TECHNICAL EVALUATION

&

PRELIMINARY DETERMINATION

APPLICANT

Okeechobee Landfill, Inc.
A Waste Management Company
2859 West Paces Ferry Road, Suite 1600
Atlanta, Georgia 30339

Okeechobee Landfill
ARMS Facility ID No. 0930104

PROJECT

Draft Permit No. PSD-FL-382
Project No. 0930104-014-AC

Landfill Gas to Energy Project

COUNTY

Okeechobee County

PERMITTING AUTHORITY

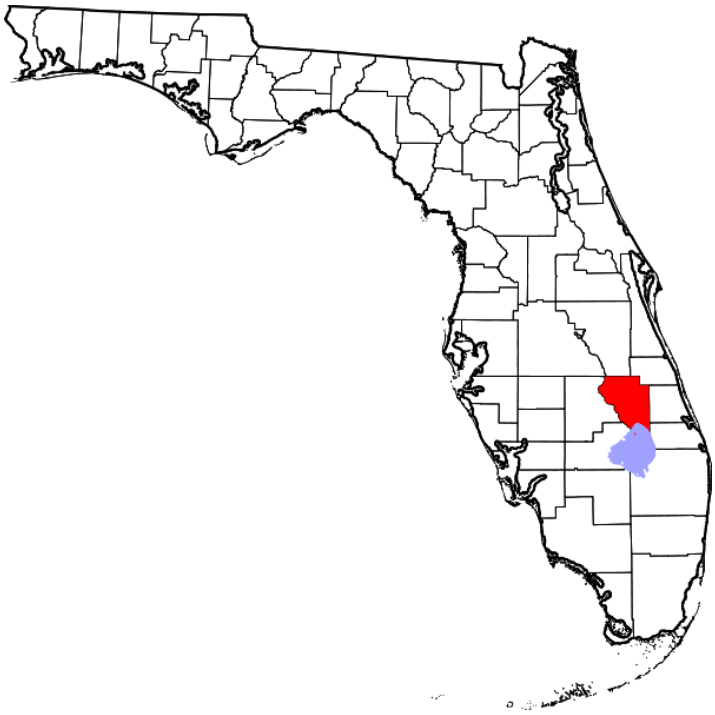
Florida Department of Environmental Protection (FDEP)
Division of Air Resource Management
Bureau of Air Regulation
Special Projects Section
2600 Blair Stone Road, MS#5505
Tallahassee, Florida 32399-2400

February 1, 2010

1. GENERAL PROJECT INFORMATION

1.1 Facility Description and Location

The Okeechobee Landfill (OL) is located in Okeechobee County. The main entrance is approximately 3.5 miles north of State Road (SR) 70 at 10800 Northeast 128th Avenue. The landfill has a Standard Industrial Classification Code (SIC) of No. 4953. The UTM coordinates are Zone 17; 530.28 km East and 3023.96 km North. The location of Okeechobee County is shown in Figure 1 below. The location of the landfill within Okeechobee County is shown in Figure 2.



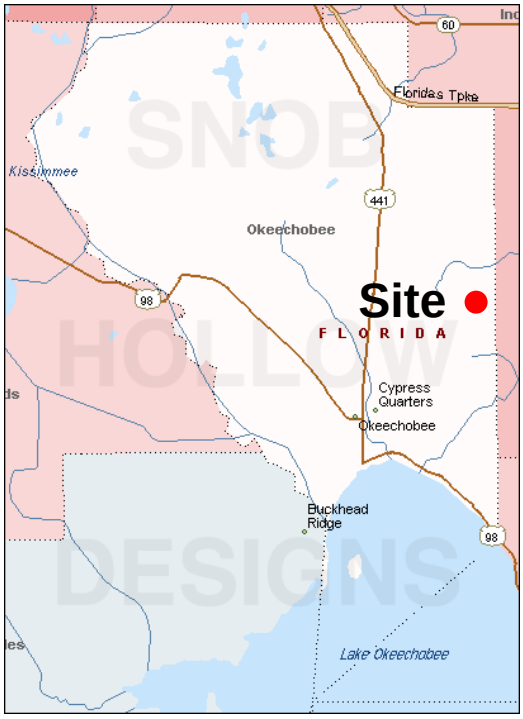


Figure 1 - Okeechobee County, Florida **Figure 2 - Location of Okeechobee Landfill**

The landfill is operated by Okeechobee Landfill, Inc. (OLI), a Waste Management Company. Communications regarding this project are through Waste Management, Inc. (WMI). In this discussion, the more familiar WMI name is used. The OL comprises the Berman Road Landfill and the authorized development known as the Clay Farms Landfill. The total OL comprises 847 acres within 4150 acres owned by the applicant. The property boundary actually extends south to SR 70 and east into neighboring St. Lucie County.

The terrain surrounding the facility is mostly flat with terrain heights reaching 60 feet within 5 kilometers (km) from the property boundary line. The vegetation is mostly grassland. Land use in the surrounding area is mostly rural. A large water body (Lake Okeechobee) is located approximately 30 km southwest of the facility.

The nearest Class I area is the large Everglades National Park (ENP) that straddles Monroe, Collier and Miami-Dade Counties. The nearest boundary point in the ENP is located approximately 169 km south of the southernmost property boundary of the facility. Biscayne Bay National Park, a Class II National Park, is located approximately 193 km from the facility towards the southwest. Big Cypress National Preserve is located approximately 121 km from the facility.

Figure 3 – The Berman Road Landfill

Okeechobee County operated a small 2-cell, 10-acre landfill on the Berman Road site beginning in 1982 and closing in 1990. The site was acquired and operated soon thereafter by companies that ultimately became part of WMI. A solid waste permit was issued in 1992 by the Department to operate/construct a 30-acre, 900 tons per day (TPD) landfill.

Figure 3 above shows the present 208-acre, 35-cell, 10,000 TPD Berman Road Landfill. Figure 4 below shows the landfill gas collection and control system (LFGCCS) for the Berman Road Landfill which is still under construction. The points are individual wells while the lines convey landfill gas (LFG) to flares.

Figure 4–LFGCCS under Continuous Expansion

Figure 5 shows the ultimate Berman Road Landfill development and the more recently authorized 639-acre development known as the Clay Farms Landfill that will begin accepting waste around 2012.

Although the two landfills presently hold separate solid waste permits, they are considered a single facility (the OL) for the purposes of air permitting.

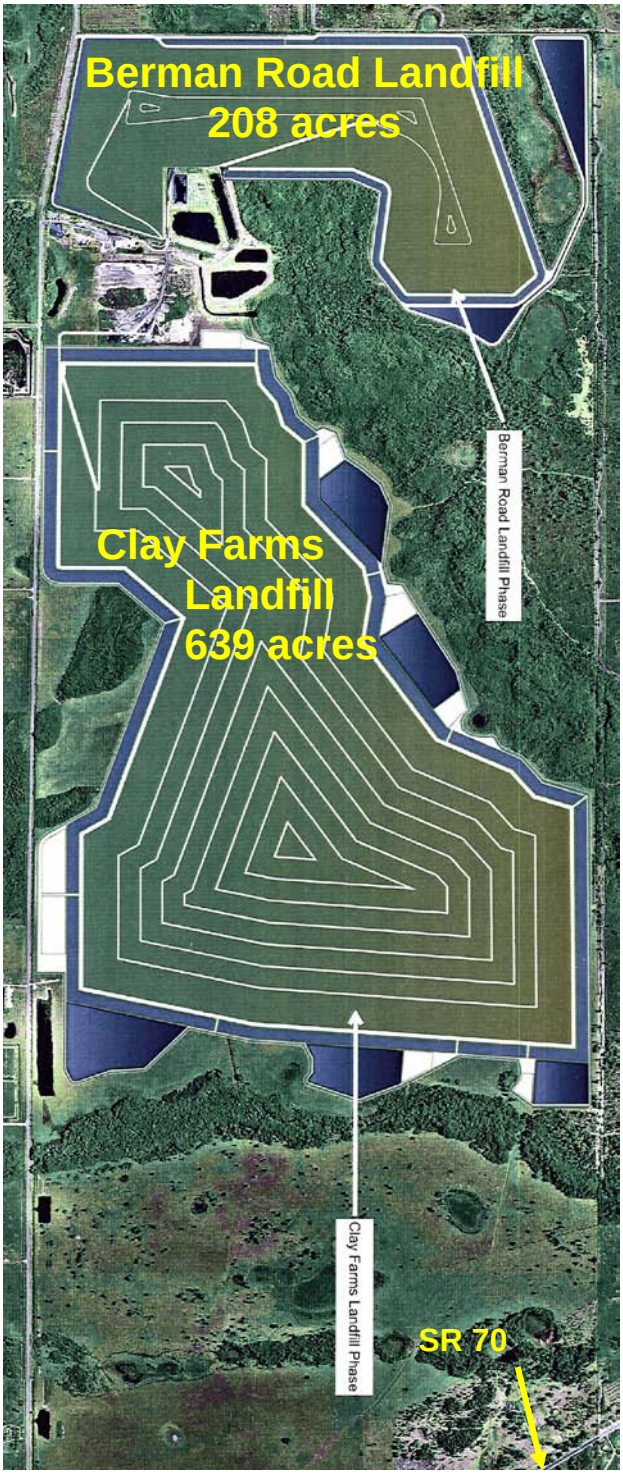


Figure 5 – Aerial View of Ultimate OL development

1.2 Present Process Description

The OL receives waste from central and southern Florida. Wastes including municipal solid waste (MSW), construction and demolition (C&D) material and special wastes are received over scales at the entrance to the landfill. Trucks are directed to the operating face of the above-grade landfill for the actual disposal.

Waste is spread in layers, compacted and covered with soil. The compacted layers compose the landfill building blocks called cells. A cell is a constructed lined area where waste is placed. Synthetic liners of high density polyethylene contain liquid (leachate) produced from waste decomposition. Waste is covered at the end of each day with soil or an approved alternative daily cover such as temporary plastic sheets. When the final permitted elevations and grades of the waste are reached, the landfill is capped. The cap systems, similar to the cell liners, are constructed of a low-permeable soil or a synthetic liner.

The waste flow is variable depending on contracts, general economic activity, hurricane debris generation, etc. Waste flow during 2005 was on the order of 5,000 to 10,000 tons per day (TPD) and 2 million tons per year (TPY) and was projected to increase at the time the application was submitted. The remaining capacity of the OL is more than 125 million tons. A description of the wastes accepted at the OL and other information is available at:

www.wmdisposal.com/static/files/fact_sheets/Okeechobee_Landfill.pdf

LFG is generated from the deposited waste. There is an extensive LFGCCS consisting of more than 200 gas extraction wells and three permanent flares. Until recently, leachate was collected and transported to a Publicly Owned Treatment Works (POTW) or evaporated on-site in systems that use LFG as a source of heat. A deep well for leachate injection started up in 2009. A network of 24 groundwater wells is regularly sampled to monitor groundwater quality around the perimeter of the landfill.

The following table is a list of the emissions units (EU) authorized at the OL. The three permanent flares are listed as EU 003, 004 and 005. Two additional open flares (CD-04 and CD-05) were authorized for temporary use to control odor by a settlement agreement between WMI and the Department (Reference: OGC-04-0094A dated 03/10/2005 and OGC-04-0094B dated 01/22/2007). The same agreement allowed the backup open flare (EU 004) to be used as needed to back up CD-04 and CD-05.

Table 1 – Presently Authorized Emissions Units at the Okeechobee Landfill

EU ID No.	Emissions Unit Description
001	Municipal solid waste landfill with LFG collection system (LFGCS).
003	Enclosed flare with a capacity of 3,000 standard cubic feet per minute (scfm) and including a leachate evaporation unit.
004	Backup open flare with a capacity of 2,800 scfm.
005	Enclosed flare with a capacity of 3,000 scfm and including a leachate evaporation unit.
CD-04	Temporary open flare with a capacity of 3,300 scfm for odor control.
CD-05	Temporary open flare with a capacity of 3,000 scfm for odor control.

Tables 2 and 3 summarize some of the key Department authorizations associated with the OL. Most of the operational limitations and expansion authorizations are given in the landfill operation permits (SO and SC permits) issued by the Department's Southeast District Solid waste Section. The air permits include construction permits (AC permits), Title V operation permits (AV permits). Certain Department Office of General Counsel (OGC) actions are included.

Table 2 – Key Department Authorizations (Air) Applicable to the Okeechobee Landfill

E.U. ID No.	Description	Permit No.	Reference Dates	Notes
001	LGCCS including 1,500 scfm enclosed flare	0930104-001-AC	05/13/1997	First air construction permit
001	Landfill and one flare	0930104-002-AV	12/16/1997	Initial Title V (TV) Permit
002	1,500 scfm enclosed flare	0930104-003-AC	05/01/1998	EU 002 separated from 001
002 003	1,500 scfm enclosed flare 3,000 scfm enclosed flare	0930104-004-AC 0930104-005-AC	07/23/2001	EU 002 operational EU 003 operational 6/2002
004	3,000 scfm open flare	0930104-007-AC	04/15/2003	EU 004 operational 1998 Backup to EU 002, 003
001 002 003 004	Landfill and 1,500 scfm enclosed flare 3,000 scfm enclosed flare 3,000 scfm open flare	0930104-006-AV	08/08/2003	TV Renewal Permit
002 005	3,000 scfm enclosed flare	0930104-010-AC	09/29/2003	EU 005 replaced EU 002 EU 005 operational 2003
005	3,000 scfm enclosed flare	0930104-011-AV	01/16/2004	TV Revision Permit
CD-04	Temporary odor flare	OGC 04-0094A	06/28/2006	Requires PSD application
004 CD-05	3,000 scfm open flare and 2nd Temporary odor flare	OGC 04-0094B	01/17/2007	Allowed continuous use of backup EU 004 as-needed. CD-05 not constructed. Requires PSD application
001 - 031	Landfill Gas to Energy	0930104-014-AC PSD-FL-382	Present Project	
001 003 004 005 CD-04 CD-05	Landfill and Flares (all relate to Berman Site)	0930104-016-AV	08/22/2008	TV Renewal Permit

Figure 6 below is a depiction of the present configuration. Figures 7, 8 and 9 are photographs of the Berman Phase, an enclosed flare (EU 003) and an odor control flare (CD-04).

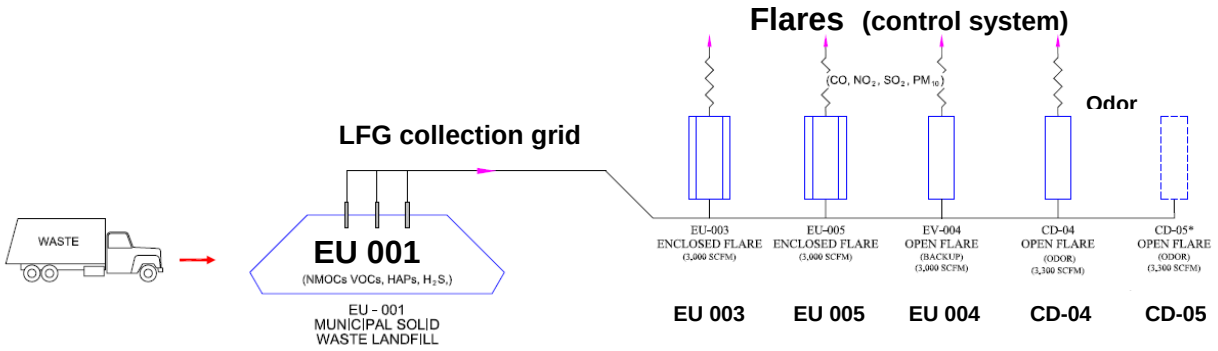


Figure 6 – Process Flow Diagram of Existing Configuration at the Okeechobee Landfill

Table 3 – Key Department Authorizations (Solid Waste) Applicable to the Okeechobee Landfill

Site	Description	Permit No.	Reference Dates	Notes
Berman	10 acre, 2-cell landfill	SF47-170390	02/12/1990	Close facility operated by Okeechobee County
Berman	900 TPD, 8-cell, 30 acre, landfill	SO47-211115	07/21/1992	Issued to CWSF
Berman	Landfill	SO47-295975	11/19/1996	Gas Collection System
Berman	5,000 TPD landfill, increase from 47 to 194 acres	040842-001-SC	02/03/1998	Operate Cells 1-8 Construct Cells 9-34
Clay Farms	639 acre, 5,000 to 7,000 TPD landfill	040842-006-SC	06/04/2001	Same facility ID, different description than Berman
Berman	Landfill	040842-010-SC	04/15/2003	Construct and operate
Clay Farms	639 acre, 5,000 to 7,000 TPD Landfill	0247963-001-SC	12/02/2005	Different facility ID
Berman	Increase from 194 to 208 acres	040842-018-SC	06/18/2008	Add 14 acres, Cell 95 10,000 TPD for Cell 95
Berman	208 acres, 10,000 TPD	040842-021-SC	10/03/2008	Berman has 57.2 acres left 107 acres are lined
Berman	Not described	040842-023-SO	03/11/2009	Pug mill to hydrate fly ash

The combined Berman and Clay site (i.e. the OL) with solid waste permits comprises 847 acres.

Figure 7 – Berman Landfill Figure 8 – Existing Enclosed Flare Figure 9 – Temporary Odor Flare

1.3 Primary Regulatory Categories

- The facility is a major source of hazardous air pollutants (HAP).
- The facility is a Title V major source of air pollution in accordance with Chapter 213, F.A.C.
- The facility is a major stationary source in accordance with Rule 62-212.400, F.A.C.

2. PROJECT DESCRIPTION

2.1 Overall Description of Project

WMI submitted an application for an air construction permit subject to the preconstruction review requirements of the Prevention of Significant Deterioration (PSD) of Air Quality pursuant to Rule 62-212.400, F.A.C. The application fulfills: the requirement to apply for a PSD permit for the recently authorized temporary flares (CD-04 and CD-05); the duty to obtain a PSD permit for the existing landfill; and authorization for emissions related to the future expansion of the OL. The applicant proposes to construct a LFG to energy (LFGTE) plant at the existing site with an ultimate capacity of 67.5 megawatts (MW). The project includes:

- Expansion of the LFG collection grid as the existing landfill is expanded;
- Treatment and desulfurization of the collected LFG;
- Ultimate installation of 16 LFG-fueled combustion turbine-electrical generators (CTG);
- Replacement of existing flares with new flares at a central flaring area; and
- Installation of additional open flares at the central flaring area as backup to the CTG.

Table 4 is a list of the changes planned to existing EU at the OL and includes the new EU authorized by this project. The two authorized open odor control flares (CD-04 and CD-05) will be replaced by permanent open flares (EU 006 and 007). The applicant identified a *near-term project* reflecting what can be expected over a reasonable permit lifetime and a *long-term project* reflecting the life of the OL. The EU designated in bold red text represent the near-term project, while the EU in bold and underlined black text represent the additional changes that result in the long-term project. EU in strikeout format are enclosed flares that will be deactivated.

Table 4 – Changes to Present Emissions Units and Future Emissions Units at the Okeechobee Landfill

EU ID No.	Emissions Unit Description
001	Municipal solid waste landfill with LFGCS and new Gas Desulfurization Plant.
~~003~~	Enclosed flare deactivated/removed during the near term.
004 **(004A)** **(004B)**	Existing open backup flare with a capacity of 2,800 scfm to be replaced by two 1,500 scfm open flares (EU 004A, 004B). Initially only EU 004A will be installed.
~~005~~	Enclosed flare deactivated/removed during the near term.
006	Open flare with a capacity of 3,000 scfm. In lieu of temporary odor control flare CD-04.
007	Open flare with a capacity of 3,000 scfm. In lieu of temporary odor control flare CD-05.
008	Open flare with a capacity of 3,000 scfm.
009	Open flare with a capacity of 3,000 scfm.
010 – 015	Up to six additional future open flares, each with a capacity of 3,000 scfm.
016	One 15 MW Model Solar Titan 130 (T-130) CTG.
017 - 019	Three 3.5 MW Model Solar Centaur 40 (C-40) CTG.
020 - 031	Up to12 additional future 3.5 MW Model Solar Centaur 40 (C-40) CTG (or substitute models as approved by future permits and permit modifications).

The near-term and the long-term configurations including all flares and CTG are shown in Figure 10. The LFG will be directed to a gas desulfurization plant (GDP), where it will be treated prior to flaring or use as fuel in the described CTG. The EU designated in red in the diagram constitute the near-term project. The GDP, CTG and future flares will be located on the east side of the OL in an area south of the developed (Berman) part of the site as shown in Figure 11. The locations of existing flares are also shown.

The equipment in this project will be installed over a period of several years to decades depending upon the rate of solid waste disposal and gas generation. The GDP will be initially constructed of sufficient size to treat the LFG produced throughout the life and closure of the OL. The LFGTE plant will be constructed in steps beginning with a single T-130 CTG and three C-40 CTG. Over the life of the development, the applicant anticipates installing as many as 15 C-40 CTG. The future models may vary based on the future products available from several manufacturers. With a LFGTE plant, the flares are primarily included for backup purposes and to burn incremental amounts of LFG until another CTG is added.

2.2 LFG Treatment and Desulfurization

WMI proposes to install a GDP to remove H_2S from LFG and to control sulfur dioxide (SO_2) from the combustion devices whether they are flares or CTG. WMI is considering two types of GDP. One is based on a chemical process called LO-CAT®. The other is a biological process called the Paques/THIOPAQ® Process.

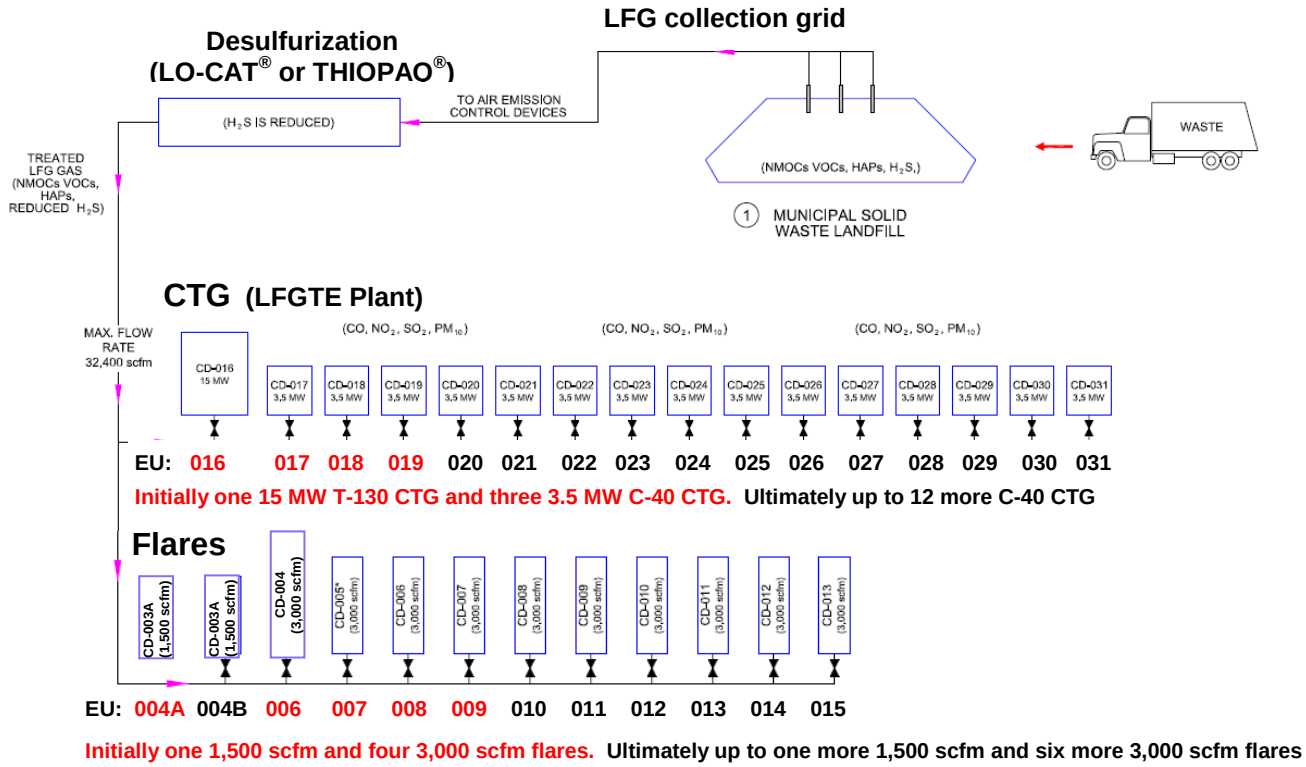


Figure 10 – Process Flow Diagram of Future LFGCCS and LFGTE Plant

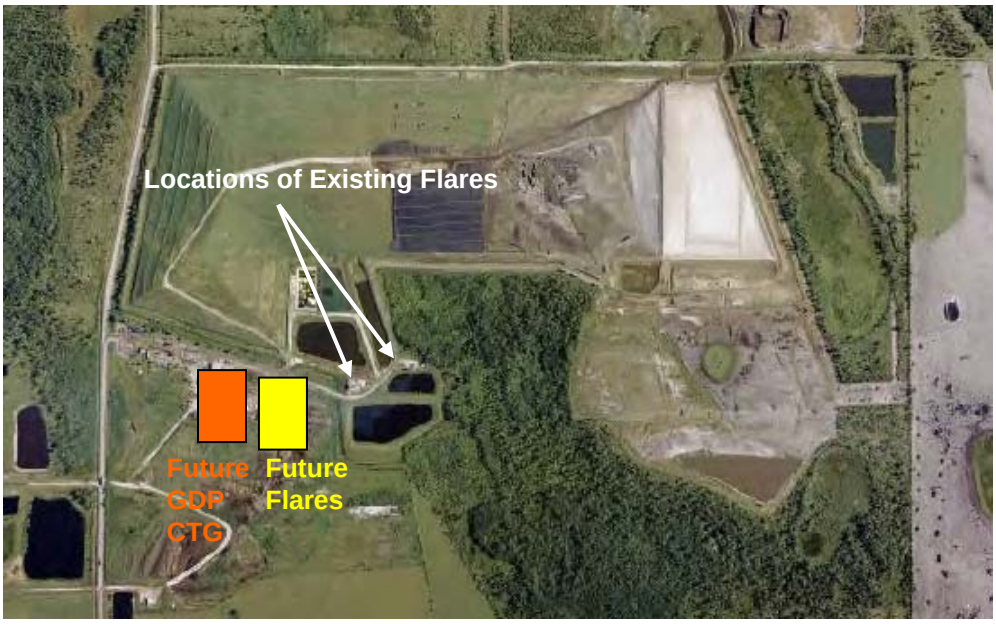


Figure 11 – Location of Existing and Future Flares, Future GDP, Future CTG

LO-CAT® Process

LO-CAT® solution is a catalytic reagent containing a proprietary biocide and surfactant to ensure that S sinks to the bottom of oxidizer from where it is removed as slurry. Figure 12 is a simplified process flow diagram of the LO-CAT® technology.

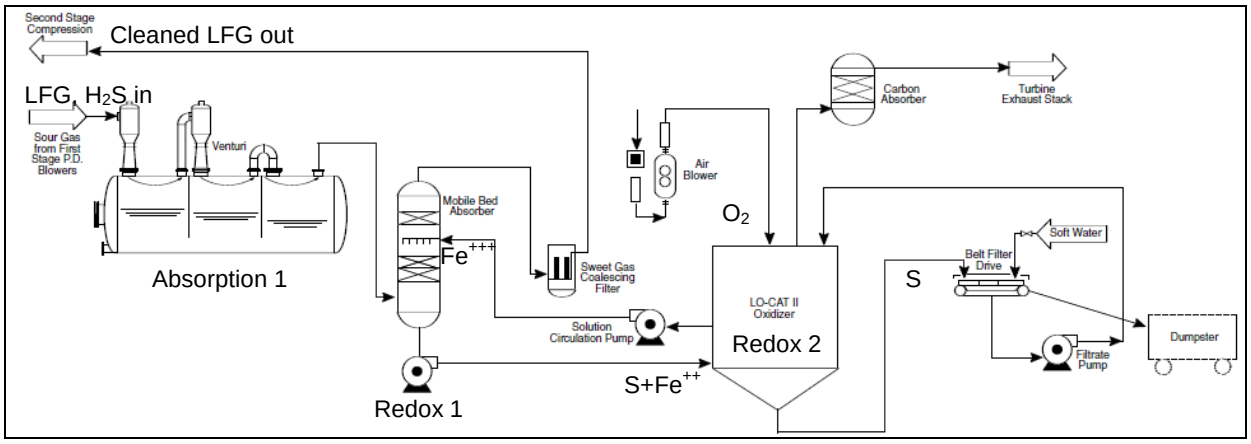


Figure 12 - LO-CAT® Simplified Process Flow Diagram

LO-CAT® is a chelated iron (Fe) liquid reduction and oxidation (redox) process that oxidizes sulfide in H_2S to elemental sulfur (S). The key reactions are:

Absorption 1: H_2S (gas) + H_2O (liquid) → H_2S (liquid) ↔ $HS^- + H^+$

Redox 1: $HS^- + 2Fe^{+++} \rightarrow S$ (solid) + $2Fe^{++} + H^+$

Absorption 2: O_2 (air) + $2H_2O$ (liquid) ↔ O_2 (liquid)

Redox 2: O_2 (liquid) + $4\ Fe^{++} + 2H_2O \rightarrow 4Fe^{+++} + 2OH^-$ (regeneration of LO-CAT® solution)

Overall: $2H_2S$ (gas) + O_2 (gas) → S + H_2O

The solution uses ethylene diamine tetra-acetic acid (EDTA) as a chelating agent to maintain the ionic Fe concentration in solution at 500 to 1800 ppm. The solution serves as a catalyst in the reaction.

A LO-CAT® II plant was installed at the WMI Central Disposal Sanitary Landfill (CSDL) in Broward County, Florida in 1994 and has since operated in conjunction with three previously installed C-40 CTG. The following photographs were taken by Department personnel at the CDSL and show the key components of the LFGTE plant including the LO-CAT® II unit with backup open flare, sulfur product handling and one of the three C-40 CTG that together produce approximately 12 MW of electricity.

Figure 13 - LO-CAT® II at CDSL

Figure 14 – Sulfur Product

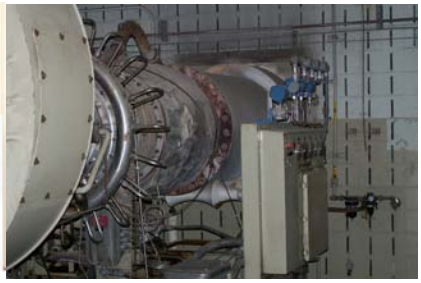


Figure 15 – LFG-fueled CTG

Paques/THIOPAQ® Process

Refer to Figure 16 below. According to Pacques (the owner of the technology):

"The H_2S containing gas enters the absorption section and is washed by scrubbing liquid (e.g. aqueous soda). The liquid has an alkaline nature and absorbs the H_2S. The biogas exits the top of the absorber virtually free of H_2S. The sulfide containing liquid flows into the bioreactor. In the reactor bacteria oxidize the sulfide with oxygen (supplied by air). The sulfur is then removed by use of a settler. The (regenerated) sulfide free liquid returns to the absorption section."

"The THIOPAQ® technology was originally developed for the purification of biogas produced during anaerobic waste water treatment. Similar gasses are biogas produced during solids digestion and landfill produced gas. Examples of successful application of the THIOPAQ® Process include water treatment plants in paper mills, distilleries, municipal sludge digestion plants and chemical industries. Gas-flows from 50 to 3500 normal cubic meters per hour (~30 to 2,000 scfm) are treated all over the world. The pressure of these gases is close to atmospheric. The biggest THIOPAQ® installation is capable of producing 14 tons of sulfur per day."

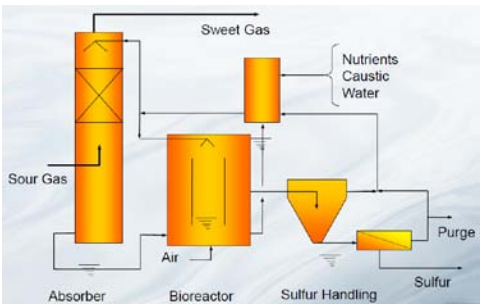


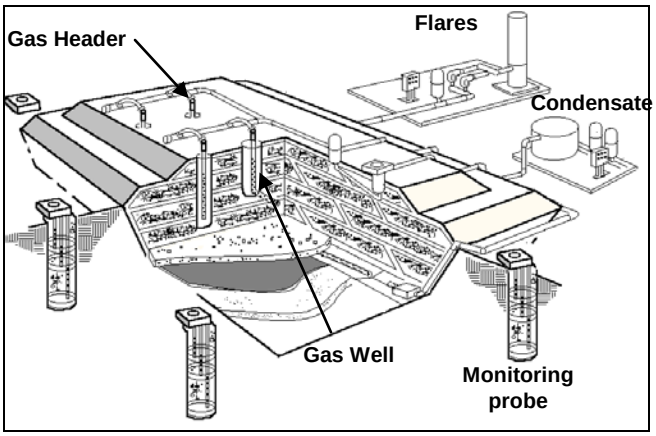
Figure 16 – THIOPAQ® Process Figure 17 – Cedar Rapids Unit Figure 18 - Sulfur Product

Further information is available at: www.paques.nl/?pid=57&parentid=56

Figure 17 is a picture of a THIOPAQ® installation located at the Cedar Rapids (Iowa) Water Pollution Control Facility (WPCA). Figure 18 is the sulfur product from a THIOPAQ installation.

2.3 LFG Combustion in CTG

Figure 19 shows a complete LFGCCS based on flaring. Figure 20 shows the LFGTE concept when using reciprocating engines but without desulfurization. There will be enough LFG generated from the OL at the start of the project to justify a single 15 MW T-130 CTG. Thereafter as many as fifteen of the smaller 3.5 MW C-40 CTG as LFG generation increases as described above.



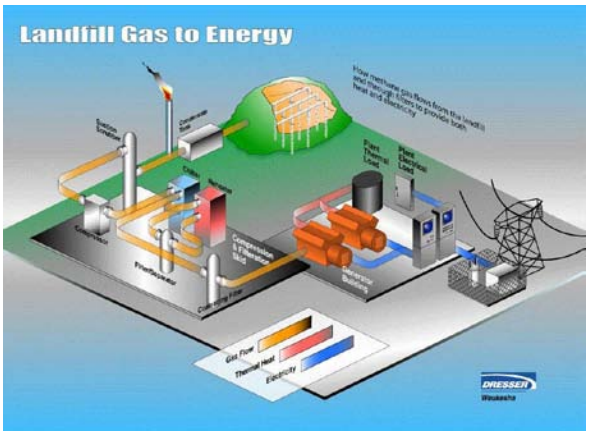


Figure 19 – Complete LFGCCS based on Flaring Figure 20 – LFGTE Plant with Backup Flaring

Figure 21 below is a diagram of the internal components of a T-130 CTG. Ambient air is drawn into the 14-stage compressor of the T-130 CTG and is compressed to a pressure ratio of 16 times atmospheric pressure. The compressed air is directed to the combustor section, where the fuel from the LFG compressors is introduced, ignited, and burned.

The hot combustion gases are then diluted with additional cooling air and directed to the rotor (expansion) section. Energy is recovered in the rotor section in the form of shaft horsepower, of which typically more than 50 percent is required to drive the internal compressor section. The balance of recovered shaft energy is available to drive the external load, which in this case is an electrical generator. Turbine exhaust gas (TEG) is discharged at a temperature greater than 900 °F.

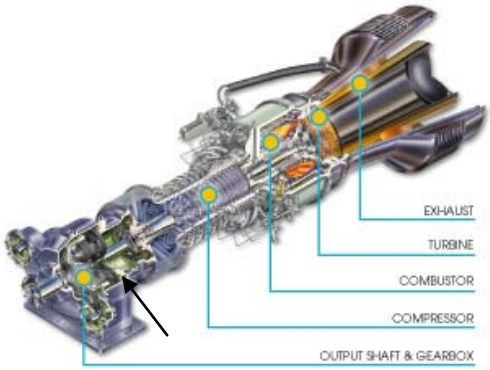


Figure 21 – Diagram of a T-130 CTG

Figure 22 – Natural Gas-fueled Combined Cycle T-130

Without heat recovery from the TEG (i.e. in simple cycle), the efficiency of the CTG is greater than 30% (based on higher heating value – HHV) when burning natural gas based on the electrical energy produced compared with the energy in the delivered gas. Configurations are available whereby such heat is recovered (i.e. combined cycle) and which result in an overall efficiency greater than 45% (based on HHV). An example of a T-130 is in combined cycle is shown in Figure 22 above.

For reference, LFG-fueled reciprocating internal compression engines (RICE) can be more energy efficient than a simple cycle LFG-fueled CTG. However CTG are less sensitive to low CH_4 concentrations than RICE and also tend to have better emission characteristics.

2.4 Different Development Scenarios

Although the applicant proposes to install a LFGTE plant, WMI requests a permit that provides for sufficient flaring capacity to completely back up the CTG with a margin of safety. According to WMI they would be required to back up all CTG with open flares anyway. The equipment scenario initially proposed by WMI for the life of the facility is summarized in the second row of Table 5. A more realistic equipment scenario based on present waste and gas flow was subsequently submitted to cover the life of the requested permit and is summarized in the third row. The corresponding gas flows for the two equipment scenarios are summarized in the fifth and sixth.

Table 5 – Summary of Development Scenarios to Combust Treated LFG from the OL

Type of Combustion Device	T-130 CTG	C-40 CTG	Open Flares		Total Flow (scfm) [1]
Flow per CTG or Flare (scfm)	5,000	1,500	3,000	1,500	
Near-Term Project (# of devices)	1	3	4	1	13,500
Long-Term Project (# of devices) [2]	1	15	10	2	32,500

1. Total flow assuming all CTG are fully utilized and any remaining flow is combusted in flares.
2. The figures for the long-term project include those of the near-term project.

The total flows above represent the upper bounds of total gas flows whether by CTG or flares. Regardless of the number of CTG or flares in operation, WMI will still need to treat all the LFG in a GDP using either by LO-CAT® or THIOPAQ® as a result of the best available control technology (BACT) determination discussed further below.

3. LFG GENERATION AND EMISSIONS

3.1 Generation of LFG

Landfill gas is generated by three main processes including:

- Primarily by decomposition by bacteria in the waste and landfill soil to methane (CH_4), carbon dioxide (CO_2) and minor constituents;
- Volatilization of solid and liquid organic compounds as non-methane organic compounds (NMOC);
- Reactions of chemicals in the waste such as ammonia (NH_3), chlorine bleach, etc. to produce gases including HAP.

Bacterial decomposition occurs in four phases as described below:

- Phase I - Aerobic decomposition by bacteria that consume oxygen (O_2) and break down long chain carbohydrates, proteins, and lipids to other organic compounds while generating CO_2;
- Phase II – Anaerobic decomposition by different bacteria of the products of the aerobic decomposition to acids and alcohols while generating CO_2 and hydrogen (H_2) and releasing nutrients that further feed and diversify bacteria;
- Phase III – Anaerobic decomposition of acids to acetates that are in-turn consumed by other bacteria to generate CH_4; and
- Phase IV – Relatively constant anaerobic CH_4 and CO_2 generation rate for about 20 years and further production for another 10 to 30 years.

Figure 23 shows the four phases and curves indicating the concentration of key gaseous constituents over time. Approximately equal concentrations of CH_4 and CO_2 that together comprise 90 to 95 percent (%) are present in Phase IV. The only minor constituent shown is nitrogen (N_2) at 2 to 5 percent (%). Oxygen (O_2) is fully depleted by Phase IV. Though not shown, hydrogen sulfide (H_2S) can be present at concentrations on the order of 10,000 parts per million by volume (ppmv) or 1% that must be considered from the standpoint of odor as well as potential emissions of PSD-pollutants upon combustion.

LFG expands and migrates through the pore spaces within the refuse and soils based on diffusion, pressure and permeability. The tendency is horizontal and upward migration with substantial emissions to the atmosphere. This movement can be influenced by application of vacuum within the landfill to cause the LFG to migrate towards wells and into a LFG collection header from which it is directed to flares.

3.2 Requirement to Collect and Control LFG

In 1996, EPA promulgated requirements under 40 Code of Federal Regulations Part 60 (40 CFR 60), Subpart Cc - Emission Guidelines and Compliance Times for Municipal Solid Waste (MSW) Landfills. Subpart Cc applies to MSW landfills for which construction, reconstruction or modification was commenced before May 30, 1991.

EPA also promulgated 40 CFR 60, Subpart WWW - Standards of Performance for MSW Landfills. Subpart WWW applies to MSW landfills that commenced construction, reconstruction or modification on or after May 30, 1991. Subpart Cc and WWW requirements are equivalent.

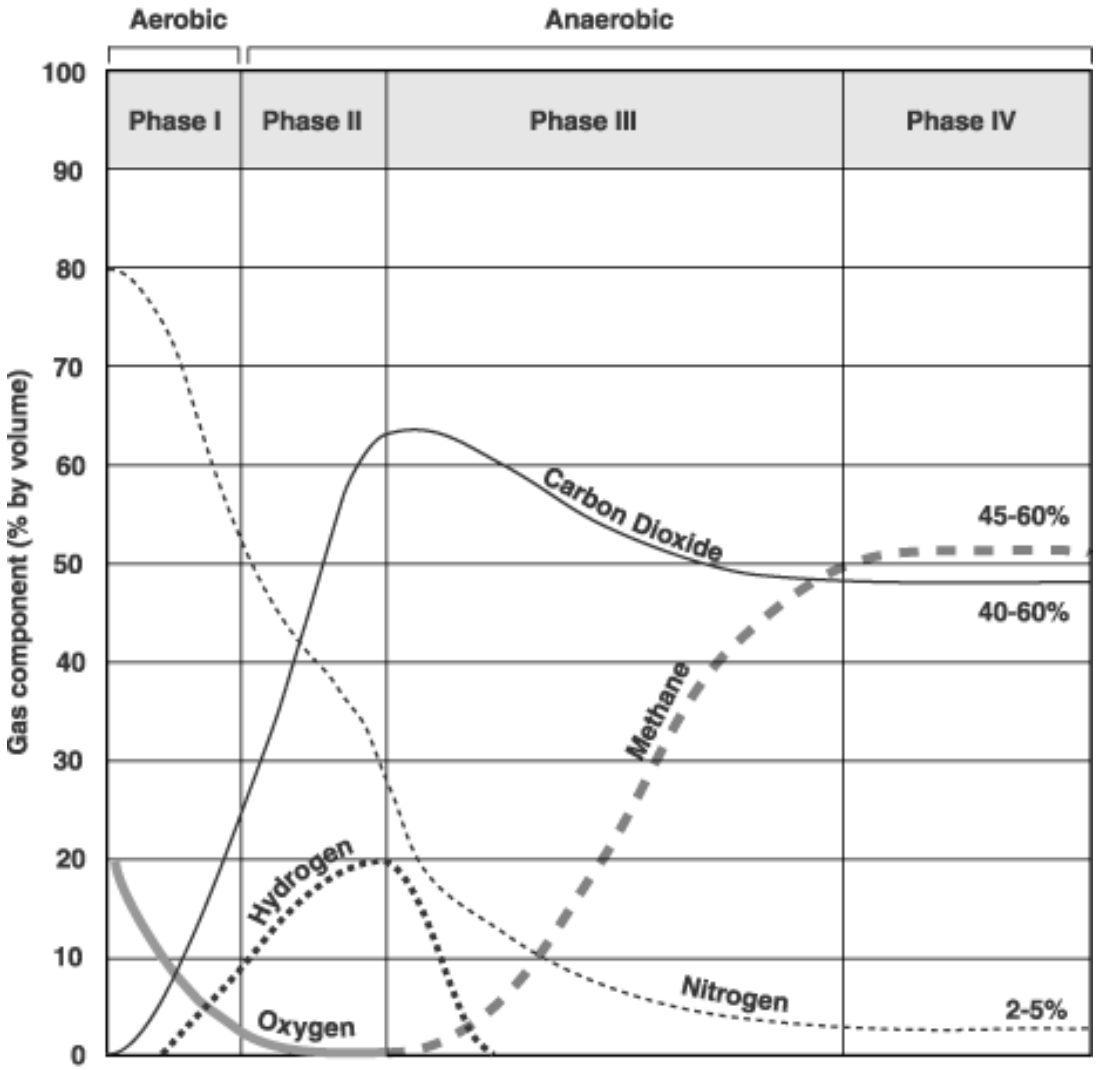


Figure 23 - Production Phases of typical LFG from Waste Landfills (source: EPA 1997)

Subparts Cc and WWW require landfills having a design capacity of 2.5 million megagrams (Mg or metric tons) or more of waste and actually emit 50 metric tons per year (metric TPY) or more of NMOC to operate a LFGCCS in accordance with specific engineering design criteria. Control devices (usually flares or other combustion devices) must reduce the NMOC emissions from the collected landfill gas by 98% or to a concentration of 20 ppmv.

MSW landfills are required to install controls based on their NMOC emission rate and must also monitor surface CH_4 emissions. If CH_4 emissions exceed background levels by more than 500 ppmv between 2 and 4 inches from the ground surface, the LFG collection grid must be adjusted or improved to achieve the 500 ppmv level. The two subparts contain various other testing, monitoring, and reporting requirements that landfills must meet.

3.3 Past and Future Waste Throughput and LFG Generation Estimates

WMI submitted information regarding past waste throughput and LFG generation with the present application. Table 6 is a summary based on past records and future projections made by WMI and its consultants circa 2007. According to the information provided, the OL was clearly capable of holding much more than 2.5 Mg of waste (approximately 2.75 million tons) and actually reached that level by 1998.

Table 6 – Past Annual Waste, LFG Generation and Recovery Estimates and Future Projections

Year	Annual Waste (TPY)	Cumulative Waste (Tons)	LFG Generation Potential (scfm)	Landfill Covered by LFGCCS (%)	LFG Recovered (scfm)
1991	28,637	315,007	194	0	0
1992	42,008	357,015	206	0	0
1993	186,295	543,310	230	0	0
1994	392,671	935,981	388	0	0
1995	452,973	1,388,954	729	0	0
1996	457,020	1,845,974	1,100	0	0
1997	655,581	2,501,555	1,447	70	1,013
1998	701,917	3,203472	1,995	65	1,271
1999	758,554	3,962,026	2,468	60	1,481
2000	954,901	4,916,927	2,994	55	1,647
2001	757,288	5,674,215	3,665	50	1,833
2002	664,891	6,339,106	4,099	50	2,049
2003	693,349	7,032,455	4,411	60	2,647
2004	2,231,950	9,264,405	4,727	70	3,309
2005	2,246,790	11,511,195	6,471	80	4,530
2006	2,007,500	13,518,695	8,095	80	6,476
2007	2,007,500	15,526,195	9,368	80	7,494
2008	2,007,500	17,533,695	10,543	80	8,434
2009	2,007,500	19,541,195	11,628	80	9,302
2018	2,555,500	41,441,195	20,877	90	18,789
2028	2,555,500	66,991,195	26,659	90	23,993
2038	2,555,500	92,541,195	29,257	90	26,332
2048	2,555,500	118,091,195	30,425	90	27,382
2058	1,669,245	142,755,440	30,949	90	27,854
2068	0	142,755,440	14,674	100	14,674

By 2000 the OL added nearly 1 million TPY to its total stored waste each year and soon thereafter held 5 million tons. Waste flow tripled from 2003 to 2004. Flow continued at a rate greater than 2 million TPY thereafter and total waste held reached 10 and 15 million tons in 2005 and 2007 respectively.

The projection submitted with the present application assumed that annual waste flow will continue at the rate of 2.0 to 2.6 million TPY, culminating in total storage of 142.8 million tons in 2058 when the landfill will presumably close. According to the application, average LFG generated will progressively increase from approximately 6,500 scfm (of which of 4,530 scfm was combusted) in 2005 to nearly 31,000 scfm (of which nearly 28,000 scfm will be combusted) in 2058. The peak value for combustion will occur soon thereafter at approximately 32,500 scfm and then decline. The LFG generation and recovery projections are key values in estimating the equipment needs for the present LFGTE project.

3.4 Errors in H_2S Generation and SO_2 Emission Estimates

While Subparts Cc and WWW addressed NMOC and CH_4, no requirements were included to regularly measure, report or control H_2S contained in the LFG or SO_2 generated by combustion of LFG. The applicant did not account for the possibility of significant SO_2 emissions when originally applying for permit 0930104-001-AC (issued 05/13/1997) to flare the LFG. According to the air construction permit application for the first 1,500 scfm enclosed flare, emission estimates were provided to the Department indicating emissions of 13.6 TPY of nitrogen oxides (NO_X), 32.9 TPY of carbon monoxide (CO) and 0.5 TPY of SO_2.

The report submitted in support of the application states:

"The enclosed flare which represents the best available control technology (BACT) has been designed in accordance with the applicable emission limitation requirements of 40 CFR Parts 60 and 61. Engineering drawings prepared by LFG Specialties, Inc. (LFG) of Cleveland, Ohio for the flare station are presented in Appendix A."

In 2003, WMI applied for permit 0930104 (issued 09/29/2003) to replace the 1,500 scfm enclosed flare (EU 001) with a 3,000 scfm enclosed flare (EU 005) and to limit the flow and emissions from the back up open flare (EU 004).

The following table is from a response to the Department's Southeast District's request for additional information (RAI) and was extracted from Attachment I to the revised application included in the response.

Table 7 – Calculated Maximum Potential Emissions (Manufacturer Guarantee)

Sources	LFG Flowrate (scfm)	PM_{10} (TPY)	SO_2 (TPY)	NO_X (TPY)	CO (TPY)	VOC (TPY)	HAP (TPY)	Single HAP (TPY)
002 004 005	6,000 Total	13.56	13.20	88.89	240.01	1.66	7.29	6.37

1. PM_{10} is particulate matter (PM) with a mean particle diameter less than 10 microns.
2. VOC are volatile organic compounds.

The table reflects the present configuration of flares with the exception of the temporary odor control flares (CD-04, 05) and the temporary authorization to continuously use EU 004 to control odor.

Certain anaerobic bacteria are capable of breaking down gypsum ($CaSO_4$) present in certain wastes, including construction and demolition (C&D) debris, and reducing the sulfur contained therein to H_2S. The process is, roughly speaking, the reverse of the oxidation process described in previous sections. Additional moisture and nourishment are provided to these bacteria by rain, conventional MSW and sewage sludge also received by landfills in South Florida. The result is that very significant concentrations of H_2S exist at such operations.

The issue of high H_2S generation had already been identified in the early 1990s at the WMI CDSL in Broward County well before submittal of the above mentioned application for the first flare at the OL. WMI installed a LO-CAT® II plant at the CDSL to remove H_2S prior to combustion in the CTG.

According to the product information, the LO-CAT® II unit commissioned in 1994 at the WMI CDSL has been operating since then and has treated incoming LFG with concentrations estimated as high as 5,000 ppmv to less than 100 ppmv H_2S after treatment. The system was subsequently upgraded and the supplier reported that the unit can "treat gas containing up to 33,350 ppmv H_2S, reducing it to less than 50 ppmv H_2S". The SO_2 emissions from the CTG at the CDSL have been in compliance with permitted SO_2 emission limits. The manufacturer's brochure highlighting its experience at the CDSL and is available at:

www.gtp-merichem.com/downloads/pompano.pdf

The experience at the WMI CDSL in the early 1990s should have provided the operators of the OL and permitting consultants with enough information to consider the likelihood of significant H_2S generation when applying for the air permit in 1997.

3.5 Recent Reporting of SO_2 Emissions

Early each year, WMI is required to submit annual operating reports (AOR) to the Department that include emission estimates of key pollutants from the previous year. Table 8 is a listing of the SO_2 emissions reported by WMI in the AOR submitted to the Department for the period 2005-2008 in TPY. The very low SO_2 emission estimates during 2005-2006 reflect the erroneous assumptions by WMI of low H_2S generation rates within the landfill. The higher estimates (est.) reported in 2007 and 2008 by WMI are more realistic, but the Department does not necessarily concur with the exact values.

Table 8 – Annual SO_2 Emissions from the OL as reported by WMI in TPY (Source: AOR)

EU ID No.	2005	2006	2007	2008
003	4.1 (error)	4.9 (error)	379 (est.)	260 (est.)
004	0.04 (error)	0.4 (error)	23.7 (est.)	1.5 (est.)
005	4.2 (error)	4.9 (error)	386 (est.)	284 (est.)
CD-04	Did not exist	0	604 (est.)	534 (est.)
Total	8.3 (error)	10.2 (error)	1392 (est.)	1080 (est.)

Figure 24 is a projection by WMI submitted in early 2007 of SO_2 emissions from 2005 through 2070 assuming that a LO-CAT® II system is installed by 2010 and based on the LFG flow projections given in Table 6. The values recognize the past reporting errors including 2005 and 2006. WMI (or its consultant) believed that an increase equal to or greater than the "significant emission rate" (SER) for SO_2 (40 TPY) would be achieved in 2007.

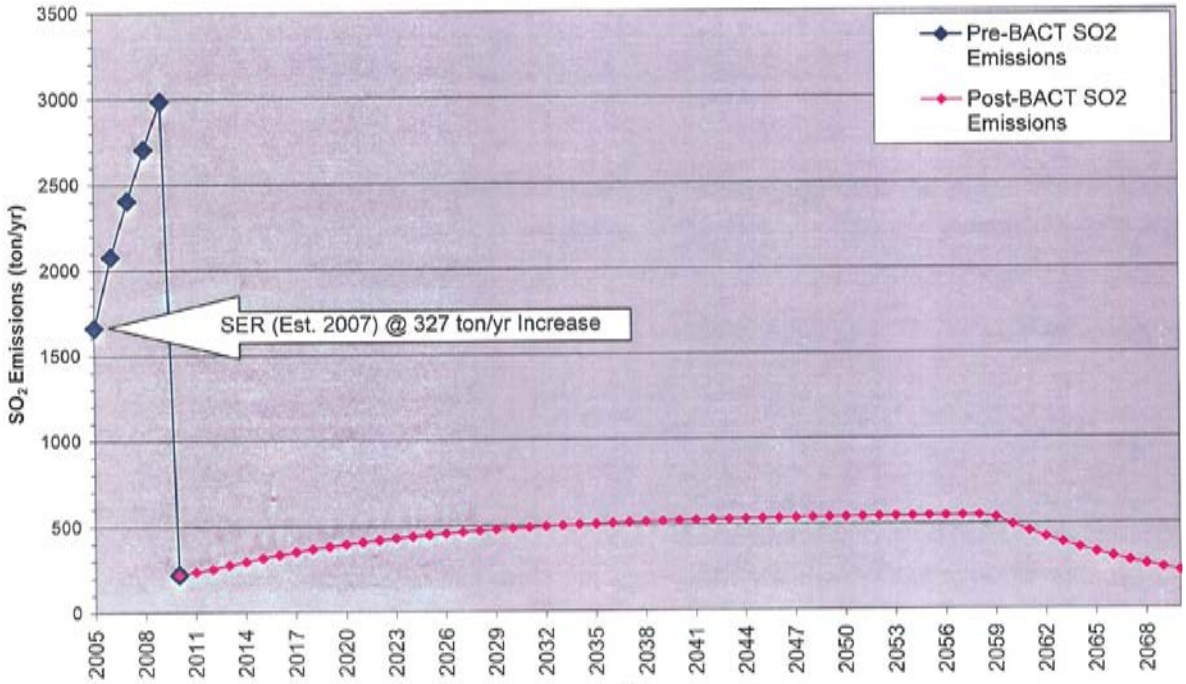


Figure 24 – WMI Estimates of Past and Projections of Future SO_2 Emissions from OL 2005-2070

At the pre-control H_2S concentration (5,800 ppmv) initially assumed by WMI for the LFGTE project, a more accurate estimate of the potential to emit (PTE) SO_2 from the first 1,500 scfm flare is calculated as follows:

$$[(1{,}500\ f^3/min)x(0.58\ f^3\ H_2S/100\ f^3)x(60\ min/hr)x(8{,}760\ hr/yr)x(lb\text{-}mol\ H_2S/379\ f^3\ H_2S)x$$
$$(1\ lb\text{-}mol\ SO_2/lb\text{-}mol\ H_2S)x(64\ lb\ SO_2/lb\text{-}mol\ SO_2)x(ton\ SO_2/2000\ lb\ SO_2)] = 386\ TPY.$$

A similar calculation for EU 003, 004 and 005 (with EU 004 used as back up only) would yield a PTE of 1,544 TPY and replace the value of 13.2 TPY given in Table 7. The PTE based on allowing continuous use of EU 004 to assist in odor control and the two temporary odor control flares allowed by the previously discussed consent orders would yield a PTE estimate closer to 3,000 TPY of SO_2. That is the peak value shown in Figure 24 prior to the reductions projected in 2010 due to operation of the GDP within the LFGTE project.

3.6 Emission Projection for Near-Term and Long-Term Projects

Table 8 indicates the applicant's stack emission projections based on the near-term and the long-term project. The reference years of 1996, 1997, 2003 are included to track PTE as new flares were added in the past. The value for 2007 reflects a revised estimate of baseline emissions by WMI since submittal of the LFGTE project application in 2007.

Table 9 – Estimate of Flow Rates, Controls and Future Emissions for Near and Long-Term Projects

Year	Controls	LFG Flow Rate scfm [7]	SO_2 TPY	CO [9] TPY	NO_X TPY	PM/PM_{10} TPY	NMOC TPY	VOC TPY	H_2S TPY
1996 [1]	None	None (fugitive)	0	0	0	0	?	374 [10]	?
1997 [2]	EU 002	1,500 (PTE)	386	32.9	13.6	?	?	?	?
2003 [3]	EU 003, 004, 005	6,000 (PTE)	1,544	240	88.9	13.6	?	1.7	?
2007-08 [4]	EU 003, 004, 005, CD-04	~6,285	1,236	246.4	50.1	14.0	69.9	27.2	?
Near-Term [5]	T-130, 3 C-40, 5 Flares	13,500	239	913	343	40	9.7	3.8	0.1
Long-Term [6]	T-130, 15 C-40, 12 Flares	32,500	578	2,466	766	75	23	9	0.3
SER			40	100	40	25/15	50	40	10
PSD?			yes [8]	yes	yes	yes	No	no	no

1. True baseline year prior to presence of any stack emissions (i.e. flares).
2. Using values estimated by Geosyntec in 1997 application, except for SO_2. SO_2 PTE based on 5,800 ppmv H_2S in LFG.
3. Using values estimated by Shaw in 2003 application, except for SO_2. SO_2 PTE based on 5,800 ppmv H_2S in LFG.
4. Emissions estimates submitted by WMI in AOR. Fugitive emissions from EU 001 included.
5. Near and long-term emission estimates are based on applicant's estimates of BACT requirements excluding fugitive emissions.
6. Long-term projections also include contributions from near-term project.
7. Total flow assuming any CTG are fully utilized and any remaining flow is combusted in flares.
8. Triggered PSD as a major stationary source prior to present project.
9. Assumes CTG will operate between 80 and 100% of full load. Emissions are greater at 50% load. As a conservative estimate, add 500 TPY of CO assuming the T-130 CTG (the largest) always operates at half-load and the rest near full load.
10. VOC (fugitive) emissions per 1997 Title V permit.

Based on the foregoing discussions, the PSD significant major stationary source status based on the PTE SO_2 was achieved when the first flare was permitted in 1997 (if not already achieved by VOC PTE). Several more increases of actual of potential SO_2 increases greater than major stationary source threshold of 250 TPY or the SER of 40 TPY occurred between 1997 and 2007.

4. APPLICABLE REGULATIONS

4.1 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 including PSD Review and BACT); 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 5 of this report. Additional details of the other state regulations are provided in Section 4 of this report.

4.2 Federal Regulations

The U.S. Environmental Protection Agency (EPA) establishes air quality regulations in Title 40 of the Code of Federal Regulations (CFR). Part 60 identifies New Source Performance Standards (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 4 of this report.

5. DEPARTMENT'S PROJECT REVIEW

5.1 Applicable State Regulations

Following are some of the key state regulations that apply to the project:

- Rule 62-212.400 (PSD), F.A.C., which regulates the entire project; and
- Rule 62-296.320, F.A.C. - General Pollutant Emission Limitation Standards.

5.2 NSPS and NESHAP

For this project, the following NSPS (40 CFR 60) or NESHAP (40 CFR 63) provisions are applicable:

- 40 CFR 60, Subpart A – NSPS General Provisions;
- 40 CFR 60.18 - General Control Device and Work Practice Requirements (Flares);
- 40 CFR 60, Subpart KKKK - NSPS for Stationary Combustion Turbines;
- 40 CFR 60, Subpart WWW - NSPS for Municipal Solid Waste Landfills;
- 40 CFR 63, Subpart A – NESHAP General Provisions;
- 40 CFR 63, Subpart AAAA – NESHAP for Municipal Solid Waste Landfills; and
- 40 CFR 63, Subpart YYYY – NESHAP for Stationary Combustion Gas Turbines.

6. PSD APPLICABILITY REVIEW

6.1 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. As defined in Rule 62-210.200, F.A.C., a facility is considered a "major stationary source" if it emits or has the potential to emit 5 tons per year of lead, 250 tons per year or more of any PSD pollutant, or 100 tons per year or more of any PSD pollutant and the facility belongs to one of the 28 listed PSD major facility categories.

PSD pollutants include: CO; NO_X; SO_2; PM; PM_{10}; VOC; lead (Pb); Fluorides (F); sulfuric acid mist (SAM); hydrogen sulfide (H_2S); total reduced sulfur (TRS), including H_2S; reduced sulfur compounds, including H_2S; municipal waste combustor organics measured as total tetra- through octa-chlorinated dibenzo-p-dioxins and dibenzofurans (D/F); municipal waste combustor (MWC) metals measured as PM; MWC acid gases measured as SO_2 and hydrogen chloride (HCl); MSW landfill emissions measured as NMOC; and mercury (Hg).

For major stationary sources, PSD applicability is based on emissions thresholds known as the SER as defined in Rule 62-210.200, F.A.C. Emissions of PSD pollutants from the project exceeding these rates are considered "significant" and BACT must be employed to minimize emissions of each PSD pollutant. Although a facility may be "major" for only one PSD pollutant, a project must include BACT controls for any PSD pollutant that exceeds the corresponding SER. The SER are listed in the following table:

Table 10 - List of SER by PSD-Pollutant

Pollutant	SER (TPY)	Pollutant	SER (TPY)
CO	100	NO_X	40
PM/PM_{10}	25/15	Ozone (VOC) [a]	40
Ozone (NO_X) [a]	40	SAM	7
SO_2	40	F	3
Pb	0.6	TRS	10
H_2S	10	MWC acid gases	40
MSW NMOC	50	MWC organics	3.5×10^{-6}
MWC metals	15	Hg [b]	0.1

a. Ozone is regulated by its precursors: NO_X and VOC.
b. Hg is not a PSD-pollutant but has an SER threshold for BACT.

6.2 PSD Applicability for the Project

The project is located in Okeechobee County, which is in an area that is currently in attainment with the state and federal AAQS or otherwise designated as unclassifiable. The facility:

- Is not one of the 28 listed stationary sources of air pollutants which emits, or has the potential to emit, 100 TPY or more of any PSD pollutant; and
- Is a stationary source which emits, or has the potential to emit, 250 tons per year or more of a PSD pollutant (specifically SO_2).

The project (GDP, CTG and flares):

- Is a physical change that would constitute a major stationary source by itself; and
- Exceeds the respective SER at least for CO, NO_X and PM/PM_{10}.

Previous projects (including the original and subsequent flares and various expansions of the OL):

- Constituted one or more physical changes equal to a major stationary source of at least SO_2 and that now require a PSD review and a BACT determination; and
- Exceeded the SER for at least SO_2 and possibly for CO, NO_X and PM/PM_{10}.

Department Rule 62-212.400(2)(a)2.c., F.A.C. (effective August 15, 1999), exempted a significant net increase undertaken solely as a result of a project undertaken for the purpose of complying with the NMOC reduction requirements of Subpart Cc or WWW from the preconstruction review requirements, provided the owner or operator demonstrates that such increase would not cause or contribute to a violation of any ambient air quality standard, maximum allowable increase, or visibility limitation.

The various flare projects conducted after the given date did not qualify for the exemption because the applicant did not estimate increases of any pollutant equal to or greater than the respective SER. Furthermore, WMI did not include a demonstration that the SO_2 emissions occurring due to the flare projects would not cause or contribute to a violation of any ambient air quality standard, maximum allowable increase or visibility limitation. Finally, the odor control flares were not for the purposes of controlling NMOC per Subparts Cc or WWW, but rather for the purpose of reducing odor (primarily due to H_2S).

The mentioned Florida rule was never approved by EPA as part of Florida's State Implementation Plan (SIP) and was withdrawn by the Department on February 2, 2006 in conjunction with the submittal of Florida's New Source Review Reform SIP Revision No. 2006-01.

With respect to a separate and more generalized EPA rule, the U.S. Court of Appeals, District of Columbia Circuit decision of June 24, 2005 held that "EPA erred in exempting from NSR certain pollution control project exemptions that decrease emissions of some pollutants but cause collateral increases of others. The statute authorizes no such exception." The decision is available at the following link:

www.ll.georgetown.edu/federal/judicial/dc/opinions/02opinions/02-1387a.pdf

7. BEST AVAILABLE CONTROL TECHNOLGY DETERMINATIONS (BACT)

7.1 Definition and Procedures for BACT

As defined in Rule 62-210.200(40), F.A.C., ***Best Available Control Technology (BACT)*** is:

(a) An emission limitation, including a visible emissions standard, based on the maximum degree of reduction of each pollutant emitted which the Department, on a case by case basis, determines is achievable through application of production processes and available methods, systems and techniques (including fuel cleaning or treatment or innovative fuel combustion techniques) for control of each such pollutant, taking into account:

1. Energy, environmental and economic impacts, and other costs;
2. All scientific, engineering, and technical material and other information available to the Department; and
3. The emission limiting standards or BACT determinations of Florida and any other state.

(b) If the Department determines that technological or economic limitations on the application of measurement methodology to a particular part of an emissions unit or facility would make the imposition of an emission standard infeasible, a design, equipment, work practice, operational standard or combination thereof, may be prescribed instead to satisfy the requirement for the application of BACT. Such standard shall, to the degree possible, set forth the emissions reductions achievable by implementation of such design, equipment, work practice or operation.

(c) Each BACT determination shall include applicable test methods or shall provide for determining compliance with the standard(s) by means which achieve equivalent results.

(d) In no event shall application of BACT technology result in emissions of any pollutant which would exceed the emissions allowed by any applicable standard under 40 CFR Parts 60, 61, and 63.

In addition, applicants must provide an Air Quality Analysis that evaluates the predicted air quality impacts resulting from the project for each PSD pollutant.

7.2 BACT for SO_2 from flares and CTG

Pre-combustion Sulfur Removal

The applicant considered several types of GDP, two of which were previously discuss (LO-CAT® and THIOPAQ®). The applicant submitted the following cost comparison for alternative GDP.

Table 11 - Cost Comparison by WMI of Alternative LFG Desulfurization Processes

Process Control	Efficiency (% Removal)	Capital Investment [1] ($)	Annualized Cost [2] ($)	Cost Effectiveness [3] ($/ton Removed)
LO-CAT®	98%	5,000,000	1,000,000	267
Biopuric	97%	16,600,000	3,984,000	1,064
H_2S Plus	95%	4,170,000	4,587,000	1,151
THIOPAQ®	95%	3,486,000	6,324,600	1,689
Sulfa Bind	< 1-2 ppmv	9,794,000	8,791,360	2,347
Sulfur-Rite ®	< 1 ppmv	332,000	12,483,200	3,333

1. Capital investment is for a plant of sufficient size for the long-term project.
2. Annualized cost is over a period of 10 years.
3. Although the process removes sulfur from LFG, cost-effectiveness is based on SO_2 emission reduction.

Applicant's SO_2 BACT Proposal

To satisfy the SO_2 BACT requirement, WMI proposes to install a LO-CAT® or THIOPAQ® system to achieve 400 ppmv of H_2S in the LFG prior to combustion in the CTG or flares.

Department's SO_2 BACT Evaluation

The Department agrees that SO_2 can be controlled by achievement of a LFG H_2S fuel specification but believes that a lower value than proposed by OL will constitute BACT. The Department notes that all of the technologies reviewed by the applicant are cost-effective. According to the assessment above, LO-CAT® appears to be superior to THIOPAQ® in terms of SO_2 removal and the assessment suggests emissions from the latter will be more than twice the emissions when employing the former. However, the Department reviewed a paper (Cline, et al, 2003) about THIOPAQ®. The paper clarifies that while sulfur recovery (as S) is on the order of 95-98%, the H_2S (and consequently SO_2) reduction is greater than 99% and can achieve H_2S levels to values as least as low as claimed by LO-CAT®.

On the basis of the application, a reduction of 98% (less than claimed to be possible by either supplier) from 5,800 ppmv will result in H_2S concentrations of 116 ppmv. Assuming a very high initial value of 10,000 ppmv, treatment to 98% removal will yield 200 ppmv or less by either process under consideration.

The applicant calculated the cost-effectiveness to reduce SO_2 to 400 ppmv on the basis of more than 7,000 TPY of uncontrolled SO_2. SO_2 control would be cost-effective even at 10 times the reported cost for LO-CAT®. Even if the uncontrolled potential to emit SO_2 were only 1,000 TPY, SO_2 control would still be cost-effective.

An upper bound to the cost-effectiveness would be to assume the same annualized costs given in Table 11 while removing only about 1,000 TPY of the SO_2 emissions reported in 2008. That value would equal 1,000/ton SO_2 removed. A similar calculation based on reduction from any of the uncontrolled emission rates projected in Figure 24 (between 2005 and 2009) would yield much lower costs per ton removed.

The value of 400 ppmv appears arbitrary and does not reflect the level which can be achieved in a cost-effective manner. Rather it is roughly equal to the value of the <u>maximum</u> H_2S consistent with the 40 CFR 60, Subpart KKKK SO_2 emission limit of 0.15 pounds of SO_2 per million (mm) Btu heat input (lb/mmBtu) for CTG fueled by biogas (of which LFG is a subset). Given that the (variable) LFG contains 450 Btu per standard cubic foot (Btu/scf or Btu/f^3), the demonstration is as follows:

$$[400\ f^3\ H_2S/mm\ f^3)x(f^3/450\ Btu)x(lb\text{-}mol\ H_2S/379\ f^3\ H_2S)x$$
$$(1\ lb\text{-}mol\ SO_2/lb\text{-}mol\ H_2S)x(64\ lb\ SO_2/lb\text{-}mol\ SO_2)] = 0.15\ lb\ SO_2/mmBtu$$

In other words, LFG containing more than approximately 400 ppmv of H_2S cannot be burned in CTG.

<u>Department's SO_2 BACT Determination</u>

The Department concludes that desulfurization to 200 ppmv H_2S constitutes BACT for SO_2 for the past flare projects and the near-term and long-term projects (including flares and CTG). At such a value the source will emit approximately 120 TPY of SO_2 after implementation of the near-term project and approximately 279 TPY of SO_2 after implementation of the long-term project.

The Department further notes that the LO-CAT® system at the WMI CDSL operates at a landfill with a lower LFG flow and less CTG (only three C-40 CTG) than planned at the OL even for the near-term project.

During the interim period, the applicant expects to continue emitting approximately 1,207 TPY of SO_2 and the PTE remains on the order of 3,000 TPY based on a pre-treatment concentration of 5,800 ppmv of H_2S. The Department finds good cause requiring the permittee to conform to new or additional conditions. Therefore, the permittee is required to install and operate by December 31, 2011 a GDP such that all collected LFG shall be treated to a concentration less than or equal to 200 parts per million by volume of hydrogen sulfide (H_2S) by volume (ppmv) as determined by a H_2S continuous emission monitoring system (CEMS) prior to combustion whether or not the permittee builds a LFGTE plant.

7.3 BACT for NO_X and CO from CTG

<u>Discussion</u>

LFG contains siloxanes, which are a class of compounds composed of units of the form 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) the consequences of which are discussed in the air pollution control sections below.

In many of its previous BACT determinations for CTG, the Department has specified wet injection or lean pre-mix combustion (LPMC) technologies also known as dry low NO_X (DLN) when burning natural gas in simple cycle CTG. The Department often requires add-on catalytic control technologies, especially for CTG operating in combined cycle. The technologies include:

- Selective catalytic reduction (SCR) for NO_X control based on NH_3 injection into the combustion gases in the presence of vanadium catalyst; and
- Oxidation catalyst for CO and VOC control.

The applicant and SOLAR contend that the following limitations exist to wet injection, DLN and catalytic technologies:

- Fuels like LFG cannot burn in LPMC modes (or do so with difficulty);
- Wet injection further reduces the heating value of LFG that is already of low heating value; and
- A separate treatment system to remove siloxanes is required to avoid adverse effects of SiO_2 deposits on catalysts or certain CTG equipment.

The low heating value and the limitations on LPMC are represented in Figure 25 that was excerpted from a SOLAR presentation. LFG has a relatively low heating value and is burned in a conventional manner meaning a diffusion flame mode. Therefore the benefits of LPMC are generally not possible to obtain when burning LFG unless it is cleaned to natural gas specifications and upgraded to similar heating value (e.g. by removing the CO_2).

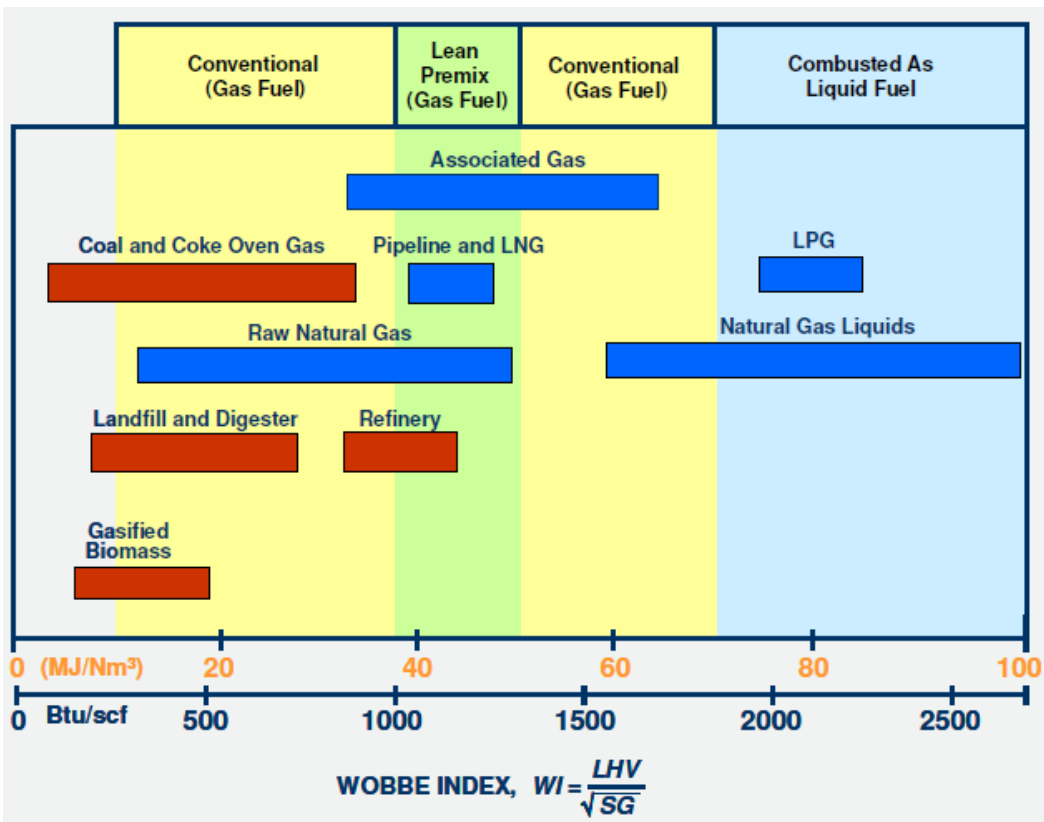


Figure 25 - Typical Fuel Wobbe Index Ranges for Combustion Systems

Interestingly, under diffusion flame combustion, CTG operating on LFG emit relatively low NO_X compared with CTG operating on natural gas. The high level of diluent CO_2 present in the LFG provides a modicum of NO_X control in a manner similar to wet injection.

<u>Applicant's NO_X and CO BACT Proposal</u>

Table 12 is a listing of the product line available from SOLAR; the key supplier of CTG for LFG applications.

Table 12 - Common Emission Values for SOLAR CTG Capable of Burning LFG [1]

Turbine Model	Emissions @ 80-100% load and @15% Oxygen (O_2)				
	NO_X [4] (ppmv)	CO [5] (ppmv)	UHC [2] (ppmv)	VOC [6] (ppmv)	Heat rate [8] (Btu/kWH)
Centaur 40 (3.5 MW)	**42**	**250**	100	~5	12,240
Centaur 50 (4.6 MW)	42	200	100	unknown	11,630
Mercury 50 (4.6MW) [7]	25	130	25	unknown	8,836
Taurus 60 (5.7 MW)	42	150	75	unknown	10,860
Mars 100 (11.3 MW)	60	200	100	unknown	10,520
Titan 130 (15 MW)	**72**	**100**	50	~5	9,695
NSPS Subpart KKKK	74 or 96 [3]	No Standard	No Standard	No Standard	

1. Guarantees are on a case-by-case basis depending on actual LFG characteristics.
2. UHC represents unburned hydrocarbons that equate approximately to NMOC plus methane from CTG.
3. 74 ppmv is applicable to the T-130 CTG and 96 ppmv is applicable to the C-40 CTG.
4. NO_X characteristics are 5 to 38 ppmv based on model when burning natural gas.
5. CO characteristics are 10 to 50 ppmv based on model when burning natural gas.
6. VOC estimates for OL project were submitted by the applicant.
7. Mercury 50 can achieve NO_X of 5 ppmv and CO of 10 ppmv if LFG is cleaned to near-natural gas specification.
8. Information purposes only. Heat rate in Btu input per kilowatt-hour of electricity generated (Btu/kWH).

The CTG and BACT proposals for the OL project are **bolded and underlined**. The actual guarantees for the project are provided in Table 13. The applicant has selected the T-130 and C-40 CTG and not the others shown in the two tables.

Table 13 – OL Project Specific Guarantees for SOLAR Turbines Burning LFG [1]

Turbine Model	Power (MW)	Gas Flow (lb/min)	Gas Temp. (°F)	NO_X			CO		
				(ppmv)	(lb/hr)	(g/bhp-hr)	(ppmv)	(lb/hr)	(g/bhp-hr)
Titan 130-20501	15.19	6,665	935	**72**	46.4	0.987	**100**	78.4	1.67
Centaur 50-6200	4.56	2,523	956	42	9.8	0.696	200	35.5	2.52
Centaur 40-4700	3.34	2,506	837	**42**	7.9	0.746	**250**	28.6	2.70

1. g/bhp-hr = grams per brake horsepower-hour; lb/hr = pounds per hour; lb/min = pounds per minute.

Table 14 is a summary of the cost-effectiveness calculated by WMI for 90% CO and NO_X reduction based on siloxanes removal coupled with SCR and oxidation catalyst. The costs were provided by WMI, but were adjusted to reflect three C-40 CTG for the near-term project rather than four C-40 CTG.

Table 14 – WMI Estimates of Annual Costs for Siloxanes and Catalytic Control Strategy

Cost Item	Annualized Costs for NO_X + CO Control Scenario			
	One T-130	**One C-40**	**One T-130 + 3 C-40**	**One T-130+ 15 C-40**
Siloxanes for T-130	$322,646		$322,646	$322,646
Siloxanes for C-40		$139,200	$417,600	$2,088,005
SCR for T-130	$1,165,516		$1,165,516	$1,165,516
SCR for C-40		$777,761	$2,333,283	$11,666,415
CO Catalyst for T-130	$402,702		$402,702	$402,702
CO Catalyst for C-40		$370,375	$1,111,125	$5,555,625
Total Annualized Costs	$1,890,864	$1,287,336	$5,752,872	$21,200,909
NO_X Reduction	183 TPY	31.5 TPY	278 TPY	655 TPY
CO Reduction	772 TPY	236.7 TPY	1,482 TPY	4,323 TPY
Total NO_X + CO Reduction	955 TPY	268 TPY	1,760 TPY	4,978 TPY
Cost Effectiveness	**$1,980/ton**	**$4,800/ton**	**$3,269/ton**	**$4,259/ton**

Department's NO_X and CO BACT Evaluation

The top control for NO_X and CO is actually part of an overall control strategy that also accomplishes SO_2 and PM/PM_{10} control. Two key projects have been recently permitted in non-attainment areas that serve as examples for the top control which is known as the lowest achievable emission rate (LAER). One project is located at the University of New Hampshire (UNH) and is being conducted in partnership with WMI. The second project is in Rhode Island.

The controls required to achieve LAER are summarized as follows:

- Desulfurization of the LFG to minimize SO_2 emissions from the CTG;
- Siloxanes removal to avoid silicon deposits on CTG equipment and to avoid interference with the operation of pollution control equipment;
- Selective catalytic reduction (SCR) or removal of CO_2 coupled with operation in LPMC mode.

Unlike BACT, cost is not a consideration when LAER is required.

The UNH project incorporates complete gas cleanup including removal of CO_2 to produce LFG with a specification nearly equal to that of natural gas. This allows use of the highly efficient SOLAR Mercury 50 (M-50) for LPMC which achieves less than 5 ppmvd of NO_X and less than 10 ppmvd of CO when fired with natural gas. By combusting LFG cleaned up to natural gas quality, the CTG can be fired in LPMC mode in accordance with the Wobbe Index chart above. The project recently started up and has reportedly achieved less than 4 ppmv of NO_X (without SCR) and less than 3 ppmv of CO when burning LFG cleaned to near natural gas specifications.

The Rhode Island project is based on the installation of five nominal 5.7 MW CTG operated in combined cycle. The CTG model is a SOLAR Taurus 60 (T-60). The project includes an SCR system that will be located within the heat recovery steam generator (HRSG). The NO_X limit is 25 ppmv of NO_X. The project incorporates LFG siloxanes removal and a sulfur specification of 100 ppmv H_2S. For reference, the project will handle nearly the same amount of LFG as the OL near-term project.

At first glance the values provided in Table 14 by WMI for LAER-type strategies appears reasonable ($2,000 to $5,000/ton pollutant removed) using the typical yardsticks of cost-effectiveness for pollutant reduction. However, if the costs are expressed in terms of the tipping fee per ton of MSW received, the impacts may be seen in a different light. At a process rate of 2,000,000 TPY, the long term costs of control (beyond the costs of combusting LFG) will be roughly $10/ton of MSW. According to one industry website, recent quotation for the MSW tipping fee at the OL is $27.79/ton. The details are available at:

www.wastemap.org/facility-profile.cfm?idsfacility=68

While tipping fees vary based on economic activity, competition, waste type, natural events, etc., the value given is fairly typical for that landfill. The long term annualized cost of the additional equipment to achieve LAER controls could equal one-third of the tipping fee if the OL calculations are correct.

The Department does not necessarily agree with the calculations submitted by OL. However, the Department concludes that at this time further cleanup (beyond desulfurization) and add-on controls is not yet cost-effective for CO and NO_X for the near-term project. The Department will re-evaluate this decision from time-to-time as the economics and requirements for renewable energy and CO_2 control become clearer for LFGTE projects.

The Department requested that OL consider the highly efficient M-50 CTG burning desulfurized LFG, without siloxanes or CO_2 removal because this model can achieve 25 ppmv of NO_X under diffusion flame mode. The M-50 delivers almost 40% more power than the C-40 from a given amount of fuel. Because of the improved efficiency and the lower NO_X concentrations for the M-50 than the C-40, the annual emissions for an M-50 scenario would be less than half of the emissions for the C-40 scenario even without SCR or LPMC.

The M-50 CTG incorporates a “recuperator” to achieve the excellent (i.e. low) heat rate indicated in Table 12. According to SOLAR there is potential for silicone deposits on the recuperator and a treatment system for siloxanes would be necessary. According to SOLAR, the firing temperature is different between the M-50 and the other available models and is more susceptible to silicone fouling because of the different firing temperature.

At this time, the Department accepts the present arguments of SOLAR and WMI regarding the siloxanes cleanup requirements to use the more efficient engines.

For the future, it should be noted that the cost to remove siloxanes from the LFG prior to use in the 15 C-40 CTG was estimated by WMI at $2,000,000 per year. With siloxanes removal, it would be possible to produce another 20 MW from about the same amount of LFG (and fewer CTG) if the 15 C-40 CTG are replaced by a corresponding number of M-50 CTG. Assuming an 80% capacity factor, and only $0.05/kWH, the additional revenues in the long run would equate to:

(20 MW)x(1,000 kW/MW)x(8,760 hr/yr)x($0.05/kW-hr)x(0.8) = $8,760,000/yr.

The further (unknown) costs of CO_2 removal would also make it possible to achieve very low NO_X and CO values by allowing M-50 CTG to operate in LPMC mode. Assuming that CO_2 removal costs about the same as siloxanes removal, there would still be a positive cash flow by adopting the M-50 CTG strategy even after paying the added cost of the more expensive CTG model.

For reference, a project was recently implemented in Georgia whereby the Municipal Gas Authority of Georgia will receive LFG treated to near pipeline quality specification. The details are available at the following two links:

http://seesorg.org/Devid_Wentworth_9-21-09.pdf

www.biomassmagazine.com/article.jsp?article_id=2424

The design includes desulfurization and CO_2 removal, but does not appear to include siloxanes removal.

For reference, WMI evaluated the possibility of conveying the untreated LFG approximately 25 miles to a coal-fueled power plant operated by Cogentrix in Martin County. The Cogentrix facility is equipped with exhaust gas cleanup equipment including scrubbers, an SCR system and a baghouse. The applicant determined that this alternative is not feasible for the OL due to the cost to design, permit and construction the pipeline.

Department's NO_X and CO BACT Determination

The Department has determined that BACT for NO_X and CO are:

- 72 and 100 ppmv @ 15% O_2 for NO_X and CO respectively from the T-130 CTG; and
- 42 and 250 ppmv @ 15% O_2 for NO_X and CO respectively from the C-40 CTG

This determination applies for all CTG for the near-term project for which construction is commenced by December 31, 2013. A separate application including an updated BACT proposal will be required for: any of the CTG authorized for the near-term project for which construction commences after 2013; and for additional CTG associated the long-term project (beyond those authorized for the near-term project). The future BACT proposals shall include a reassessment of the development and cost of LFG cleanup technologies, further advances in CTG LPMC technology, and catalyst for NO_X and CO control.

7.4 BACT for PM/PM_{10} from CTG

Clean fuel is necessary to avoid damaging turbine blades and other components already exposed to very high temperatures and pressures. The particulate concentration of LFG is relatively low. Some is removed by the LFG conditioning equipment prior to compression and delivery to the CTG.

Siloxanes and sulfur compounds such as H_2S provide the opportunity for fine PM ($PM_{2.5}$) formation. Desulfurization of the LFG will reduce the possibility of $PM_{2.5}$ formation in the environment. Siloxanes not only contribute to PM/PM_{10}/$PM_{2.5}$, they also limit the ability to use catalyst for NO_X and CO and to use the more efficient recuperative CTG.

Efficient combustion will minimize PM/PM_{10} emissions, while SO_2 and NO_X control will minimize $PM_{2.5}$ emissions.

7.5 BACT ANALYSIS FOR THE LANDFILL (EU 001)

As previously discussed, 40 CFR 60, Subpart WWW is the key standard applicable to landfills. The main requirements for an active landfill are as follows:

- Install and operate a LFGCC system;
- Design the active LFGCC system to handle the maximum expected gas flow rate from the entire area of the landfill that warrants control over the intended use period of the gas control or treatment system equipment;
- Collect gas at a sufficient extraction rate, while minimizing off-site migration of subsurface gas from each area, cell, or group of cells in the landfill in which the initial solid waste has been placed for a period of 5 years or more;
- Route all the collected gas to a processing system for subsequent sale or to an open flare or enclosed combustion device (such as boiler, process heater, combustion turbine or enclosed flare) to reduce NMOC by 98% by weight.

The applicable NESHAP is 40 CFR 63, Subpart AAAA. Simply stated, the only meaningful requirement is that MSW landfills shall meet the requirements of 40 CFR part 60, Subpart Cc or WWW.

Referring back to Table 6, it is noted that the LFGCCS at the OL covered only 50 to 80% of the LFG generation between 1997 and 2005 (possibly the last year for which the values in the table are based on experience). The temporary odor control flares CD-004 and CD-005 (neither actually a permanent part of the LFGCCS) were necessary due to the insufficient capability of the installed LFGCCS to collect and flare malodorous LFG.

It is possible that the applicant complied with the exact requirements of Subpart WWW described above. However, the landfill (EU 001) is at the very least a fugitive source of PSD-pollutants and can be regulated by requiring BACT in addition to the minimum NSPS requirements.

The past history suggests that it would be more appropriate for large landfills in warm and rainy environments and employing techniques such as those at OL (comingling MSW, C&D/hurricane debris and sewage sludge) to require collection of gases earlier than required by Subpart WWW or to specify a minimum coverage.

The Department under the authority of BACT to reduce fugitive emissions and also for the purposes of odor control will require that gas extraction be practiced at cells in which the initial solid waste has been placed for a period of 3 years (rather than 5 years) or more.

The described practice represents a reasonable precaution to minimize fugitive (non-stack) emissions of PSD-pollutants such as H_2S, NMOC and VOC.

7.6 BACT ANALYSIS FOR THE LFG FLARES

As 40 CFR 60, Subpart A (Section 60.18) is the key standard applicable to open flares. The main requirements for flares are as follows:

- Install and operate a LFGCC system;
- Flares shall be designed for and operated with no visible emissions as determined by the EPA Method 22, except for periods not to exceed a total of 5 minutes during any 2 consecutive hours; and
- Flares shall be operated with a flame present at all times.

Most permitting jurisdictions require installation of enclosed combustion devices to comply with Subparts Cc and WWW because emissions are easier to measure and the flames are not visible. Typically such jurisdictions specify enclosed flares as BACT for non-LFGTE projects when the choice is between open and enclosed flares.

For reference, the emissions of SO_2 will be the same when using the backup open flares as when using enclosed combustion devices such as CTG or enclosed flares. According to the application, the proposed SO_2 limit from the flares is 0.149 lb/mmBtu at 400 ppmv of H_2S. Proposed limits for CO and NO_X are 0.37 and 0.068 lb/mmBtu, respectively.

Emissions CO and NO_X will be much less from the open flares than from the CTG. For example, a single continuously operating 1,500 scfm flare of the design proposed by WMI will emit 13.6 TPY of NO_X and 73.1 TPY of CO. A single 1,500 scfm C-40 CTG will emit 34.6 TPY of NO_X and 125 TPY of CO (as much as 263 TPY of CO if operated at low load).

For the present project, open flares compliant with 40 CFR 60.18 rather than enclosed flares are proposed by the applicant to back up the enclosed combustion devices (i.e. CTG). According to the applicant, open flares respond promptly to surges of LFG such as occur if CTG are suddenly shut down for one reason or another. In contrast to enclosed flares, the open flares do not require time to heat refractory and exhibit greater turndown capability.

Table 15 - NO_X and CO Emission Limits for Recently Permitted Landfill Gas Flares

Facility [1]	Total Capacity (scfm)	Number Type	Permit Date	NO_X (lb/mmBtu)	CO (lb/mmBtu)
MCUA LFG Utilization Project, NJ	~3,333 [2]	Open	3/9/99	0.06	0.18
Minnesota Methane Tajiguas, CA	~2,370 [2]	Enclosed	9/8/04	0.048	0.232
WMI Northwest Regional Landfill, AZ	~1,480 [2]	Enclosed	10/27/03	0.041	0.13
WMI Atlantic Waste Disposal, VA	15,500	Five (5) Enclosed	2/5/03	0.051	0.017
Los Angeles Bureau of Sanitation, CA	8,750	Seven (7) Enclosed	3/29/01	0.06	0.01
RI Resource Recovery Corporation, RI	6,000	Enclosed	7/1/2003	0.025	0.06
WMI Turnkey Landfill, NH	3,500	Enclosed	6/15/02	0.025	0.06
WMI UNH, NH	~8,890 [2]	Two (2) Open	7/25/07 11/7/08	0.068	0.37
Proposed WMI LFGTE Project, FL	32,500	Twelve (12) Open	2010	0.068	0.37

1. It has not been verified that the all projects were actually built.
2. Values derived from mmBtu heat input rates assuming 450 Btu/f^3. Values will be lower if CO_2 removal is practiced.

The proposed CO and NO_X limits for the backup flares from the project are equal to those for the WMI UNH project where the flares also serve as back up control devices. The values were considered LAER for NO_X and BACT for CO. Because of the difficulty in measuring emissions (except for H_2S as surrogate for SO_2), a work practice standard as provided by 40 CFR 60.18 is appropriate for these back up open flares in conjunction with a design standard equal to the proposed BACT limits.

BACT for the backup open flares is:

- 0.068 lb CO/mmBtu and 0.37 lb NO_X/mmBtu achieved by design to those specification and operation in accordance with 40 CFR 60.18.
- 0.075 lb SO_2/mmBtu on a 30-day basis with compliance demonstrated by achieving 200 ppmv of H_2S measured with a H_2S CEMS.
- 0.016 lb PM_{10}/mmBtu achieved by design to that specification, limiting the LFG H_2S concentration to 200 ppmv and compliance with the 40 CFR 60.18 that states that "there shall be no visible emissions (as measured by EPA Method 22) allowed from the flare, except for periods not to exceed a total of 5 minutes in any consecutive hours".

8. AIR QUALITY ANALYSIS

8.1 Introduction

This project includes an ambient air quality analysis since the facility is subject to PSD for emissions of PM/PM_{10}, CO, SO_2 and NO_X. SO_2, PM_{10} and NO_X are criteria pollutants and have national and state ambient air quality standards (AAQS), PSD increments, significant impact levels and de minimis monitoring levels defined for them. CO is a criteria pollutant and has only AAQS, significant impact levels and de minimis monitoring levels defined for it. NO_X is an ozone precursor and any net increase of 100 TPY of pollutant requires an ambient air impact analysis including the gathering of preconstruction ambient air quality data.

8.2 Major Stationary Sources in near Okeechobee Landfill

There are few large emission sources in Okeechobee County. The following tables are lists of the largest stationary sources, by pollutant, in counties adjacent to Lake Okeechobee including Okeechobee County. The future emissions from the proposed LFGTE project are also shown.

Table 15 - Largest Sources of NO_X (2008) in Counties Adjacent to Lake Okeechobee

Owner	Site Name	TPY
Florida Power and Light (FPL)	FPL Martin Plant, Martin County	4,688
FPL	FPL Riviera Plant, Palm Beach County (PBC)	2,245
Indiantown Cogeneration	Indiantown Power Plant, Martin County	2,095
Solid Waste Authority of PBC	North Resource Recovery Facility, PBC	1,401
US Sugar Corporation	Clewiston Mill, Hendry County	886
New Hope Power Company	Okeelanta Cogeneration Plant, PCB	826
WMI/OLI	**OL – long term**	**766**
Sugar Cane Growers Coop	Sugar Cane Growers Coop, PBC	514
Osceola Farms	Osceola Farms, PBC	392
Tampa Electric Company (TECO)	TECO Phillips Station, Highlands County	353
WMI/OLI	**OL – near term**	**343**
Florida Gas Transmission (FGT)	FGT Station 20 St. Lucie	308
Florida Municipal Power Agency	Treasure Coast Energy Center, St. Lucie County	104
WMI/OLI	**OL – as reported in 2008 AOR**	**51**

Table 16 - Largest Sources of SO_2 (2008) in Counties Adjacent to Lake Okeechobee

Owner	Site Name	TPY
FPL	FPL Martin Plant, Martin County	7,734
FPL	FPL Riviera Plant, PBC	2,643
Indiantown Cogeneration	Indiantown Power Plant, Martin County	2,018
WMI/OLI	**OL – as reported in 2008 AOR**	**1,080**
WMI/OLI	**OL – long term @ 400 ppmv H_2S, 13,500 scfm**	**578**
Sugar Cane Growers Coop	Sugar Cane Growers Coop, PBC	426
New Hope Power Company	Okeelanta Cogeneration Plant, PBC	250
SWA of PBC	North Co. Resource Recovery Facility, PBC	248
TECO	TECO Phillips Station, Highlands County	245
WMI/OLI	**OL - near term @ 400 ppmv H_2S, 32,500 scfm**	**239**
U.S. Sugar Corporation	Clewiston Mill, Hendry County	151
PBC Water Utilities	PBC Water Utilities	72

Table 17 - Largest Sources of PM/PM_{10} (2008) in Counties Adjacent to Lake Okeechobee

Owner	Site Name	TPY
FPL	FPL Martin Plant, Martin County	844
Osceola Farms	Osceola Farms, PBC	333
US Sugar Corporation	Clewiston Mill, Hendry County	323
Sugar Cane Growers Coop	Sugar Cane Growers Coop, PBC	257
FPL	FPL Riviera Plant, PBC	173
New Hope Power Company	Okeelanta Cogeneration Plant, PBC	124
Solid Waste Authority PBC	North CO. Resource Recovery Facility, PBC	102
WMI/OLI	**OL – long term**	**75**
WMI/OLI	**OL – near term**	**40**
Okeelanta Corporation	Okeelanta Sugar Refinery, PBC	21
WMI/OLI	**OL – as reported in 2008 AOR**	**14**
TECO	TECO Phillips Station, Highlands County	10

Table 18 - Largest Sources of CO (2008) in Counties Adjacent to Lake Okeechobee

Owner	Site Name	TPY
U.S. Sugar Corporation	Clewiston Mill, Hendry County	11,774
Osceola Farms	Osceola Farms, PBC	11,456
Sugar Cane Growers Coop	Sugar Cane Growers Coop, PBC	10,655
WMI/OLI	**OL – long term (all but one CTG at full load)**	**2,466**
New Hope Power Company	Okeelanta Cogeneration Plant, PBC	2,254
FPL	Martin Plant, Martin County	1,451
WMI/OLI	**OL – long term (all but one CTG at full load)**	**913**
SWA of PBC	North Co. Resource Recovery Facility, PBC	772
Southern Gardens Citrus	Southern Gardens Clewiston, Hendry County	622
FPL	Riviera Plant, PBC	443
Louis Dreyfus Citrus	Indiantown Plant, Martin County	370
WMI/OLI	**OL – as reported in 2008 AOR**	**250**
Indiantown Cogeneration	Indiantown Power Plant, Martin County	158

8.3 Air Quality and Monitoring in the Okeechobee Landfill Region

State agencies operate monitors at seven sites measuring NO_X, SO_2, ozone, PM_{10}, or $PM_{2.5}$ (also called PM_{fine}) in the counties surrounding Lake Okeechobee. The sites are shown in Figure 26. The OL LFGTE project will be located in East Okeechobee County, adjacent to St. Lucie County. There are PM_{10} and $PM_{2.5}$ monitors in nearby rural Belle Glade, which is the center of the sugar industry. There are ozone and $PM_{2.5}$ monitors in the rural to urban transition area in Royal Palm Beach. The rest are along the east coast in the communities of Riviera Beach, Delray Beach and West Palm Beach (WPB Lantana).

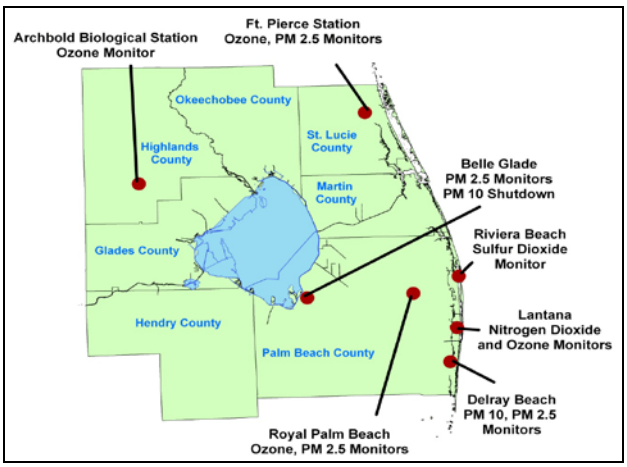


Figure 26 - Air Monitoring Network

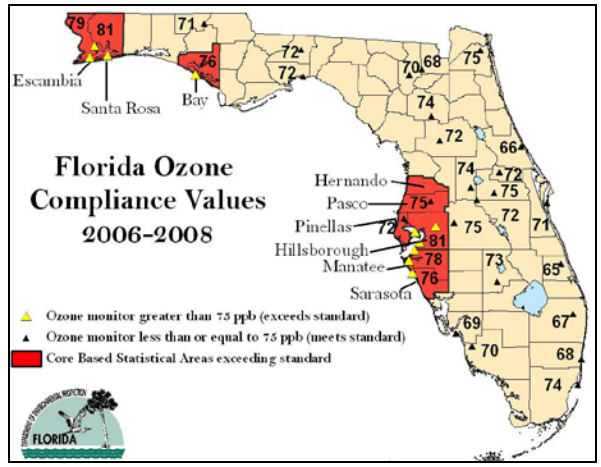


Figure 27 – Ozone Compliance Values

Measured ambient air quality information is summarized in the following table.

Table 19 - Ambient Air Quality Measurements Nearest to the Project Site (2008)

Pollutant	Location	Averaging Period	Ambient Concentration				
			High	2nd High	Mean	Standard	Units [a]
PM_{10}	Belle Glade	24-hour	79	49		150 [b]	$\mu g/m^3$
		Annual			19	50 [c]	$\mu g/m^3$
$PM_{2.5}$	Ft. Pierce	24-hour	32	30		35 [d]	$\mu g/m^3$
		Annual			9	15 [e]	$\mu g/m^3$
SO_2	Riviera Beach	3-hour	4	4		500 [f]	ppb
		24-hour	4	4		100 [f]	ppb
		Annual			2	20 [c]	ppb
NO_2	WPB Lantana	Annual			8	53 [c]	ppb
CO	WPB (shutdown)	1-hour	2	2		35 [f]	ppm
		8-hour	1	1		9 [f]	ppm
Ozone	Ft. Pierce	8-hour	69	67		75 [g]	ppb
		8-hour	2006-08 3-yr. avg.		65	75 [g]	ppb

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 24-hour concentrations.
e. Three year average of the weighted annual mean.
f. Not to be exceeded more than once per year.
g. Three year average (avg.) of the 4th highest daily maximum.

On March 27, 2008 the U.S. Environmental Protection Agency (EPA) published a final rule reducing the 8-hour ozone AAQS from 85 to 75 ppb. The average of the annual fourth highest measurements over the period 2006-2008 is the value that is compared to the ozone AAQS for determining whether an area is in attainment. For the Fort Pierce monitor (the nearest to the OL), the value was 65 ppb.

On January 10, 2010 EPA proposed to strengthen the 8-hour ozone standard, to a level within the range of 60-70 ppb and a final standard is expected to be issued by August 31, 2010. Based on the map in Figure 27, the ozone monitor at Ft. Pierce was in attainment with the limit of 75 ppb. Preliminary data for the period 2007-2009 indicates that the 3-year average of the 4th highest ozone value is 63 ppb, suggesting that the ozone monitor nearest the OL will be in attainment with all but the most stringent of the limits under consideration by EPA.

The highest measured values of all pollutants are all less than the respective National Ambient Air Quality Standards (NAAQS). Based on local emission trends, it is not likely that ground-level concentrations will approach the NAAQS levels, at least at the monitoring locations. One exception is ozone because it is formed from precursors that are clearly available (NO_X and VOC) from local industrial and transportation emissions. The tendency to form ozone is accentuated by hot ambient temperature, solar insolation, high pressure, and relatively low wind speed.

8.4 Air Quality Impact Analysis

The applicant's PM_{10}, CO, NO_2, and SO_2 air quality impact analyses for this project was done for four operating scenarios. These four scenarios include the previously described interim scenario and three future operating scenarios.

Table 20 – Future Operating Scenarios Evaluated in Modeling Analysis

Scenario	Enclosed Flares	Open Flares	Titan Turbines	Centaur Turbines	Total scfm
Interim	2	1			5,700
2		2	1	15	32,400
2A		11			32,400
B		12			32,400

Significant Impact Analysis

Significant Impact Levels (SIL) are defined for PM_{10}, CO, NO_2 and SO_2. A significant impact analysis is performed on each of these pollutants to determine if a project will cause an increase in ground level concentration greater than the SIL for each pollutant.

In order to conduct a significant impact analysis, the applicant uses the proposed project's emissions at worst load conditions as inputs to the models. The models used in this analysis and any required subsequent modeling analyses are described below. 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 Everglades National Park (ENP) and the PSD Class II Area (everywhere except the ENP).

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. The receptor grid consisted of discrete Cartesian receptors spaced at 100-meter intervals around the facility fence line out to 0.5 kilometers. The remaining receptor grid consisted of Cartesian receptors at 250 meters apart starting from .5 kilometers and extending to 1 kilometer. Beyond 1 kilometer, Cartesian receptors with a spacing of 500 meters were used out to 5 kilometers from the facility. From 5 to 10 kilometers, Cartesian receptors with a spacing of 1000 meters were used.

In some cases, the Department added receptors to ensure the accuracy of the SIL modeled results. For example, 50 meter receptor spacing was added along the property or fence-line for the PM_{10} SIL modeling where the greatest impacts were initially modeled by the applicant.

For the Class I analysis, receptors provided by the National Park Service (NPS) were used.

If this modeling, at worst-load conditions shows ground-level increases less than the SIL, the applicant is exempted from conducting any further modeling. If the modeled concentrations from the project exceed the SIL, then additional modeling including emissions from all major facilities or projects in the region (multi-source modeling) is required to determine the proposed project's impacts compared to the AAQS and PSD increments.

The results shown below are the highest impacts from all four operation scenarios combined. One of the scenarios, the "interim" is temporary and leads to the highest impacts for SO_2, therefore once the GDP is constructed, the impacts shown here for SO_2 will be lower.

Except for CO, maximum predicted impacts from all pollutants are greater than the applicable SIL for the Class II area. Therefore, further full impact modeling is required for these pollutants. The maximum predicted values are also compared with existing ambient air quality measurements from the local ambient monitoring network.

Table 21 - Maximum Predicted Air Quality Impacts from the Okeechobee Landfill Expansion (all 4 scenarios) for Comparison to the PSD Class II SIL

Pollutant	Averaging Time	Max Predicted Impact ($\mu g/m^3$)	Significant Impact Level ($\mu g/m^3$)	2008 Baseline Concentrations ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Significant Impact?
SO_2	Annual	8	1	~5	60	YES
	24-Hour	54	5	~10	260	YES
	3-Hour	82	25	~10	1300	YES
PM_{10}	Annual	1	1	~19	50	YES
	24-Hour	7	5	~79	150	YES
CO	8-Hour	173	500	~1150	10,000	NO
	1-Hour	1450	2000	~2300	40,000	NO
NO_2	Annual	8	1	~15	100	YES

The nearest PSD Class I area is the Everglades National Park (ENP) located about 169 km to the south of the project site, at its closest point. Maximum predicted air quality impacts from the proposed project are summarized in Table 22. The results of the initial PM_{10}, NO_2 and SO_2 air quality impact analyses for this project indicated that maximum predicted impacts from these pollutants are less than the applicable SIL for the Class I area. Therefore, no further detailed modeling efforts are required for these pollutants in the Class I area.

Preconstruction Ambient Monitoring Requirements

A preconstruction monitoring analysis is done for those pollutants with listed de minimis impact levels. These are levels, which, if exceeded, would require pre-construction ambient monitoring. For this analysis, as was done for the significant impact analysis, the applicant used the proposed project's emissions at worst load conditions as inputs to the models. As shown in Table 23, the maximum predicted impacts for all pollutants with listed de minimis impact levels were less than these levels except for SO_2 on a 24-hour basis. Therefore, no pre-construction monitoring is required for those pollutants except for SO_2 on a 24-hour basis.

Table 22 - Maximum Predicted Air Quality Impacts from the Okeechobee Landfill Expansion (all 4 scenarios) for Comparison to the PSD Class I SIL at ENP

Pollutant	Averaging Time	Max. Predicted Impact at Class I Area ($\mu g/m^3$)	Class I Significant Impact Level ($\mu g/m^3$)	Significant Impact?
PM_{10}	Annual	0.0004	0.2	NO
	24-hour	0.01	0.3	NO
NO_2	Annual	0.002	0.1	NO
SO_2	Annual	0.002	0.1	NO
	24-hour	0.1	0.2	NO
	3-hour	0.2	1	NO

Table 23 - Maximum Air Quality Impacts for Comparison to the De Minimis Ambient Impact Levels

Pollutant	Averaging Time	Max Predicted Impact ($\mu g/m^3$)	De Minimis Level ($\mu g/m^3$)	Baseline Concentrations ($\mu g/m^3$)	Impact Greater Than De Minimis?
PM_{10}	24-hour	7	10	~79	NO
NO_2	Annual	8	14	~15	NO
SO_2	24-hour	54	13	~10	YES
CO	8-hour	173	575	~1150	NO

There are no ambient standards or *de minimus* air quality levels associated with VOC, which is a precursor for the pollutant ozone. The impacts of VOC emissions on ozone levels are not usually seen locally, but contribute to regional formation of ozone. Projects with VOC and NO_X emissions greater than 100 tons per year are required to perform an ambient impact analysis for ozone including the gathering of preconstruction ambient air quality data. The Okeechobee Landfill expansion is not PSD for VOC. The applicant estimated annual potential NO_X emissions from the project to be 766 tons per year. Therefore, preconstruction monitoring for ozone is required.

Based on the preceding discussions, the only additional detailed air quality analyses required by the PSD regulations for this project are the following:

- A multi-source AAQS and PSD increment analysis for PM_{10}, SO_2 and NO_2 in the Class II area;
- A Preconstruction Monitoring analysis for SO_2 and ozone;
- An analysis of impacts on soils, vegetation, visibility, and of growth-related air quality modeling impacts.

Models and Meteorological Data Used in the Foregoing Air Quality Analysis

PSD Class II Area: The AERMOD modeling system was used to evaluate the pollutant emissions from the proposed project in the surrounding Class II Area. AERMOD was approved by the EPA in November 2005. The AERMOD modeling system incorporates air dispersion 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. The stacks associated with this project all satisfied the good engineering practice (GEP) stack height criteria.

The AERMET meteorological data used for this analysis consisted of a concurrent 5-year period of hourly surface weather observations and twice-daily upper air soundings from the National Weather Service at Palm Beach International (PBI) Airport and Florida International University in Miami respectively. The 5-year period of meteorological data was from 2001 through 2005.

In reviewing this permit application, the Department has determined that the application complies with the applicable provisions of the stack height regulations as revised by EPA on July 8, 1985 (50 FR 27892). Portions of the regulations have been remanded by a panel of the U.S. Court of Appeals for the D.C. Circuit in NRDC v. Thomas, 838 F. 2d 1224 (D.C. Cir. 1988). Consequently, this permit may be subject to modification should EPA revise the regulation in response to the court decision. This may result in revised emission limitations or may affect other actions taken by the source owners or operators. A more detailed discussion of the required analyses follows.

PSD Class I Area: The California Puff (CALPUFF) dispersion model was used to evaluate the pollutant emissions from the proposed project in the Class I ENP beyond 50 km from the proposed project. Meteorological MM4 and MM5 data used in this model was from 2001, 2002 and 2003.

CALPUFF is a non-steady state, Lagrangian, long-range transport model that incorporates Gaussian puff dispersion algorithms. This model determines ground-level concentrations of inert gases or small particles emitted into the atmosphere by point, line, area, and volume sources.

The CALPUFF model has the capability to treat time-varying sources, is suitable for modeling domains from tens of meters to hundreds of kilometers, and has mechanisms to handle rough or complex terrain situations. Finally, the CALPUFF model is applicable for inert pollutants as well as pollutants that are subject to linear removal and chemical conversion mechanism.

Multi-source PSD Class II Increment Analysis

The PSD increment represents the amount that new sources in an area may increase ambient ground level concentrations of a pollutant from a baseline concentration. The maximum predicted annual PM_{10}, SO_2, and NO_2 and maximum predicted high, second-high PSD Class II area impacts from this project and all other increment-consuming sources in the vicinity of the Okeechobee Landfill are shown in Table 24.

In no case is the impact greater than the allowable increment. However, during the interim operation scenario it is predicted that 91% of the allowable increment will be consumed. SO_2 emissions projected during the interim scenario are less than reported during 2007-2008 and substantially less than the PTE. Without installation of the GDP, it is possible that emissions in the future can fully consume or exceed the 24-hour allowable SO_2 increment. Therefore the Department requirement to install a GDF regardless of the LFGTE project is further justified.

Table 24 - PSD Class II Increment Analysis – Maximum from Four Operating Scenarios

Pollutant	Averaging Time	Max Predicted Impact ($\mu g/m^3$)	Allowable Increment ($\mu g/m^3$)	Impact Greater Than Allowable Increment?
SO_2	24-hour	83	91	NO
	3- hour	139	512	NO
	Annual	14	20	NO
NO_2	Annual	11	25	NO
PM_{10}	24-hour	6	30	NO
	Annual	1	17	NO

AAQS Analysis

For pollutants subject to an AAQS review, the total impact on ambient air quality is obtained by adding a "background" concentration to the maximum modeled concentration. This "background" concentration takes into account all sources of a particular pollutant that are not explicitly modeled. The results of the AAQS analysis are summarized in the table below. As shown in Table 25, emissions from the proposed facility are not expected to cause or contribute to a violation of an AAQS.

Table 25 - Ambient Air Quality Impacts – Maximum from Four Operating Scenarios

Pollutant	Averaging Time	Major Sources Impact ($\mu g/m^3$)	Background Conc. 2006- 2008 ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	Total Impact Greater Than AAQS?	Florida AAQS ($\mu g/m^3$)
SO_2	24-hour	92	11	103	NO	260
	3- hour	160	11	171	NO	1300
	Annual	15	5	20	NO	60
NO_2	Annual	11	19	30	NO	100
PM_{10}	24-hour	6	42	48	NO	150
	Annual	1	20	21	NO	50

Ozone

Ozone is an area-wide pollution problem and the solution to reducing ozone levels is broad-based local and regional reductions in NO_X and VOC emissions (the precursors to ozone formation). The Okeechobee Landfill Expansion will add less than PSD significant amounts of VOC and 766 TPY of NO_X.

To conclusively prove whether or not the 766 tons of NO_X will not cause or contribute to a violation, a very sophisticated and expensive model would need to be run for the entire region. The key inputs to the model would be traffic, power plants throughout the region, other industrial sources, and meteorology.

The Department graphed the NO_X and SO_2 emission trends during the period 1998-2007 from FPL fossil-fueled plants located in the Florida peninsula. The data source is the EPA Clean Markets Acid Rain database. The results are summarized in Figure 28.

During the period 1998-2007 there was a *decrease* from 98,500 to 31,800 TPY (68%) in NO_X emissions from the FP&L fossil fleet in peninsular Florida. Similarly there was a *decrease* from 221,400 to 50,900 TPY (77%) in SO_2

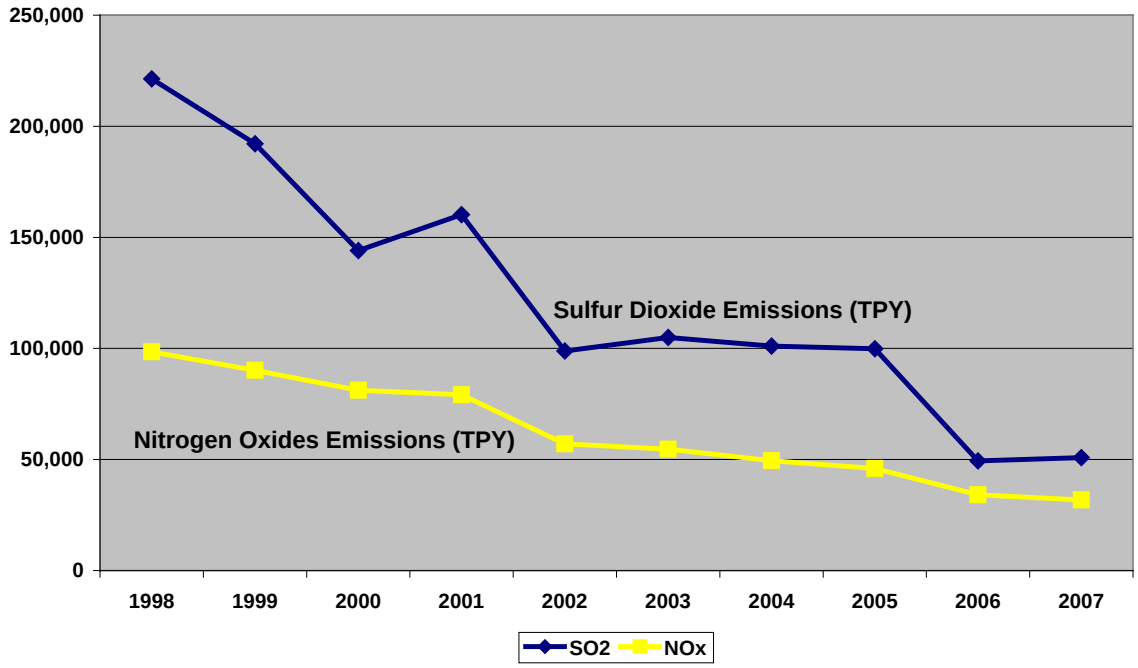


Figure 28 – SO_2 and NO_X reductions at FPL peninsular facilities (1998-2007)

It would be difficult to model overall ozone changes due to the OL LFGTE project within the context of ongoing and future NO_X reductions from FPL that are two or more orders of magnitude greater than the contribution from the OL LFGTE project.

Preconstruction Monitoring Analysis for SO_2 and Ozone

The closest ozone monitor is in adjacent St. Lucie County. Ozone is a regional pollutant therefore the monitor in St. Lucie is considered representative or at least is in a region where there are greater sources of VOC and NO_X than the landfill. The monitor in St. Lucie County is in compliance with the current and recently established ozone AAQS. Therefore, placing a preconstruction ozone monitor at the project site is not needed, nor required to obtain background air quality concentrations.

The closest SO_2 monitor is in Palm Beach County. The monitor is in attainment for SO_2. While this monitor is not representative of concentrations in Okeechobee County, is has remained in attainment with the AAQS even though the monitor is near a larger source of SO_2 than the OL.

8.5 Additional Impacts Analysis

Impact on Soils, Vegetation, and Wildlife:

As part of the Additional Impact Analysis, Air Quality Related Values (AQRV) are evaluated with respect to the Class I area. This includes the analysis of sulfur and nitrogen deposition for all proposed operating scenarios. The CALPUFF model is also used in this analysis to produce quantitative impacts. The results of the analysis show that nitrogen and sulfur deposition rates are less than the significant impact levels (0.01 kg/ha/yr) determined by the NPS.

According to the applicant, the predicted deposition rates of sulfur and nitrogen of 0.002 and 0.002 kg/ha/yr respectively, impacts are still much less than the buffering capacities of the soils in the ENP and much less than the observed deposition rates existing in the area.

Impact on Visibility:

The applicant submitted a regional haze analysis for the ENP. The analysis included modeling from the CALPUFF model. The proposed operating scenario which includes seven turbines, created the largest visibility impact on the ENP. This scenario produces impacts above the NPS visibility threshold of 5% for 1, 3 and 5 days for the years 2001, 2002 and 2003 respectively. No days were above 10%.

The NPS was provided the opportunity to comment regarding the aforementioned AQRV analysis, including visibility, for this project. Based on the information provided in the OL permit application and addendum, the National Park Service informed the Department that they "do not anticipate any significant impacts to air quality related values at Everglades National Park, Biscayne National Park, and Big Cypress National Preserve". The finding was premised on the short duration of the interim high SO_2 emissions prior to installation of the GDP.

Growth-Related Impacts Due to the Proposed Project:

According to the applicant, only 1 or 2 additional permanent personnel will be required due to this project. According to the applicant, no additional industrial, commercial or residential growth is expected from this project. Therefore, there will be no adverse impacts due to personnel growth.

9. 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.