environmental Protection to establish rules and regulations regarding air quality as part of the Florida Administrative Code (F.A.C.). This project is subject to the applicable rules and regulations defined in the following Chapters of the F.A.C.: 62-4 (Permitting Requirements); 62-204 (Ambient Air Quality Requirements, PSD Increments, and Federal Regulations Adopted by Reference); 62-210 (Permits Required, Public Notice, Reports, Stack Height Policy, Circumvention, Excess Emissions, and Forms); 62-212 (Preconstruction Review, PSD Review and Best Available Control Technology (BACT), and Non-attainment Area Review); 62-213 (Title V Air Operation Permits for Major Sources of Air Pollution); 62-296 (Emission Limiting Standards); and 62-297 (Test Methods and Procedures, Continuous Monitoring Specifications, and Alternate Sampling Procedures). PSD applicability and the preconstruction review requirements of Rule 62-212.400, F.A.C. are discussed in Section 2 of this report. Additional details of the other state regulations are provided in Section 3 of this report.

2.2. Federal Regulations

The Environmental Protection Agency (EPA) establishes air quality regulations in Title 40 of the Code of Federal Regulations (CFR). Part 60 identifies NSPS for a variety of industrial activities. Part 61 specifies National Emissions Standards for Hazardous Air Pollutant (NESHAP) based on specific pollutants. Part 63 specifies NESHAP provisions based on the Maximum Achievable Control Technology (MACT) for given source categories. Federal regulations are adopted in Rule 62-204.800, F.A.C. Additional details of the applicable federal regulations are provided in Section 3 of this report.

3. PSD APPLICABILITY REVIEW

3.1. General PSD Applicability

The Department regulates major stationary sources in accordance with Florida's PSD program pursuant to Rule 62-212.400, F.A.C. PSD preconstruction review is required in areas that are currently in attainment with the state and federal Ambient Air Quality Standards (AAQS) or areas designated as "unclassifiable" for these regulated pollutants. Commonly addressed PSD pollutants for IC engines firing LFG at landfills include: CO; NO_X; sulfur dioxide (SO_2); particulate matter (PM); PM smaller than 10 micrometers (PM_{10}); $PM_{2.5}$; VOC; and hydrogen sulfide (H_2S); and municipal solid waste (MSW) landfills emissions measured as NMOC.

Additional PSD pollutants that are more common to certain other industries include: lead (Pb); mercury (Hg); fluorides (F); sulfuric acid mist (SAM); total reduced sulfur (TRS), including H_2S; reduced sulfur compounds, including H_2S; municipal waste combustor (MWC) organics measured as total tetra- through octa-chlorinated dibenzo-p-dioxins and dibenzofurans; MWC metals measured as PM; and MWC acid gases measured as SO_2 and hydrogen chloride (HCl).

As defined in Rule 62-210.200(194)(a)1, F.A.C., a "major stationary source" (major PSD source) is any of 28 listed stationary sources of air pollutants which emits, or has the potential to emit, 100 tons per year (TPY) or more of any PSD pollutant. Link to Rule 62-210, F.A.C. The major stationary source threshold for source categories not on the cited list is 250 TPY or more of any PSD pollutant.

The list given in the citation does not include the category of "landfills" or "LFG-fired electric plants." Therefore, CCSWDC major stationary source threshold is 250 TPY or more of any PSD pollutant. The proposed LFG-to-energy project is a major stationary source based on the potential to emit 250 TPY or more of CO emissions, a PSD pollutant.

For major stationary sources, such as CCSWDC, PSD applicability is based on emissions thresholds known as the significant emission rates (SER) as defined in Rule 62-210.200 (Definitions), F.A.C. For each PSD pollutant that exceeds the corresponding SER, BACT must be employed to control emissions and an air quality impact analysis must be conducted if the PSD pollutant has a defined AAQS. SER also means any emissions rate or any net emissions increase of a PSD pollutant associated with a major stationary source or major modification which would construct within 10 km of a Class I area and have an impact on such area equal to or greater than 1 gram per cubic meter (g/cm^3), 24-hour average.

Although a facility may be "major" (i.e. emits or has the potential to emit 100 or 250 TPY as applicable) for only one PSD pollutant, a project must include BACT controls for any PSD pollutant that exceeds the corresponding SER given in Table 1 below.

Table B: List of SER by PSD-Pollutant [1, 3]

Pollutant	SER (TPY)	Pollutant	SER (TPY)
CO	100	NO_X	40
$PM/PM_{10}/PM_{2.5}$	25/15/10	Ozone (VOC) [2]	40
$PM_{2.5}$ (NO_X)	40	$PM_{2.5}$ (SO_2)	40
Ozone (NO_X) [2]	40	SAM	7
SO_2	40	Pb	0.6
Hg	0.1	GHG (CO_2e)	75,000 [3]

1. Excluding fluoride and those pollutants defined MWC and MSW landfills.
2. Ozone (O_3) is regulated by its precursors (VOC and NO_X). PSD for $PM_{2.5}$ can be triggered by its precursors (NO_X and SO_2).
3. Federal SER of 75,000 TPY for greenhouse gases (GHG) (as CO_2e) for PSD sources and has not been incorporated into Department rules.

According to 40 CFR 52.21, six greenhouse gases (GHG), are also be subject to regulation at new stationary sources that will emit or have the potential to emit 100,000 TPY (SER equal to 75,000 TPY) expressed as the carbon dioxide equivalent emissions (CO_2e). This requirement has not been incorporated into Department rules but is a separate requirement of the EPA.

3.2. Project Subject to PSD Preconstruction Review

CCSWDC is currently a minor source in accordance with Rule 62-212.400, F.A.C. However, the application submitted for this project identified emissions of CO have to potential to emit more than 250 TPY. As a result, the proposed electricity generation plant will be subject to PSD review in accordance with Rule 62-210.200(194)(a)2, F.A.C.

Additionally, Landfill Energy Systems Florida is proposing lease land from the existing CCSWDC for the construction of a LFG-to-energy facility. Therefore, Department must consider whether state and federal law require to treat the proposed facility as an expansion of the existing facility for purposes of PSD preconstruction

review. In determining PSD applicability to new sources, the department must first define the source, which includes: all related pollutant-emitting activities associated with the same industrial grouping, which are generally identified by their two-digit SIC Code number; if the facilities are under common control or ownership; location of facilities; and if the facilities convey, store, or assist in the production of the principal product (or group of products), also known as support facilities. Such evaluations are fact-dependant and made on case-by-case bases.

CCSWDC is a MSW landfill, which includes associated solid waste collection and disposal activities. Both facilities are classified under SIC major group 49. The facilities are under separate ownership; however, when one facility locates on the property of another, the law presumes that both facilities operate under "common control" such that PSD requirements must be applied. Common control for purposes of PSD preconstruction review also exists where one facility serves to support the activity of another. Landfill Energy Systems Florida will be utilizing the LFG generated from CCSWDC facility to produce electricity to be sold under the provisions of a Power Purchase Agreement with the local utility company. Notably, the efficacy of the proposed facility depends on the LFG generated from CCSWDC facility for Landfill Energy Systems Florida ability to sell power.

Considering all factors including those discussed above, the Department concludes that there is common control since the CCSWDC facility is a support facility for Landfill Energy Systems Florida and the proposed electricity generating plants potential emission exceeds the major stationary source threshold. Therefore, the project is subject to PSD preconstruction review. Emissions increases from the project will be evaluated based on the PSD SER. Nevertheless, the Department intends to issue to Landfill Energy Systems Florida, LLC a separate PSD air construction permit to build the proposed LFG-to-energy facility.

3.3. PSD Applicability for the Project

The project is located in Sarasota County, which is in an area that is currently in attainment with the AAQS or otherwise designated as unclassifiable. Table 2 summarizes the annual emissions from the project as defined in the application. The table compares these emissions to the PSD significant emission rates.

Table C: Annual Emission Summary and PSD Applicability

Pollutant	Project Potential Emissions (TPY)		Significant Emissions Rate (TPY)	Subject to PSD?
	Per Engine	All Four Engines		
CO	75.8	303.1	100	**Yes**
NO_X	13.0	52.0	40	**Yes**
PM	5.0	20.8	25	No
PM_{10}	5.2	20.8	15	**Yes**
$PM_{2.5}$	5.2	20.8	10	**Yes**
SO_2 [b]	9.0	36.0	40	No
VOC [b]	9.0	36.4	40	No
H_2S [c]	0.5	0.2	10	No
NMOC [b]	11.26	45.0	50	No
GHG (CO_2e)	---	33,596	75,000	No

a. Tons per year (TPY)
b. The potential emissions are based on the worst-case scenario operating the engines 8,760 hours/year. The applicant based the potential annual emissions of SO_2, VOC and NMOC on 90% of the SER threshold of 40 TPY for SO_2 and VOC, and 50 TPY for NMOC and requested an emissions CAP for the project of 36 TPY for SO_2, 36.4 TPY for VOC and 45 TPY for NMOC.
c. The LFG is treated to remove 99% of H_2S prior to combustion in the engines. It is assumed that all sulfur in the LFG will be converted to SO_2 when combusted.

As shown in the above table, the project is subject to PSD preconstruction review for CO, NO_X and $PM_{10}/PM_{2.5}$ emissions in accordance with the provisions of Rule 62-212.400, F.A.C. Therefore, BACT determinations and air quality modeling analysis are required for CO, NO_X and $PM_{10}/PM_{2.5}$ emissions. An air quality modeling analysis is required for CO, nitrogen dioxide (NO_2) and $PM_{10}/PM_{2.5}$ emissions.

The applicant provided a GHG and CO_2e emissions PSD analysis to demonstrate that the proposed project would not trigger a PSD review per 40 CFR 52.21, i.e., the PSD Tailoring Rule.

4. DEPARTMENT'S PROJECT REVIEW

Emission sources associated with this facility include four identical 1.6 MW Caterpillar Model G3520C RICE/electrical generator sets. As previously described, the project is subject to PSD preconstruction review for CO, NO_X and $PM_{10}/PM_{2.5}$ emissions from the LFG engines.

4.1. General Discussion of Emissions

NSPS Subpart JJJJ regulations establish operating limitations and emissions standards for CO, NO_X and VOC. The applicant provided technical data sheets showing that the engines firing low energy fuel will meet the emission limits established in NSPS Subpart JJJJ. The vendor, Caterpillar, will not certify the CAT G3520C engines when burning LFG as fuel. Based on operating identical engines firing LFG at other landfills, the applicant has proposed emission limits, as shown in Table D below, to be below the emissions limits identified in NSPS subpart JJJJ for all pollutants and below engine manufacturers estimated emission standards for CO and VOC and a slightly higher emission standard for NO_X emissions. As a result, the Department will require that the engines are tested to demonstrate compliance with these emissions standards.

Table D: NSPS Subpart JJJJ and CAT G3520C Emission Standards and Proposed Emission Limits

Pollutant	Subpart JJJJ Standards	CAT G3520C Standard	Proposed Limits
CO	5.0 g/bhp-hr	4.22 g/bhp-hour	3.5 g/bhp-hr
NO_X	2.0 g/bhp-hr	0.5 g/bhp-hour	0.6 g/bhp-hr
VOC	1.0 g/bhp-hr	0.56 g/bhp-hour	0.42 g/bhp-hr

4.2. Emission Standards

Based on Landfill Energy Systems Florida, LLC experience in operating numerous identical LFG fuel engines at various other facilities and the BACT analysis, the applicant proposes the following maximum emission rates for the CAT G3520C engines:

- NO_X: 0.60 g/bhp-hour
  2.97 pound/hour (lb/hour) and 13.09 TPY per engine
  52.0 TPY for all four engines
- CO: 3.5 g/bhp-hour
  17.3 lb/hour and 75.8 TPY per engine
  303.1 TPY for all four engines
- VOC: 0.42 g/bhp-hour
  2.08 lb/hour and 9.0 TPY per engine
  36.4 TPY for all four engines
- NMOC: 0.52 g/bhp-hour
  2.57 lb/hour and 11.26 TPY per engine
  45.0 TPY for all four engines
- $PM/PM_{10}/PM_{2.5}$: 0.24 g/bhp-hour
  1.19 lb/hour and 5.2 TPY per engine
  20.8 TPY for all four engines

- SO_2: 289 ppmv of H_2S and48 lb/MMscf
  2.05 lb/hour and 9.0 TPY per engine
  36.0 TPY for all six engines

Potential CO, NO_X and $PM_{10}/PM_{2.5}$ emissions were based on the results of BACT analyses. These emissions were estimated using emission factors developed by Landfill Energy Systems Florida based on operating identical units at other landfills. The applicant requested a CAP at 90% of the PSD SER threshold of 40 TPY for SO_2 and VOC, and 50 TPY for NMOC.

SO_2 emissions can be produced during the combustion of LFG since it contains sulfur-bearing compounds (such as H_2S) that are oxidized at normal engine operating temperatures. Results of the site-specific chemical composition analysis indicated that the LFG generated by the landfill has a total sulfur content that is less than 100 parts per million by volume (ppmv). Therefore, to account for uncertainties and variability's in the future sulfur content of the LFG, data developed by U.S. EPA, AP-42, Section 2.4 and an emission CAP of 36 TPY were used to establish a SO_2 emission limit for the engines.

Emissions data from Caterpillar indicates a not to exceed (NTE) of 4.22 g/bhp-hour for CO and 0.5 for NO_X emissions. Site-specific emissions testing in Florida for these engines firing LFG have been installed and are in operation. CO and NO_X emission limits established for these facilities are the same emission limits that Landfill Energy Systems Florida is proposing of 3.5 g/bhp-hour for CO and 0.6 g/bhp-hr for NO_X. Annual compliance tests conducted at these facilities are shown in Table E.

Table E – CO and NO_X for LFG Fired in Internal Combustion Engines Permitted in Florida

	CO				NO_X			
	Actual Emissions (g/bhp-hr) [c, d]				Actual Emissions (g/bhp-hr) [c, d]			
Facility [a, b]	Initial Year		2012	Increase	Initial Year		2012	Increase
Brevard Energy – No. 3	2010	2.41	2.76	0.36	2010	0.46	0.52	0.06
Brevard Energy – No. 4	2010	2.41	2.76	0.35	2010	0.46	0.52	0.06
Brevard Energy – No. 5	2010	2.41	2.77	0.36	2010	0.46	0.52	0.06
Brevard Energy – No. 6	2010	2.41	2.76	0.35	2010	0.45	0.52	0.06
Trail Ridge Energy – No. 1	2010	2.67	2.86	0.20	2010	0.43	0.49	0.06
Trail Ridge Energy – No. 4	2010	2.67	2.86	0.20	2010	0.42	0.49	0.07
Trail Ridge Energy – No. 5	2010	2.67	2.86	0.19	2010	0.43	0.49	0.06
Seminole Energy – No. 3	2009	2.08	2.68	0.61	2009	0.60	0.47	-0.12

a. Caterpillar Model G3520C – 2,233 bhp (1,600 kW)
b. Permit limit of 3.50 g/bhp-hour for CO and 0.6 g/bhp-hour for NO_X.
c. Actual emissions based on the air operating report (AOR) submitted by the facility for the initial and most current full year of operation.
d. Facility, year of compliance test, engine number (#), and hours/year of operation for the following facilities consist of: Brevard Energy - # 3: 8,564 (2010)-8,576 (2012), #4: 8,556 (2010)-8,443 (2012), #5: 8,478 (2010)-8,569 (2012), and #6: 8,491 (2010)-8,566 (2012); Trail Ridge Energy - #1: 8,475 (2009)-8,477 (2012), #4: 8,533 (2009)-8,477 (2012), and #5: 8,587 (2009)-8,546 (2012); Seminole Energy - #3: 8,165(2010)-8,066 (2012).
e. Based on actual hours of operation (as shown above) and the difference in TPY of data submitted in AOR.

As shown in Table E, actual tested emissions of CO and NO_X from these engines are well below the proposed emissions limits established in NSPS Subpart JJJJ of 40 CFR 60 and requested by the applicant. While these CO compliance test results are significantly less than the manufacturers' not-to-emit limit, variability in the LFG fuel methane content and engine maintenance cycles will have a significant impact on projected CO emissions in the future.

Based on the comparison of site-specific emissions testing in Florida on engines operating over a two and three year span as illustrated in Table E above, emissions of CO and NO_X shows an increase of 0.19 g/bhp-hour to 0.36 g/bhp-hour of CO emissions and 0.06 g/bhp-hour to 0.07 g/bhp-hour of NO_X emissions for engines operating for approximately two years at the Brevard Energy and Trail Ridge Energy facilities. Seminole Energy has been operating identical engines for approximately three years and shows an even higher increase in CO

emissions of 0.61 g/bhp-hour and yet a decrease in NO_X emission of 0.12 g/bhp-hour. Research has shown that siloxanes deposits produced from the LFG degrade the performance of these engines over time. As the engine performance degrades, it is difficult to maintain the engine tuned for low CO and NO_X emissions. Maintenance is required to restore the combustion equipment to proper operation.

In support of this concept, the Department found a recent white paper report by the Bay Area Air Quality Management District (BAAQMD) titled, "Revisiting BACT for Lean-Burn Landfill Gas Fired Internal Combustion Engines" from February of 2009. The paper discussed the difficulties in maintaining to maintain the engine tuned for low CO and NO_X emissions. Based on test data (62 individual tests) for firing LFG in three types of spark-ignited RICE (15 total engines), the report indicates the following:

- The engines were annually demonstrating compliance with the CO and NO_X standards; however, this appeared to be more of a function of careful preparation of the engine for the annual test rather than the design of the engine.
- The same engine type could be "biased for low NO_X emissions" (0.5 g NO_X/bhp-hour or less with greater than 2.1 g CO/bhp-hour) or "biased for low CO emissions" (2.1 g CO/bhp-hour or less with greater than 0.5 g NO_X/bhp-hour) depending on the air-fuel controller.
- The exhaust from some of the tested engines was periodically monitored throughout the year by hand-held portable probes. This data showed degradation with regard to CO emissions such that many engines were frequently in excess of the low CO BACT standard. The report indicates a gradual CO increase of up to 1.5 g/bhp-hour over a year of operation.

The conclusion of the report is that CO and NO_X emissions standards should be paired when relying on combustion design and control. As shown below, the Bay Area Air Quality Management District chose to establish standards based on a low NO_X bias or a low CO bias and then allow the CO standard to increase approximately 1.5 g/bhp-hour over a year of operation calling the upper CO standard a "not to exceed" limit:

Low NO_X Bias:	NO_X:	0.5 g/bhp-hour
	CO:	2.5 g/bhp-hour (and NTE 3.9 g/bhp-hour)
Low CO Bias:	NO_X:	0.6 g/bhp-hour
	CO:	2.1 g/bhp-hour (and NTE 3.6 g/bhp-hour)

The emission controls were based on the engine design and good combustion practices (including maintenance).

4.3. Hazardous Air Pollutants

Hazardous Air Pollutants (HAP) as specified in Rule 62-210.200(160), F.A.C are produced during the combustion of LFG to be used as fuel by the IC engines since:

1. HAP compounds are present in the gas generated by CCSWDC landfill and the fuel combustion process is not 100% complete and a small portion of the HAPs pass through the fuel combustion system.
2. Chlorinated compounds present in LFG have the potential to form hydrogen chloride (HCl, a regulated HAP) when they are combusted.
3. The presence of methane and elevated temperatures (700°F – 900°F) in the IC engine exhaust produces formaldehyde (CH_2O, a regulated HAP).

Site-specific HAP content analysis was performed on the LFG generated by CCSWDC landfill. Results of the chemical composition of the LFG indicated that a limited number of VOC constituents are present in the LFG above the thresholds of the analytical method (0.025 ppmv or 0.1 ppmv, which is dependent on the chemical). Those LFG constituents that were measured are present in concentrations that are relatively low (<1.0 ppmv). Thus, data developed by EPA in AP-42, Section 2.4 (Table 2.4-1) were used to estimate the total potential HAP content of the LFG to be used as fuel. Engines typically reduce halogenated species by 93% and non-halogenated species by 86.1%. For that reason, the control efficiencies were considered in the HAP potential emission determinations. Based on 100% design capacity of the engines, the applicant estimates total annual HAP emissions (LFG constituents) from all four engines to be 2.3 TPY.

The contribution of HCl to the HAP potential emissions for the engines were estimated based on a conversion of the individual chlorinated compound measurements presented in AP-42. Based on 100% design capacity of the engines, the applicant estimates HCl emissions from all four engines to be 8.4 TPY.

Caterpillar (Model G3520C), the engine manufacturer recognizes that formaldehyde (CH_2O) is produced in the combustion of low energy fuel, such as LFG, and has developed an emission factor for the equipment of 0.42 g/bhp-hour. Based on 100% design capacity of the engines, the applicant estimates CH_2O emissions from all four engines to be 36.4 TPY.

Total annual HAP emissions were based on chemical composition of the LFG including the contribution of HCl and formaldehyde. Based on the maximum operating scenarios, the applicant estimates total annual HAP emissions from all four engines to be 47.0 TPY.

The proposed LFG fueled engines have the potential to emit more than 10 TPY of a single HAP, as well as more than 25 TPY for any combination of HAPs. Therefore, the Department identifies this facility to be Title V major source of air pollution.

5. BEST AVAILABLE CONTROL TECHNOLOGY (BACT) DETERMINATION

The project to install four LFG engines is a physical modification of the facility. As previously described, the project is subject to PSD preconstruction review for CO, NO_X and $PM_{10}/PM_{2.5}$ emissions from the LFG engines (EU 010 - 013).

5.1. General Discussion of CO, NO_X and $PM_{10}/PM_{2.5}$ Emissions

The CAT G3520C engines are the primary source of CO, NO_X and $PM_{10}/PM_{2.5}$ emissions from this project. Table F summarizes the potential annual emissions produced from the engines.

Table F: Potential Annual Emissions

Pollutant	Tons/Year
	CAT G3520C Engines
CO	303.1
NO_X	52.0
PM_{10}/PM2.5	20.8

The applicant reviewed data in EPA's RACT/BACT/LAER Clearinghouse (RBLC) to identify control technology determinations for the operation of RICE firing LFG. The following table summarizes this information.

Table G: CO, NO_X and $PM_{10}/PM_{2.5}$ BACT Determination for LFG fired IC engines.

Facility	Engine Type and Size	Date	Control Method CO/NO_X	Type	g/bhp-hour			
					CO	NO_X	PM_{10}	$PM_{2.5}$
PPL Renewable Energy, LLC (VT)	CAT 3520 2233 HP	07/12/2012	LBD & Maintenance	CBC	3.5	---	---	---
North America Natural Resources (MI)	CAT 3520 2233 HP	05/08/2012	A/F Controller	BACT	3.3	0.6	---	0.2
Twin Bridges Recycling & Disposal (IN)	CAT 3520 2233 HP	03/05/2012	GCP	BACT	3.3	---	---	---
Loraine County LGF Power Station (OH)	CAT 3520 2233 HP	09/14/2011	LBD	BACT	2.75	0.5	0.1	---
Waste Management, Medley Landfill (FL)	CAT 3520 2233 HP	08/25/2011	LBD &GCP	BACT	3.5	---	0.24	0.24

Facility	Engine Type and Size	Date	Control Method CO/NO_X	Type	g/bhp-hour			
					CO	NO_X	PM_{10}	$PM_{2.5}$
Sumter Energy Associates (MI)	LFG-ICE 2233 HP	06/29/2011	GCP & A/F Controller	BACT	3.3	0.6	0.23	---
Granger Electric Company (MI)	LFG-ICE 2233 HP	06/17/2011	GCP & A/F Controller	BACT	3.3	1.0	0.15	0.15
Green Gas Pioneer Crossing Energy (PA)	LFG-ICE 2233 HP	12/13/2010	LBD & A/F Controller	BACT	3.0	0.5	0.17	---
Pine Tree Landfill (ME)	LFG-ICE 1359 HP	10/15/2007	---	BACT	2.75	0.65	---	---
University of New Hampshire (NH)	LFG-ICE 2233 HP	07/25/2007	Combustion Controls	BACT/ LAER	2.75	0.5	0.1	---
Brevard Energy, LLC (FL)	CAT 3520 2233 HP	03/06/2007	GCP	BACT	3.5[f]	0.6	0.27	---
Seminole Energy, LLC (FL)	CAT 3520 2146 HP	01/17/2007	GC	BACT	3.5[f]	0.6	0.24	---
Monmouth County Reclamation Center (NJ)	LFG-ICE 1468 HP	12/12/2006	---	CBC/ LAER	2.53	0.53	0.18[b]	---
Manchester Renewable Power Corp. (NJ)	CAT 2233 HP	10/06/2006	A/F Controller	BACT/ LAER	2.75	0.5	0.2	0.2
Burlington County Resource Recovery (NJ)	Jenbacher 2012 HP	08/03/2006	GCP	CBC/ LAER	2.5	0.6	0.17[c]	---
Trail Ridge Energy, LLC (FL)	CAT 3520 2233 HP	02/24/2006	GC	BACT	3.5[f]	0.6	0.24	---
Ridgewood Rhode Island Generation (RI)	CAT 3520 2229 HP	01/05/2005	A/F Controller	BACT/ LAER	2.75	0.5	0.1	---
New England Waste Services, Inc. (VT)	CAT 3520 2221 HP	12/16/2004	LBD	CBC	2.75	0.5	---	---
Bio Energy Texas, LLC (TX)	CAT 3520 2172 HP	07/23/2004	LBD	BACT	2.8	0.6	0.15[d]	---
Lee County Landfill (SC)	Jenbacher 2677 HP	01/13/2004	LBD & GCP	BACT	3.4	0.57	0.2	---

a. Abbreviations: Air/Fuel Controller (A/F Controller); Case-By-Case (CBC); Good Combustion Practices (GCP); Good Combustion (GC); Horsepower (HP); Internal Combustion Engines (ICE); Landfill Gas (LFG); and Lean Burn Design (LBD).

b. Project shows CBC emission limit for PM_{10} as 0.58 lb/hour per engine, conversion to g/bhp-hour.

c. Project shows CBC emission limit for PM_{10} as 0.75 lb/hour per engine, conversion to g/bhp-hour.

d. Project shows BACT limit for PM_{10} as 0.71 lb/hour, conversion to g/bhp-hour.

e. Calculated value based on USEPA RBLC database.

f. Reflects the approved (2011) higher BACT emission limit for CO for LFG-fired engines in Florida. Original BACT limit for CO emissions was 2.75 g/bhp-hr.

The specified CO and NO_X BACT/LAER determinations are applicable to the operation of lean-burn engines with air-to-fuel ratio control. The proposed CAT G3520C engines have a power rating of 2,242 bhp. As shown in the table, for LFG engines rated greater than 1,359 bhp and less than 2,677 bhp, the CO BACT ranges from 2.75 to 3.5 g/bhp-hour. The corresponding NO_X BACT/LAER range from approximately 0.5 to 0.65 g/bhp-hour. The $PM_{10}/PM_{2.5}$ BACT ranges from 0.1 to 0.27 g/bhp-hour.

Table H: BACT Emission Limits Proposed by Applicant (per Engine)

Pollutant	Emission Limit	Control Technology
CO	3.5 g/bhp-hr and 17. 3 lb/hour	Lean-burn engine with air-to-fuel controller
NO_X	0.6 g/bhp-hr and 2.97 lb/hour	Lean-burn engine with air-to-fuel controller
$PM_{10}/PM_{2.5}$	0.24 g/bhp-hr and 1.19 lb/hour	Pretreatment of LFG and good combustion practices

5.2. BACT for CO

Combustion byproducts are generally controlled by an efficient combustion design, but thermal oxidation and catalytic technologies are available for reducing these emissions.

5.2.1. Identification of Control Technologies

The applicant provided the following control technologies:

- *Oxidation Catalysts:* The basic principle in the operation of the oxidation catalyst is the chemical reaction (oxidation) of CO in the presence of excess oxygen (O_2), heat and a catalyst to form CO_2. The primary design is a flow through exhaust device that contains a honeycomb structure covered with a layer of chemical catalyst that operates at high temperatures. This layer contains small amounts of precious metal that promote the complete oxidation of pollutants in the exhaust stream. This control device will reduce CO emissions as well as VOC emissions, depending on the type and concentration. Destruction efficiencies for CO and VOC emissions can be greater than 90%.
- *Thermal Oxidation – Flare:* Thermal oxidation through the use of a flare is a process in which CO is controlled through its oxidation at a high temperature in the presence of O_2 to form CO_2. The use of a flare for CO emission control would require the IC engine exhaust gas to be piped to a central location where it is combusted in an open flame through the use of a specially designed burner tip and auxiliary fuel source. In general, a flare can provide CO control efficiencies of up to 98%.
- *Thermal Oxidation – Recuperative Oxidizer:* Thermal recuperative oxidizer primarily is a direct fired thermal oxidizer with heat recovery added at the discharge end of the combustion chamber. The exhaust gas from the engine is piped to the combustion chamber and is heated using an auxiliary fuel source. Secondly, an air-to-air shell and tube heat exchanger located after the exhaust gas combustion chamber will use the high temperature of the exhaust gas to preheat the incoming gas. This control device will reduce CO emissions as well as VOC emissions. Destruction efficiencies of 65% to 95% for CO emissions are dependent upon high temperatures (1200°F to 1425°F) produced from the heat exchangers and combustion chamber, respectively.
- *Thermal Oxidation – Regenerative Oxidizer:* The regenerative thermal oxidizer (RTO) is for the treatment of exhaust air for CO reduction. RTO utilizes beds of ceramic media to retain the temperature of the flue gas in the optimum range of approximately 1600 ^{o}F to reduce emissions of CO as well as VOC. The use of a direct contact heat exchanger allows for greater heat recovery efficiencies. Typical RTO can achieve CO control efficiencies of up to 98%.
- *Good Design and Operating Practices:* The design and operation of the combustion chamber is the primary mechanism in controlling CO emissions. The CAT G3520C engines are designed for high-combustion efficiency to extract the most useful energy from the LFG possible, which will minimize CO emissions. Proper design and operation practices can limit the amount of CO that is generated by IC engine operations. Operating the IC engine at the proper air to fuel ratio ensures more complete combustion of the fuel and reduces CO emissions (which are a by-product of incomplete combustion). Engine timing is also important in reducing CO emissions. Fuel ignition must occur when the proper air to fuel mixture is achieved in the combustion cylinder. Fuel ignition prior to or after achieving the proper air to fuel mixture can result in incomplete combustion and generation of greater CO emissions.

5.2.2. Discussion of Technically Infeasible Control Options and Ranking of Remaining Options

Oxidation catalyst are susceptible to poisoning (i.e., encapsulation and deactivation of the catalyst) by impurities that may be present in the incoming waste gas. Impurities in LFG include siloxanes, which are a class of compounds that exist in the form of R_2SiO, where R is a hydrogen atom or a hydrocarbon and Si is silicon. Siloxanes are present in certain landfill waste streams such as toiletries, cosmetics and other personal grooming items. When combusted, such compounds produce silica (SiO_2), which can quickly poison a catalyst rendering it ineffective. A separate treatment system to remove SiO_2 would be necessary to avoid the adverse effects of deposits and the rapid decrease in reactivity of the catalyst.

The California Air Resource Board (CARB) has developed and published *Guidance for the Permitting of Electrical Generation Technologies* in July 2002, to assist companies and organizations in the permitting of electrical generating equipment. In this guidance document, CARB:

- Recognizes the benefits of generating electricity from waste gases (landfill and digester gas) and the recovery of useful energy.
- Indicates that waste gases "… contain impurities that, if combusted will likely poison catalyst-based post combustion control systems."
- Determines that additional fuel treatment and post combustion controls have limited success and/or have not been proven to be cost effective in reducing air pollutant emissions from waste combustion applications.

Other state regulatory agencies (e.g., Texas, Rhode Island and New Jersey) have made similar determinations and issued permits that specify BACT for LFG-fueled engines that do not include the use of add-on emission controls because of catalyst poisoning by siloxanes. Such poisoning leads to poor reduction efficiencies and eventually destruction and early replacement of the catalyst. In the preamble to the NSPS for Stationary Spark Ignition IC engines and the NESHAP for RICE, EPA recognizes the affect that siloxanes combustion has on add-on control devices. The preambles of these rules state that:

> *Both landfill and digester gases contain a family of silicon-based gases collectively called siloxanes. Combustion of siloxanes forms compounds that have been known to foul fuel systems, combustion chambers, and post-combustion catalysts.*

For a post fuel combustion emission control system to operate on a sustained basis, siloxanes must be removed from the LFG prior to its use to avoid fouling these catalyst-based systems, otherwise the control system is rendered ineffective in a relatively short amount of time. Adsorption-based siloxane removal systems can be used to reduce the content of siloxanes in LFG. However, these systems (like most control systems) only reduce the siloxane content to a certain level or have a specified control efficiency that is less than 100%. Parker Hannifin Corporation/Domnick-Hunter, one of the leading manufacturers of siloxane removal systems, guarantees that its LFG treatment system will reduce siloxane concentrations at its outlet to a concentration of approximately 5 milligrams/cubic meter (mg/m^3). However, vendors of catalyst-based control systems will not guarantee the performance of their units unless all or virtually all) of the silicon-based compounds have been removed from the fuel stream. Clean Air Systems provides a warranty on the catalyst emission control systems manufactured and installed on IC engines. However, the warranty statement specifies that *"Using fuels with … contaminates such as siloxanes … will void the warranty coverage."*

Another catalyst manufacturer, Miratech Corporation, provided a list of catalyst poisons that limits the amount of siloxanes found in biofuels to levels below 0.5 mg/kg (equivalent to 0.6 mg/m^3). On July 7, 2011, CCSWDC landfill reported a siloxane level of 10.94 mg/m^3, which is much higher than the catalyst manufacturer recommends. This will mean more frequent preventative maintenance as well as major maintenance overhauls. Therefore, add-on control technologies using a catalyst are considered technically infeasible for this project due to premature deactivation by siloxanes.

The remaining control options (Thermal Oxidation – Flare, Recuperative Oxidizer, Regenerative Oxidizer, and Good Combustion Design and Controls) are commercially available, though not specifically designed for use on IC engines that are fueled with LFG. Additionally, none of the following control devices identified have been installed and successfully operated on a LFG fueled IC engine on a long-term basis.

The use of a flare would require an auxiliary fuel to maintain the heating value necessary to sustain a stable flame. In addition, the combustion of a non-renewable fuel to operate this flare would result in the generation of significant amounts of CO, NO_X and $PM_{10}/PM_{2.5}$ in addition to the potential emissions estimated for the project. Therefore, the use of a non-renewable fuel to operate a flare would defeat the purpose of the proposed project, which is to generate electricity from a readily available renewable fuel source. Therefore, the flare is not feasible for the LFG engines.

Typical recuperative oxidizers and RTO's are also susceptible to plugging of the ceramic material by impurities produced by LFG combustion, which over time will reduce the thermal efficiency of the heat exchangers.

Additionally, both the recuperative oxidizer and RTO would also require air added to the combustion chamber of the device so that its O_2 content is at least 16.5% by volume. Therefore, the recuperative oxidizer and RTO are not feasible for the LFG engines.

The remaining control option is combustion design and controls. As previously shown by the applicant, data in the RBLC database (2004 – 2012) supports the lean-burn combustion design, air-fuel controller and good combustion practices as BACT for LFG engines.

5.2.3. Selection of BACT and Rationale

The applicant proposes to use efficient combustion design and air-fuel controllers to establish BACT for CO as 3.5 g/bhp-hour. As shown in previous Table G summarizing BACT standards posted in the RBLC database, the range of previous CO BACT standards is 2.5 to 3.5 g/bhp-hour. The control method identified consisted of the operation of lean burn engines with air to fuel ratio control. The applicant's proposed limit is based on Landfill Energy Systems Florida experience with operating numerous identical LFG fired engines and the ambient temperatures throughout Florida. Caterpillar, LLC specifies a "not to exceed" limit of 4.22 g CO/bhp-hour at 100% load. The proposed limits are lower than NSPS Subpart JJJJ emissions standards of 5.0 g CO/bhp-hour.

For several previous projects using the CAT G3520C engines firing LFG, the Department originally established CO BACT as 2.75 g/bhp-hour, which were based on the applicant's proposals as well as the efficient combustion design and air-fuel controllers. The engines have been installed and are in operation. Three facilities (Brevard Energy, Seminole Energy and Trail Ridge Energy) have been issued revised permits increasing the CO emissions standards to 3.5 g/bhp-hour stating that the gradual degradation of the engines will cause higher CO emissions.

In support of this concept, The BAAQMD white paper also discussed this very issue. The study discovered that the variability in engine combustion efficiency was not being accounted for since, "… *CO deterioration during the year is not typically detected nor limited*". Existing BACT emissions limits "achieved in practice" were based on once per year compliance tests. Such tests do not account for variability of emissions due to degraded engine performance resulting from siloxane deposits on combustion surfaces. In addition, existing BACT limits were "… *established based on early, limited source test data for digester gas fired engines …*" and as such, are not appropriate for LFG combustion engines. Wastewater digester gas has higher methane content than LFG meaning that it also has a higher amount of energy per unit volume. The BAAQMD concluded that:

> "… *Our discussions with waste gas engine operators leads us to believe that engines generally perform at their best after overhaul events and that combustion performance tends to deteriorate as siloxane deposits form throughout the combustion surfaces … it is apparent that it is normal for CO emissions to increase as the engines are operated, and establishment of not to exceed limits based on a nominal rate of CO increase would seem to be a reasonable approach for these engines … and additional monitoring is needed to ensure that the engines get needed maintenance in a timely fashion. Engine maintenance events may not have a significant impact on NO_X emissions, but for LFG engines regular maintenance is of paramount importance for minimizing CO emissions." The BAAQMD recommends a 'not-to-emit' emissions limit of 3.6 g/bhp-hr for low-CO biased engines.*

As discussed in Section 4.2, the Department also agrees that additional flexibility with CO emissions is necessary to concurrently maintain and tune the engines for low NO_X emissions. The applicant's proposed BACT limits of 3.5 g CO/bhp-hour appear to be in line with this concept and is based on actual performance of these engines at Landfill Energy Systems Florida other facilities. Therefore, considering all available information, the Department establishes the following preliminary CO BACT standards for the proposed engines:

CO: 3.5 g/bhp-hour and 17.2 lb/hour (initial and annual EPA Method 10 stack test)

This will provide adequate room for reasonable CO emission levels for the IC engines/generator sets.

5.3. BACT for NO_X

Combustion byproducts are generally controlled by an efficient combustion design, but catalytic technologies are available for reducing NO_X emissions.

5.3.1. Identification of Control Technologies

- *Selective Catalytic Reduction (SCR):* The basic principle of SCR is the injection of ammonia (NH_3) into the exhaust stream prior to a catalyst. In the presence of a catalyst, ammonia and NO_X will be reduced to nitrogen (N_2), CO_2 and water vapor (H_2O). Several different catalysts are available for use at different exhaust gas temperatures. Removal efficiencies may be greater than 90%.
- *Regenerative Selective Catalytic Reduction (RSCR):* Regenerative selective catalytic reduction is targeted for tail-end applications. RSCR utilizes beds of ceramic media to retain the temperature of the flue gas in the optimum range for the catalytic reaction (approximately 500º F to 900º F), which is a key operating parameter for effective NO_X removal. Such systems are capable of 95% heat recovery, which minimizes operating costs while reducing NO_X emissions by 80% to 90% or more.
- *Selective Non-Catalytic Reduction (SNCR)*: Selective non-catalytic reduction uses ammonia injection into the high temperature combustion zone or flue gas. This is a post-combustion control technology that reduces NO_X to N_2, CO_2 and H_2O in the presence of excess O_2, ammonia and heat. The chemical reaction for this technology is driven by high temperatures (1600ºF to 2100ºF) normally found in combustion sources. Removal efficiencies are in the range of 30% to 75% depending on the application.
- *Non-Selective Catalytic Reduction (NSCR):* Non-selective non-catalytic reductions use a three-way catalyst to remove NO_X from IC engine exhausts. NSCR are primarily used to reduce emissions of NO_X in exhaust gas streams that have low O_2 concentrations. The operation of a NSCR system is based on the chemical reaction (reduction) of NO and NO_2 to form N_2, CO_2 and H_2O in the presence of excess methane (i.e., an O_2 depleted atmosphere), heat and a catalyst. The second reaction will only occur in the absence of O_2. The NO_X reduction in the catalyst bed requires the presence of temperatures in the range of 500 ˚F to 1350 ˚F. Removal efficiencies may be greater than 95% depending on the application.
- *Combustion Design and Air-Fuel Controllers:* The CAT G3520C engines are designed for high-combustion efficiency to extract the most useful energy from the LFG possible. Combustion controls include technologies designed to limit the formation of NO_X as well as CO by controlling the combustion temperature and the mixing of air and fuel in the combustion zone. Combustion controls for NO_X include injection timing retard, pre-ignition chamber combustion, controlling air-to-fuel ratio, or de-rating of the engine. The primary NO_X control is a lean-burn combustion design, which uses approximately 75% more air than needed for complete combustion into the combustion chambers. The weak air-fuel mixture leads to lower combustion temperatures and therefore reduces thermal NO_X formation. The proposed CAT G3520C engines are lean-burn engines equipped with an electronic air-fuel ratio controller that will minimize incomplete combustion and maintain a proper balance between NO_X and CO emissions.

5.3.2. Discussion of Technically Infeasible Control Options and Ranking of Remaining Options

In 2010, landfills permitted in the state of Florida to operate the Caterpillar Model G3520C reported siloxane levels of approximately 21 ppm (1.6 micrograms/Btu (µg/Btu)), which is higher than the level recommended by the engine manufacturer, Caterpillar (0.60 µg/Btu). This will mean more frequent preventative maintenance as well as major maintenance overhauls.

As previously discussed in papers issued by BAAQMD, CARB, EPA's preambles for NSPS and NESHAP as well as information provided by RBLC, catalyst manufacturers and manufacturers of siloxanes removal systems, the Department recognizes the following issues and determinations made for firing LFG in IC engines:

- LFG contains multiple silicon-based gases called siloxanes. Combustion of siloxanes forms compounds that have been known to foul fuel systems, combustion chambers, and post-combustion catalysts.

- Siloxanes present in waste gas quickly poison a catalyst rendering it ineffective as well as degrade the performance of the engines over time. As the engine performance degrades, it is difficult to maintain the engine tuned for low CO and NO_X emissions.
- The rapid decrease in reactivity of the catalyst would require a separate treatment system necessary to remove siloxanes. However, additional fuel treatment and siloxanes removal systems have limited success in removing all siloxanes from the waste gas.
- Post combustion controls have not been proven to be cost effective in reducing air pollutant emissions.
- According to RBLC, other state agencies issued permits that do not include add-on emission controls and have made determinations that emissions will be controlled by the efficient combustion design, an air-to-fuel controller system, and good combustion and maintenance practices.

Siloxanes are present in LFG and therefore, add-on control technologies using a catalyst are considered technically infeasible for this project due to premature deactivation by siloxanes. Also, SNCR is not feasible for the LFG engines because there is no high-temperature window that will forward this chemical reaction. The remaining control option is combustion design and controls. As previously shown by the applicant, data in the RBLC database (2004 – 2012) supports the air-fuel controller and good combustion practices as BACT for engines firing LFG.

5.3.3. Selection of BACT and Rationale

The applicant proposes to use efficient combustion design and air-fuel controllers to establish BACT for NO_X as 0.6 g/bhp-hour. As shown in Table G, previous NO_X BACT determinations for LFG fired engines range from 0.5 to 0.6 g/bhp-hour. The applicant's proposed limits are based on the applicants experience with operating numerous identical LFG fired engines throughout Florida. Caterpillar LLC specifies a "not to exceed" limit of 0.5 g NO_X/bhp-hour at 100% load.

As previously discussed, the Department recently revised BACT determinations for several projects using the Caterpillar Model G3520C engines firing LFG to accommodate a low- NO_X bias engine setup: 3.5 g CO/bhp-hour paired with 0.6 g NO_X/bhp-hour. Stack testing has shown compliance with the standards, which are based on the applicants' proposals as well as the efficient combustion design and air-fuel controllers.

Considering all available information, the Department establishes the following BACT standard for each proposed engine:

NO_X: 0.6 g/bhp-hour (initial and annual EPA Method 7 or 7E stack test)

This will provide the maximum flexibility to tune the engines for low-NO_X emissions and accommodate gradual equipment degradation from firing this low-energy fuel. NO_X emissions will be controlled by the efficient combustion design, an air-to-fuel controller system, and good combustion and maintenance practices.

5.4. BACT for Particulate Matter (PM_{10}/$PM_{2.5}$)

5.4.1. Identification of Available Control Technologies

"Smoke" is defined as the collection of airborne solid and liquid particulates and gases emitted as products of incomplete combustion. In AP-42 Section 3.3, EPA identifies two types of smoke that may be emitted from internal combustion engines during stable operations: blue smoke and black smoke, both which indicate problems with the engine operation. Blue smoke is emitted when lubricating oil leaks (result from normal wear on piston rings and seals) into the combustion chamber of the engine and is partially burned. Black smoke is agglomerated carbon particles (soot) formed in regions of the combustion mixtures that are oxygen deficient. Black smoke reflects inefficient combustion. Proper maintenance is the most effective method of preventing blue smoke emissions from all types of internal combustion engines, while proper design minimizes black smoke. The applicant identified the following control techniques for reducing and minimizing particulate matter emissions from the engines.

- *Fabric Filters:* Fabric filters, which are commonly referred to as a baghouse, use fabric filter media to remove PM (filterable) from the exhaust gas of appropriate air pollutant emission sources. Baghouse emission control technology to the exhaust of an IC engine would require the system be designed to withstand temperatures of approximately 900 ^{o}F. Baghouses can achieve filterable PM removal efficiencies of up to 99.9%.
- *Gas Refrigeration and Condensate Recovery:* Condensation, refrigeration, and cryogenic systems remove process exhaust vapors (condensable PM) by making them condense on cold surfaces. These cold conditions can be created by passing cold water through an indirect heat exchanger, by spraying cold liquid into an open chamber with the gas stream, by using a freon-based refrigerant to create very cold coils, or by injecting cryogenic gases such as liquid nitrogen into the gas stream. cooling of the exhaust gas stream can achieve
- *Wet Scrubber:* Wet scrubbing devices remove PM from a gas stream through a process called impaction. A scrubbing liquid (typically water with an anticorrosion agent) is sprayed into the exhaust gas stream. Contact between the atomized scrubbing liquid and the suspended PM removes the PM from the gas stream and passes it through a mist eliminator (demister pads) to remove the water droplets. Wet scrubbers have a typical removal efficiency of up to 90% for emissions of PM_{10} and significantly lower for $PM_{2.5}$.
- *Electrostatic Precipitator (ESP) and Wet ESP:* An ESP removes filterable PM from a gas stream through the use of electric fields. The incoming exhaust gas is ionized, which negatively charges the filterable PM and causes it to be attracted to and collected on electrodes. At preset intervals, the electrodes are rapped to mechanically dislodge the PM, which is appropriately collected and disposed. Filterable PM removal efficiencies of up to 98 % are achievable for particulate matter in the range of 0-5 microns.
- *Mechanical Separators:* Mechanical separators include cyclonic and inertial separators. A centrifugal force separates filterable PM from a gas stream. The exhaust gas enters a cylindrical chamber on a tangential path and is forced along the outside wall of the chamber at a high velocity causing the filterable PM to impact collectors on the outer wall of the unit and fall into a hopper for collection. Mechanical separators have a typical removal efficiency of up to 90% for PM_{10} and 50% to 70% for $PM_{2.5}$.
- *Good Design and Operating Practices:* The primary options for reducing and minimizing PM emissions from the engines typically include optimizing the design of the combustion chamber, implementing practices that improve the oxidation process to minimize incomplete combustion and proactive maintenance, which are collectively referred to as good combustion practices. In addition, proper maintenance and operation of the IC engine results in maximum fuel combustion efficiency and minimizes PM emissions.

5.4.2. Identification of Technically Feasible Control Alternatives and Ranking

According to Section 2.4 in AP-42 (Municipal Solid Waste Landfills), data posted in the RBLC database, and other recent permits and permit applications, no add-on controls have been required for reducing PM from engines firing LFG. LFG contains siloxanes, which are oxidized to silicon dioxide during combustion. This abrasive substance is also very sticky and can clog add-on controls such as fabric filters making them inoperable in a short period of time. As previously discussed, the technology to remove siloxanes from LFG for engines is just emerging. In addition, satisfactory pretreatment of the LFG makes it cost prohibitive to install add-on particulate controls and/or a siloxane removal system. Therefore, post-combustion add-on control technologies are not considered appropriate for IC engines. Therefore, the combination of fuel pre-treatment combined with good combustion practices is selected as the top control option.

5.4.3. Selection of BACT and Rationale

As shown in previous Table G summarizing BACT standards posted in the RBLC database, the range of previous BACT for PM_{10} and $PM_{2.5}$ ranges from 0.1 to 0.27 g/bhp-hour and 0.15 to 0.24 g/bhp-hour, respectively. Florida's most recent BACT determination for a similar LFG engine was 0.24 g/bhp-hour based on fuel pretreatment and good combustion practices. Although initial stack tests for PM emissions from new LFG engines have been very low (< 0.1 g/bhp-hour), subsequent tests on the same equipment tend to show

higher emission levels with increased engine operating hours. Based on operating experience, Caterpillar, Inc. confirms an increase in PM resulting from normal wear and tear on piston rings and seals. Therefore, the Department establishes the following work practice standards as the preliminary BACT determination for $PM_{10}/PM_{2.5}$ from the engines:

- Use of LFG as the only fuel;
- The permittee shall install, operate and maintain a LFG pretreatment system to dewater, compress and filter (down to 1 micron) the LFG prior to combustion in the engines.
- The permittee shall implement the following good combustion practices to minimize PM emissions: lean-burn combustion design, efficient combustion through the air-fuel controller and preventive and periodic maintenance in accordance with the requirements of NSPS Subpart JJJJ.
- As determined by EPA Method 9, visible emissions from the LFG engines shall not exceed 10% opacity.
- Sampling, analysis and reporting requirements to ensure that the project remains minor with respect to SO_2 emissions, which is a precursor of $PM_{2.5}$ emissions; and
- Establishing a NO_X standard of 0.6 g/bhp-hour (another precursor of $PM_{2.5}$ emissions), which is 70% below the applicable 2011 NSPS Subpart JJJJ limitation of 2.0 g/bhp-hour.

The above work practice standards should achieve a $PM_{10}/PM_{2.5}$ emission rate of less than 0.24 g/bhp-hour.

5.5. VOC and NMOC Emission Caps

The Caterpillar G3520C gas IC engine is designed to produce low NO_X emissions. These lower emissions are produced in part based on the high CO_2 content of LFG fuels that results in cooler combustion temperatures, which influence VOC destruction and control efficiencies. Experience with compliance demonstrations performed on low emission LFG fueled IC engines by Landfill Energy Systems Florida indicates that the 0.42 g/bhp-hr (2.08 lb/hour/engine) total VOC and 0.52 g/bhp-hr (2.57 lb/hour/engine) total NMOC emission rates or less are readily achievable.

The combination of fuel pre-treatment combined with good combustion practices of the LFG will result in reductions in the amounts of total VOC and NMOC that are generated by the landfill. Operation at these levels will ensure that project emissions will be much less than the corresponding significant emission rate of 40 TPY for VOC and 50 TPY for NMOC. Therefore, the Department establishes the following emissions caps for VOC and NMOC for this project:

- Total VOC emissions from the combustion sources in this project (EU 010 – EU 013) shall not exceed 36.4 tons during any consecutive 12 months.
- Total NMOC emissions from the combustion sources in this project (EU 010 – EU 013) shall not exceed 45.0 tons during any consecutive 12 months.

Compliance with the VOC/NMOC emission caps will be shown on a 12-month rolling basis by utilizing the following equation.

(EF_{engine})(lb/454)(ton/2000 lb)(Engine 1+ Engine 2 + Engine 3 + Engine 4) ≤ 36.4 TPY, VOC/45 TPY, NMOC

Where:

EF_{engine} = VOC/NMOC emission rate from most recent annual stack test, g/bhp-hour

$Engine_{bhp\text{-}hours}$ = Rolling 12-month total of operating bhp-hours for each engine (EU 010 - 013)

Example:

Assume the engines: tested actual VOC emissions at 0.2 g/bhp-hour; total engine hours 31,536 hours/year (~90% of the time); and an average operating rate of 2,130 bhp (95% of capacity).

VOC (Engines) = (0.2 g/bhp-hour)(lb/454 g)(ton/2,000 lb) (31,536 engine hours/year) (2130 bhp) = 14.8 TPY, VOC

5.6. SO_2 Emission Cap

Landfill Energy Systems Florida provided site-specific chemical composition analyses which indicated that the LFG generated by the CCSWDC has a total sulfur content that is less than 100 ppmv. However, to account for uncertainties and variability in the future sulfur content of the LFG U.S. EPA AP-42, Section 2.4 (Municipal Solid Waste Landfills) was used to establish a SO_2 emission limit for the CAT® G3520C gas IC engines. The hydrogen sulfide (H_2S) default LFG concentration of 35.5 ppmv was replaced with a higher value of approximately 274 ppmv, which results in total potential SO_2 emissions for the IC engine operations of 36 TPY (i.e., the maximum sulfur content of the LFG to be used as IC engine is required to be equal to or less than 289 ppmv as H_2S).

The draft permit establishes a SO_2 limit of 11.17 pound/million standard cubic foot (lb/MMscf) (0.48 lb/hour/engine). To ensure that SO_2 emissions will not exceed the PSD SER of 40 TPY, the draft permit includes the following SO_2 emission cap.

> The emissions of SO_2 from the combustion sources in this project (EU 010 – EU 013, combined) shall not exceed 36 tons per consecutive 12 months. Compliance with this SO_2 emissions cap shall be demonstrated on a 12-month rolling basis using the following information: the sulfur level in the scrubbed LFG fired; the amount of LFG fired in each combustion source; and the assumption that all sulfur is converted to SO_2.

The permit requires at least semiannual sampling and analysis of the sulfur content of the LFG and monitoring of the LFG flow rates to the engine/generator sets.

6. AIR QUALITY ANALYSIS

6.1. Air Quality Impact Analysis

The Central County Solid Waste Complex (the landfill) has a maximum LFG collection rate of 4,318 cfm while the four proposed IC engines require a fuel supply of only 2,216 cfm. Thus, the existing open flaring system has a maximum potential operating capacity of 2,102 cfm of LFG. The air dispersion modeling analysis presented in this section was based on the simultaneous operation of all four proposed IC engines at base load capacity as well as continuous operation of the existing open flaring system as a background source at its maximum potential capacity. This approach is highly conservative in nature as the current permitted waste volume of the landfill is not sufficient to create enough LFG to fuel all five devices at full capacity simultaneously and is currently producing only 1,700 cfm of LFG. Consequently air quality impacts resulting from the proposed Sarasota LFG-to-Energy project will be less than presented in this section.

6.2. Introduction

The proposed Sarasota LFG-to-Energy project will increase emissions of the following PSD-pollutants at levels in excess of the respective PSD significant emission rates: PM_{10}, $PM_{2.5}$, CO, and NO_X. For these pollutants the applicant must provide a demonstration using approved air quality models that project emissions will not cause or contribute to a violation of an ambient air quality standard (AAQS) or PSD increment for the pollutants where they apply. All of these pollutants have defined national and AAQS and the pollutants PM_{10}, $PM_{2.5}$, and NO_X (as NO_2) have defined PSD increments. In addition, significant impact levels (SIL) are defined for these pollutants and are used to determine the scope of the modeling analysis. The landfill site is shown in Figure 4 while Figure 5 shows the location of the project site.

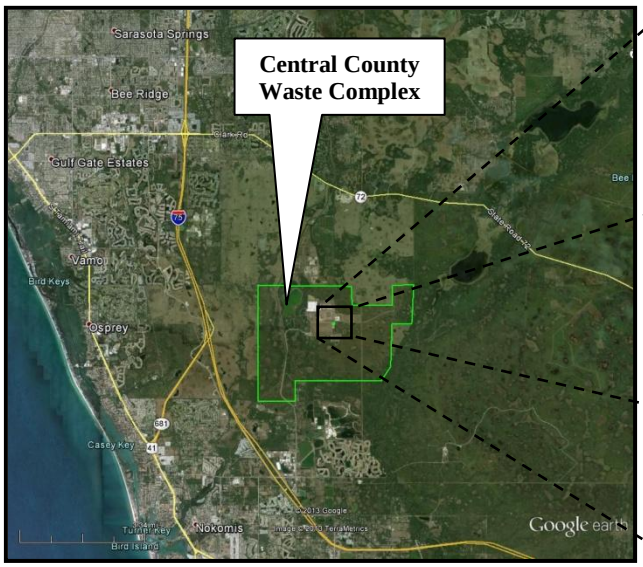

Figure 4. Location of the Landfill

Figure 5. Sarasota LFG-to-Energy Project Location

6.3. Major Stationary Sources near the Sarasota LFG-to-Energy Project Site

To provide some perspective on the relative scale of the proposed Sarasota LFG-to-Energy project, the following tables list the largest stationary sources, by pollutant, in and around Sarasota County. The maximum expected future emissions in TPY from the project are also shown for comparison (the project is highlighted in green).

Table I. Largest Sources of NO_X (2012) near the Sarasota LFG-to-Energy Project Site (TPY)

Owner/Company Name	Site Name	County	Emissions
FP & L	Manatee Power Plant	Manatee	877.8
Tropicana Manufacturing	Tropicana Bradenton	Manatee	89.4
Sarasota LFG-to-Energy	Central County Landfill	Sarasota	52.0
Gulfstream Natural Gas System	Gulfstream Compressor Station	Manatee	12.6
Manatee County	Lena Rd. Landfill	Manatee	9.5
Ajax Paving Industries	Palmetto Facility	Manatee	7.3

Table J. Largest Sources of CO (2012) near the Sarasota LFG-to-Energy Project Site (TPY)

Owner/Company Name	Site Name	County	Emissions
FP & L	Manatee Power Plant	Manatee	1480.2
Peace River Citrus Products	Peace River	DeSoto	368.8
Sarasota LFG-to-Energy	Central County Landfill	Sarasota	303.1
Manatee County	Lena Rd Landfill	Manatee	136.0
Tropicana Manufacturing	Tropicana Bradenton	Manatee	103.9

Table K. Largest Sources of $PM_{2.5}/PM_{10}$ (2012) near the Sarasota LFG-to-Energy Project Site (TPY)

Owner/Company Name	Site Name	County	Emissions
FP & L	Manatee Power Plant	Manatee	158.2
Manatee County	Lena Rd. Landfill	Manatee	44.0
Tropicana Manufacturing	Tropicana Bradenton	Manatee	27.9

Owner/Company Name	Site Name	County	Emissions
Sarasota LFG-to-Energy	Central County Landfill	Sarasota	20.8
Peace River Citrus Products	Peace River	DeSoto	20.5
Rocktenn CP	Bradenton Container Plant	Manatee	10.7

To further illustrate the major emission sources nearest to the project site, refer to Figure 6 below. All facilities that were used in cumulative modeling for the 1-hour NO_2 and 24-hour $PM_{2.5}$ AAQS (see subsection 6.5.2 below) are shown in Figure 6.

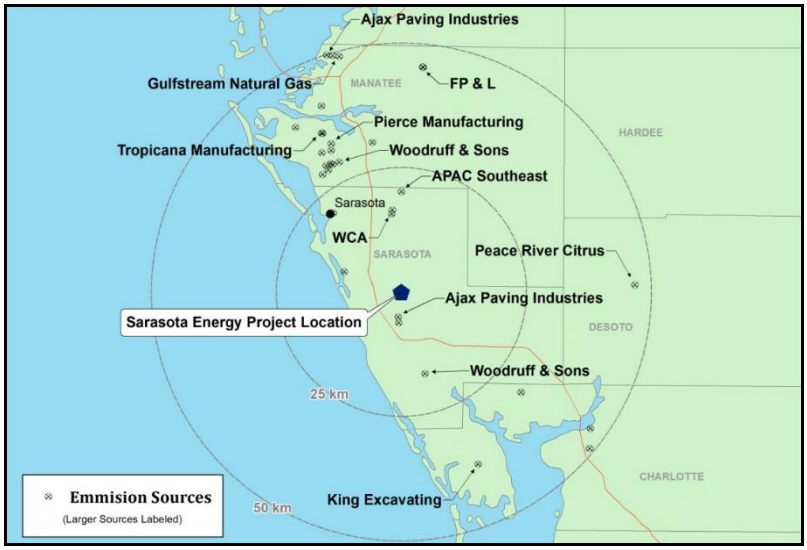

Figure 6. Background Emission Sources within 50 km of the Project Site

6.4. Ambient Air Monitoring Surrounding the Sarasota LFG-to-Energy Site

The State ambient air monitoring network operated by the Florida Department of Environmental Protection (DEP) and its partners (local air pollution control programs) includes monitors in most Florida counties. The chosen monitors shown in Figure 7 are conservatively representative of the project site. These monitors are used to estimate the existing air quality in the area of the project site. Table 7 provides the ambient air quality design values for the selected monitors.

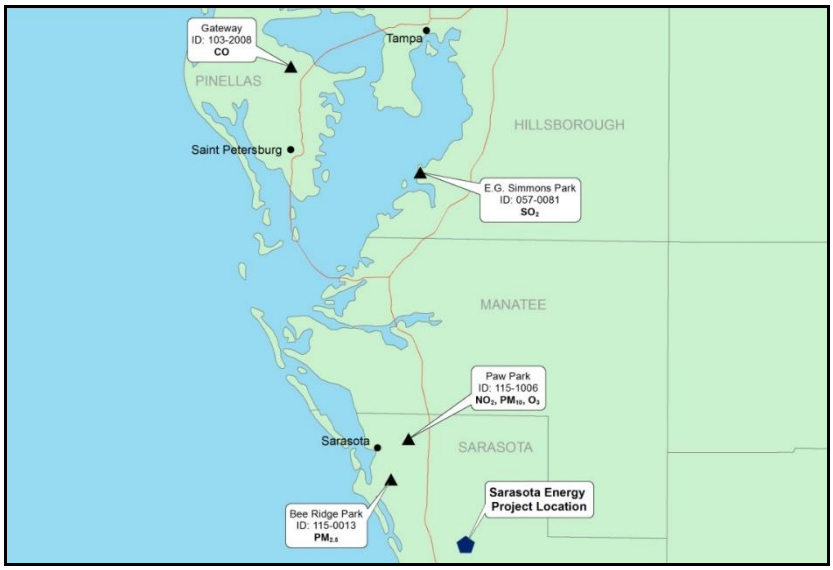

Figure 7. Ambient Air Monitors near the Sarasota LFG-to-Energy Project Site

Table L. Ambient Air Quality Measurements Nearest to the Sarasota LFG-to-Energy Project Site (2010-2012).

Pollutant	Location (Site Number)	Averaging Period	Ambient Concentration			
			Compliance Period	Value	Standard	Units [a]
PM_{10}	Sarasota Co (L1151006)	24-hour [b]	2012	51	150	$\mu g/m^3$
		Annual [c]	2012	14.6	50	$\mu g/m^3$
$PM_{2.5}$	Sarasota Co (L1150013)	24-hour [d]	2010-2012	15	35	$\mu g/m^3$
		Annual [e]	2010-2012	7.0	15	$\mu g/m^3$
NO_2	Sarasota Co (L1151006)	Annual [c]	2012	3.7	53	ppb
		1-hour [h]	2010-2012	17	100	ppb
CO	Pinellas Co (L1032008)	1-hour [f]	2012	2.9	35	ppm
		8-hour [g]	2012	1.5	9	ppm
Ozone	Sarasota Co (L1151006)	8-hour [g]	2010-2012	0.071	0.075	ppm

a. Units are in: micrograms per cubic meter ($\mu g/m^3$); parts per billion (ppb); or parts per million (ppm).
b. Not to be exceeded on more than an average of one day per year over a three-year period.
c. Arithmetic mean.
d. Three year average of the 98th percentile of maximum daily 24-hour concentrations.
e. Three year average of the arithmetic annual means.
f. Not to be exceeded more than once per year.
g. Three year average of the annual 4th highest daily 8-hour maximum.
h. Three-year average of the annual 98th percentile maximum daily 1-hour value
i. Three-year average of the annual 99th percentile maximum daily 1-hour value

The ambient air measurements listed above are values that do not contain 'exceptional events'. An 'exceptional event' is defined by EPA in accordance with 40 CFR 50.14 as an event that affects air quality, is not reasonably controlled or preventable, and is an event caused by human activity that is unlikely to recur at a particular location or natural event. Such events include complex wildfires that are driven by prolonged drought conditions and other large-scale meteorological patterns. The department has evaluated several $PM_{2.5}$ episodes and found that they occur in conjunction with certain meteorological conditions, combined with very high SO_2 emissions and sulfate deposition.

6.5. Existing Ambient Air Quality near the Sarasota LFG-to-Energy Project Site – $PM_{2.5}$ and Ozone

Ozone is a key indicator of the overall state of regional air quality. It is not emitted directly from combustion processes. Rather it is formed from VOC and NO_X emitted primarily from regional industrial and transportation sources. VOC is also emitted from authorized agricultural fires, natural drought-related fires and natural emissions from vegetation. These two precursors participate in photochemical reactions that occur on an area-wide basis and are highly dependent on meteorological factors.

Ozone limits and measurements in are summarized on three year blocks, rolled annually. The reported ozone value was calculated by taking the maximum 8-hour readings recorded each day during the three years (2010-2012). The fourth highest of the recorded maxima were identified for each year and then the average of those three values was reported as the compliance value given in Table L and Figure 8.

$PM_{2.5}$ (also known as PM_{fine}) is another key indicator of the overall state of regional air quality. Some $PM_{2.5}$ is directly emitted as a product of combustion from transportation and industrial sources as well as fires. Much of it consists of particulate nitrates and sulfates formed through chemical reactions between gaseous precursors such as SO_2 and NO_X from combustion sources and ammonia (NH_3) naturally present in the air or added by other industrial sources.

$PM_{2.5}$ limits and measurements are summarized on three-year blocks, rolled annually. The 24-hour compliance value for $PM_{2.5}$ for the Sarasota County site was calculated by taking the average 24-hour readings recorded each day during the three years (2010-2012). The value for each year that exceeds 98% of all daily

measurements within each given year was identified and then the average of those three numbers was reported as the 24-hour compliance value (15 micrograms per cubic meter ($\mu g/m^3$)) and compared with the standard of 35 $\mu g/m^3$ as shown in Table L.

The simple average of all $PM_{2.5}$ measurements within each three years (2010-2012) was also calculated and then the mean of the three averages (7.0 $\mu g/m^3$) was reported as the annual compliance value and compared with the standard of 15 $\mu g/m^3$ in Table L. Comparisons of the 24-hour and annual $PM_{2.5}$ compliance values for the Sarasota County monitor are shown in Figure 9 along with compliance values for the rest of the state. The results indicate that Sarasota County is in attainment with the applicable ozone and $PM_{2.5}$ AAQS.

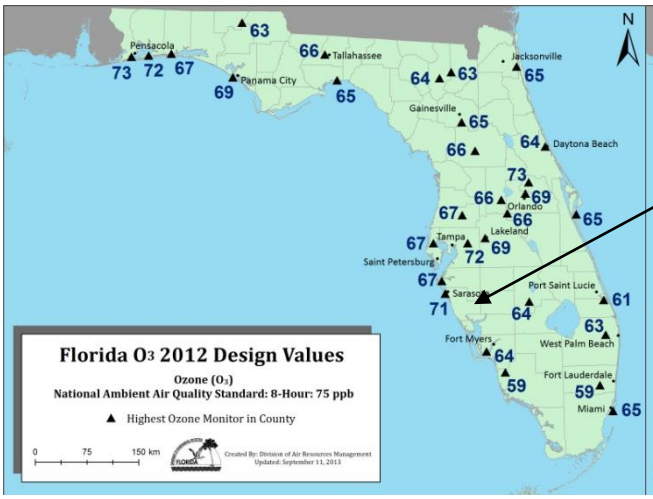

Figure 8. Florida Ozone Compliance Values

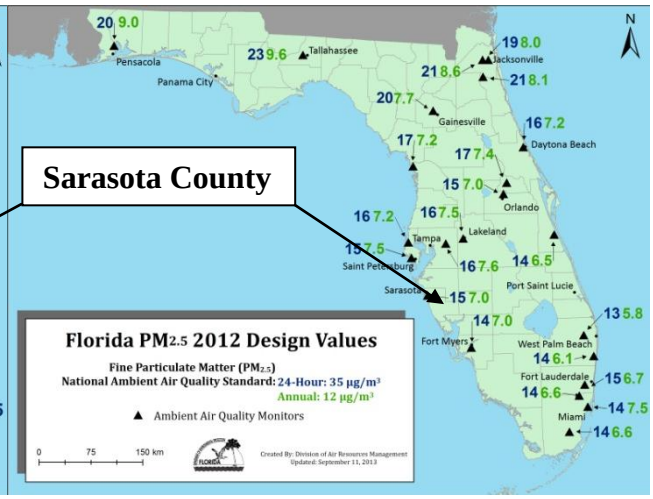

Figure 9. Florida $PM_{2.5}$ Compliance Values

6.6. Air Quality Impact Analysis

6.6.1. Models, Emissions Data, and Meteorological Data

The EPA-approved AERMOD modeling system was used to evaluate the pollutant emissions from the project in the surrounding Class II Areas. The Gaussian steady-state plume dispersion AERMOD modeling system simulates pollutant dispersion methods based on planetary boundary layer turbulence structure and scaling concepts, including the treatment of both surface and elevated sources, and both simple and complex terrain. AERMOD contains two input data processors, AERMET and AERMAP. AERMAP is the terrain processor and AERMET is the meteorological data processor.

A series of specific model features, recommended by the EPA, are referred to as the regulatory options. The applicant used the EPA recommended regulatory options. Direction specific downwash parameters were used for all sources for which downwash was considered. Emissions data used in the modeling analysis were obtained from the DEP ARMS database, DEP permit files, and recent PSD permit reviews.

The AERMET meteorological data used with the AERMOD model to determine air quality impacts consisted of a concurrent 5-year period of hourly surface weather observations from the National Weather Service (NWS) Automated Surface Observing System (ASOS) station located at the Sarasota Bradenton International Airport (SRQ) and upper air sounding data collected at the NWS office in Tampa (TBW). This data was compiled by the DEP for the period 2008 through 2012. The ASOS station at SRQ is located approximately 27 km northwest of the proposed Sarasota LFG-to-Energy project site and is the closest primary weather station considered to have representative meteorological data. As the SRQ ASOS station is only 27 km from the project site, both sites are approximately the same distance from the coastline, and the terrain between the two sites is mostly flat, the wind direction and wind speed frequencies measured at the ASOS are considered to be very similar to those experienced at the project site.

6.6.2. Significant Impact Analysis

The general modeling approach for the significant impact analysis for the proposed Sarasota LFG-to-Energy project followed the EPA and DEP modeling guidelines for determining compliance with AAQS and PSD increments. For all criteria pollutants that will be emitted in excess of the PSD significant emission rate due to a proposed project, a significant impact analysis is performed to determine whether the emission and/or stack configuration changes due to the project alone will result in predicted impacts that are in excess of the EPA SIL. For the proposed project, emission increases above the PSD significant emission rates occur for the following criteria pollutants: PM_{10}, $PM_{2.5}$, CO, and NO_X. A significant impact analysis is performed on each of these pollutants to determine if a project can cause an increase in ground level concentration greater than the SIL for each pollutant. As AAQS and PSD increments exist for NO_2, PM_{10}, $PM_{2.5}$, and CO, a significant impact analysis is required for these pollutants. For this project, SO_2 did not exceed the PSD significant emission rate but was included for informational purposes.

In order to conduct a significant impact analysis, the applicant has used the proposed project's maximum short-term emissions from the continuous base load operation of the set of four IC engines to be constructed, as well as the existing open flaring system, as inputs to the models. This is considered a conservative approach given that the currently permitted landfill volume is not capable of producing sufficient LFG to fuel all five devices simultaneously. The highest predicted short-term concentrations and highest predicted annual averages predicted by this modeling are compared to the appropriate SIL for the PSD Class I and II Areas.

If the modeling for a particular pollutant shows ground-level increases less than its SIL, the applicant need not conduct any further modeling. If the modeled concentrations from the project exceed the SIL, then additional refined modeling including emissions from nearby facilities or projects (multi-source modeling) is required to determine the proposed project’s impacts compared to the AAQS and PSD increments for those pollutants.

For the Class II analysis, a combination of fence line, near-field and far-field receptors were chosen for predicting maximum concentrations in the vicinity of the project. Receptor locations used in the modeling analysis were based on Universal Transverse Mercator (UTM) coordinates from Zone 17, North American Datum 1983 (NAD83). The air modeling origin was assumed to be located at the approximate center of the proposed Sarasota LFG-to-Energy project site, UTM east and north coordinates of 362850 and 3008954 meters, respectively. A discrete Cartesian grid of 12,290 receptors was located at the following intervals and distances:

- Every 25 m along the landfill property boundary and fence line;
- Every 70 m from the landfill property boundary to 5,000 m from the origin;

Additionally, for each pollutant emitted in excess of the EPA significant emission rate, analyses are required to determine the project’s maximum impacts on the air quality-related values (AQRV) at PSD Class I areas. For the Chassahowitzka National Wildlife Refuge (CNWR) PSD Class I area in Crystal River, Florida, the AQRV of interest is visibility impairment and sulfur and nitrogen deposition. The CNWR is the closest Class I area to the project site and is located approximately 157 km to the north. For PSD Class I areas that are located within 50 km of a proposed project site, visibility impairment is in the form of plume blight. For PSD Class I areas that are located beyond 50 km from a proposed project site, visibility impairment is in the form of regional haze. Visibility impairment is determined for a 24-hour averaging time. Total nitrogen and total sulfur deposition are predicted for an annual averaging time.

An initial screening criterion that could exempt a source from AQRV impact review based on its maximum annual emissions and distance from a Class I area has been provided by the Federal Land Managers’ (FLMs’) AQRV Workgroup (FLAG): Phase I Report-Revised 2010 document. According to the FLAG report, a project that is located more than 50 km from a Class I area will likely not be required to conduct AQRV impacts if the total emissions increase of SO_2, NO_X, PM_{10} and SAM annual emissions (Q, in TPY, based on 24-hour maximum allowable emissions), divided by the distance from the Class I area (D, in km), Q/D, is 10 or less.

Based on the maximum 24-hour emissions for SO_2, NO_X, PM_{10} and SAM, the Q for proposed project is 108.8 TPY, resulting in a Q/D of 0.69 at the CNWR. As this ratio is well below the screening criterion of 10, the proposed Sarasota LFG-to-Energy project is considered unlikely to pose a significant impact on AQRVs at the CNWR, pursuant to FLMs’ guidance from the 2010 FLAG Report.

6.6.2.1. *Class II SIL*

The maximum pollutant concentrations predicted for the proposed Sarasota LFG-to-Energy project are compared to the PSD Class II SIL in Table M. The modeling results demonstrate that maximum concentrations due to the project are predicted to be less than the SIL for all pollutants except for the 1-hour NO_2 and 24-hour $PM_{2.5}$ impacts. As a result, additional modeling analyses for these two pollutants were required.

Table M. Max Predicted Air Quality Impacts of the Sarasota LFG-to-Energy Project Compared to Class II SIL

Pollutant	Averaging Time	Max Impact [a] (µg/m^3)	SIL (µg/m^3)	AAQS (µg/m^3)	Significant Impact?
PM_{10}	Annual 24-Hour	0.08 1.70	1 5	50 150	No No
$PM_{2.5}$	Annual 24-Hour	0.08 1.70	0.3 1.2	15 35	No **Yes**
NO_2 [a]	Annual 1-Hour	0.21 11.03	1 7.6	100 189	No **Yes**
SO_2	3-hour 1-hour	6.83 7.61	25.0 7.9	1309 196	No No
CO	8-hour 1-hour	46.08 64.29	500 2,000	10,000 40,000	No No

a. Assumes 100% conversion of NO_X to NO_2, i.e., the tier 1 modeling approach.

Since the NO_2 and $PM_{2.5}$ impacts are greater than the SIL, the air modeling analyses must consider other nearby sources and background concentrations and determine the cumulative impact of these sources for comparison to AAQS and PSD increments.

The 1-hour NO_2 and 24-hour $PM_{2.5}$ AAQS are probabilistic standards and compliance is based on the highest predicted 98th percentile (i.e., 8th highest) daily maximum 1-hour average concentrations, on a receptor-by-receptor basis, averaged over 5 years of meteorological data.

The AAQS and PSD analyses are cumulative source analyses that evaluate whether the air quality impact concentrations from all sources will comply with the AAQS and PSD increments. The analyses consider the modeled impacts from existing and future sources at the proposed Sarasota LFG-to-Energy project site, emissions from other nearby facility sources, as applicable, and a non-modeled background concentration that is intended to account for all sources not included in the modeling analyses.

An increment analysis was performed for the 24-hour $PM_{2.5}$ impact; however, because a 1-hour PSD Class II increment does not exist for NO_2, an increment analysis is not required for that pollutant.

6.6.2.2. *Class I SIL*

The EPA-approved version of the CALPUFF non-steady-state puff dispersion is approved and recommended for evaluation of emission impacts at distances greater than 50 km. This model was used to evaluate pollutant dispersion and visibility impairment in the CNWR Class I area. This area contains 113 discrete modeling receptors that were provided by the National Park Service. Meteorological input data used in the modeling analysis was provided by DEP for the years 2001-2003. The maximum pollutant concentrations predicted for the proposed Sarasota LFG-to-Energy project are compared to the PSD Class I SILs in Table . The modeling results indicate that maximum concentrations due to the project are predicted to be less than the Class I SILs for all pollutants. As a result, detailed analyses to demonstrate compliance with the allowable PSD Class I increments is not required.

Table N. Max Predicted Air Quality Impacts of the Sarasota LFG-to-Energy Project Compared to Class I SIL

Pollutant	Averaging Time	Max. Predicted Impact (µg/m^3) at CNWR	Class I SIL (µg/m^3)	Significant Impact?
SO_2	Annual 24-hour 3-hour	0.0001 0.003 0.01	0.1 0.2 1.0	No No No
NO_2 [a]	Annual	0.00006	0.1	No
PM_{10}	Annual 24-Hour	0.0001 0.002	0.2 0.3	No No
$PM_{2.5}$ [b]	Annual 24-hour	0.0001 0.002	0.04 0.07	No No

a. Assumes 100% conversion of NO_X to NO_2, i.e., the tier 1 modeling approach.
b. Assumes 100% of PM_{10} consists of $PM_{2.5}$, i.e., the most conservative estimate.

6.6.3. 1-Hour NO_2 and 24-Hour $PM_{2.5}$ AAQS Analyses

For addressing the 1-hour NO_2 and 24-hour $PM_{2.5}$ AAQS, all background sources within 50 km of the project site were included in the multi-source modeling. As stated by EPA, the routine inclusion of all sources within 50 km of a project location, the nominal distance for which AERMOD is applicable, is likely to produce an overly conservative result in most cases for 1-hour NO_2 AAQS compliance demonstrations.

Data on current NO_2 background sources were obtained from FDEP and all facilities located within 50 km of the proposed project were identified. As shown in Figure 6, there are 34 background sources within 50 km of the project site. For each, the highest of their potential, allowable, or actual emissions was entered into AERMOD for the modeling demonstration. In addition, non-modeled background concentrations obtained from nearby, representative monitors (Table L) for NO_2 (45.9 µg/m^3) and $PM_{2.5}$ (18.0 µg/m^3) were included to represent potential impacts due to emission sources not directly included in the modeling analysis. The concentrations used were the highest 3-year (2010-2012) 1-hour NO_2 concentration and 24-hour $PM_{2.5}$ concentration. This is considered to be a highly conservative approach as many of the included background sources may also be represented in the monitoring data leading to a double-counting of some sources. In addition, the chosen monitored values were significantly higher than the required 98th percentile concentrations.

Table shows the results of this analysis. In order to satisfy the AAQS analysis, the 5-year average of the highest, eighth-high NO_2 and $PM_{2.5}$ impacts must not exceed the established AAQS. As shown in the table, emissions from the proposed Sarasota LFG-to-Energy Project are not expected to cause or contribute to a violation of the 1-hour NO_2 or 24-hour $PM_{2.5}$ AAQS.

Table O. Ambient Air Quality Impacts from all Sources Near the Sarasota LFG-to-Energy Project Site

Pollutant	Averaging Time	Major Sources Impact (µg/m^3)	Monitored Background Conc.(µg/m^3)	Total Impact (µg/m^3)	Total Impact Greater Than AAQS?	AAQS (µg/m^3)
NO_2 [a]	1-hour	94.4	45.9	140.3	No	188
$PM_{2.5}$ [b]	24-hour	0.91	18.0	18.9	No	35

a. Concentration reported is highest 5-year daily 1-hour maximum value. This is considered a highly conservative approach because, by definition, the highest daily 1-hour maximum value reported will be higher than the required 5-year average of 98th percentile daily 1-hour maximum values.
b. Concentration reported is highest 5-year daily value. This is considered a highly conservative approach because, by definition, the highest daily value reported will be higher than the required 5-year average of 98th percentile daily values.

6.6.4. 24-Hour $PM_{2.5}$ PSD Increment Analysis

The PSD increment represents the amount new sources in an area may increase ambient ground level concentrations of a pollutant from a baseline concentration in order to avoid approaching the AAQS. As mentioned, there is no established PSD increment for the 1-hour NO_2 standard but an increment analysis was required for the 24-hour $PM_{2.5}$ standard. The combined impacts of all increment-consuming sources in the area of the new source cannot exceed the PSD increment. As before, the proposed Sarasota LFG-to-Energy project was modeled assuming base load operation of all four proposed IC engines as well as continuous operation of the existing open flaring system. No other PSD increment consuming sources were identified in the area. The results of this analysis are presented in Table P below and show that the combination of the emissions from the project and all background sources does not exceed the applicable PSD increment for 24-hour $PM_{2.5}$ concentrations.

Table P. PSD Increment Analysis Results

Pollutant	Averaging Time	Maximum Combined Impact ($\mu g/m^3$)	PSD Class II Increment ($\mu g/m^3$)	Total Impacts Exceed Increment?	Increment Consumed
$PM_{2.5}$[a]	24-hour	1.74	9.0	No	19.3%

a. Concentration reported is highest 5-year daily value. This is considered a conservative approach as the required value is the highest, second highest value.

6.6.5. Ozone Modeling

Projects with VOC or NO_X emissions greater than 100 TPY are required to perform an ambient impact analysis for ozone including the gathering of preconstruction ambient air quality data. The applicant estimated annual potential VOC and NO_X emissions from the project to be 36.4 and 52 TPY respectively; thus, an ambient impact analysis for ozone is not required.

6.7. Additional Impacts Analysis

6.7.1. Growth-Related Impacts Due to the Proposed Project

The proposed Sarasota LFG-to-Energy project will employ up to two people and will rely on existing infrastructure. The existing LFG pipeline used by the existing open flaring system will be used to supply the four proposed IC engines. The project site is within an active landfill with sufficient roads and other infrastructure to support the project's operations. The electricity generated will be connected to the local distribution network through an existing nearby power line to satisfy local energy demand. Based on the rural location and limited scope of the project, significant growth impacts are not expected.

6.7.2. Impact on Soils and Vegetation

The proposed Sarasota LFG-to-Energy Project site is located near the center of an existing, active landfill. The construction of four proposed IC engines at the site will not disturb any soil or vegetation that is not already being disturbed by the presence of the landfill and no land clearing of forested or heavily vegetated areas will be necessary. In addition, the emissions released will, to an extent, be simply replacing already existing emissions from the existing open flaring system. Since the project's impacts on the local air quality are predicted to be less than the AAQS, impacts on soils and vegetation in the vicinity are expected to be negligible.

6.7.3. Impact on Wildlife

The major air quality risk to wildlife in the United States is from continuous exposure to pollutants above the AAQS. This occurs in non-attainment areas, e.g., Los Angeles Basin. Risks to wildlife also may occur for wildlife living in the vicinity of an emission sources that experience frequent upsets or episodic conditions resulting from malfunctioning equipment, unique meteorological conditions, or startup operations (Newman and Schreiber, 1988). Under these conditions, chronic effects (e.g., particulate contamination) and acute effects (e.g., injury to health) have been observed (Newman, 1981).

Although air pollution impacts to wildlife have been reported in the literature, many of the incidents involved acute exposures to pollutants, usually caused by unusual or highly concentrated releases or unique weather conditions. It is highly unlikely that emissions from the proposed Sarasota LFG-to-Energy project will cause adverse effects to wildlife due to the project's low impacts, well below the AAQS. Coupled with the mobility of wildlife, the potential for exposure of wildlife to the project's impacts is extremely unlikely.

6.7.4. Class I Area Impacts- Air Quality Related Values (AQRV)

Because the proposed project's Q/D ratio is 0.69 (see subsection 5.5.2), the project's emissions are not expected to significantly impact AQRVs of the CNWR. As a result, additional analyses to assess visibility impairment and acid deposition at the CNWR were not necessary; however, both VISCREEN and CALPUFF were used to assess AQRV at CNWR. Both analyses determined that the project would result in no adverse impacts.

6.8. Conclusion

Based on the results presented in the air quality analysis, DEP has reasonable assurance that the increased pollutant emissions associated with this project will not cause or contribute to any violation of a AAQS or PSD increment. In addition, DEP finds that there will be no adverse impact on AQRV's in any Class I areas.

7. PRELIMINARY DETERMINATION

The Department makes a preliminary determination that the proposed project will comply with all applicable state and federal air pollution regulations as conditioned by the Draft Permit. This determination is based on a technical review of the complete application, reasonable assurances provided by the applicant, and the conditions specified in the Draft Permit. Tammy McWade is the project engineer responsible for reviewing the application and drafting the permit changes. Brian Himes is the meteorologist responsible for reviewing and approving the ambient air quality analyses. Additional details of this analysis may be obtained by contacting the project engineer at the Department's Office of Permitting and Compliance at Mail Station #5505, 2600 Blair Stone Road, Tallahassee, Florida 32399-2400.