



2020 MDE EMISSIONS CERTIFICATION REPORT
MILLERSVILLE LANDFILL GAS TO ELECTRICITY FACILITY
Facility ID No.: 003-1471

389 Burns Crossing Rd.
Severn, Maryland

March 26, 2021

Project No. 2100040

MDE Emissions Certification Report Forms

MARYLAND DEPARTMENT OF THE ENVIRONMENT
 1800 Washington Boulevard, Suite 715 • Baltimore Maryland 21230-1720
 410-537-3000 • 1-800-633-6101 • <http://www.mde.state.md.us>
 Air and Radiation Management Administration
 Air Quality Compliance Program
 410-537-3220

FORM 1:

**GENERAL FACILITY INFORMATION
 EMISSIONS CERTIFICATION REPORT**

Calendar Year: 2020

A. FACILITY IDENTIFICATION				Do Not Write in This Space	
Facility Name Millersville Landfill Gas to Electricity Facility				Date Received Regional	
Address 389 Burns Crossing Road				Date Received State	
City Severn		County Anne Arundel		AIRS Code	
Zip Code 21144				FINDS Code	
B. Briefly describe the major function of the facility					
Landfill gas (LFG) fueled electricity generation facility					
SIC Code					
Facility Number:					
TEMPO ID:					
C. SEASONAL PRODUCTION (% if applicable)					
<u>Winter</u> (Dec.-Feb.)		<u>Spring</u> (Mar - May)		<u>Summer</u> (Jun - Aug)	
<u>Fall</u> (Sept - Nov)		25%		25%	
25%		25%		25%	
Reviewed by:					
Name				Date	
D. Explain any increases or decreases in emissions from the previous calendar year for each registration at this facility.					
CY2020 actual emissions are similar to CY2019 actual emissions.					
E. CONTROL DEVICE INFORMATION (for NOx and VOC sources only)					
Control Device		Capture Efficiency		Removal Efficiency	
engine design - no add on					
emission controls					

I am familiar with the facility and the installations and sources for which this report is submitted. I have personally examined the information in this report, which consists of 25 pages (including attachments), and certify that the information is correct to the best of my knowledge.

Christopher Skaggs Executive Director 3/29/2021
 Name (Print/Type) Title Date
 Christopher Skaggs
 Signature Telephone (410) 333-2730

FORM 2:

**CRITERIA AIR POLLUTANTS
EMISSIONS CERTIFICATION REPORT**

Calendar Year: 2020

Facility Name: Millersville Landfill Gas to Electricity Facility Facility ID: 003-1471 Pollutant: CO

Equipment Description/ Registration No.	SCC Number	Fuel		Actual Emissions		Operating Schedule (Actual)				TOSD	Operating Schedule		Emissions Methods	
				Tons/yr	Lbs/day	Hrs/dy	Dys/wk	Wk/yr	Days/yr	Lbs/dy	Hrs/dy	Start		End
2 LFG Fueled IC Engines 9-1034	20100802	LFG	S	104.8	572.6	24	7	52	366					c1
			F											
			S											
			F											
			S											
			F											
			S											
			F											
			S											
			F											
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			S											
			F											
			S											
			F											
			S											
			F											
Total				104.8	572.6									

S - Stack Emissions F - Fugitive Emissions Daily emissions (lbs/day) are lbs/operating day of the source

TOSD: Typical Ozone Season Day means a typical day of that period of the year during which conditions for photochemical conditions are most favorable, which is generally during sustained periods of direct sunlight and warm temperatures (April-September). This section needs to be completed only for VOC and NOx sources.

Fuel: Include emissions for each fuel used. If more than one fuel is used, calculate and list emissions separately for each fuel.

Emission Estimation Method

- A1-U.S. EPA Reference Method
- A2-Other Particulate Sampling Train
- A3-Liquid Absorption Technique
- A4-Solid Absorption Technique
- A5-Freezing Out Technique
- A9-Other, Specify

- C1-User calculated based on source test or other measurement
- C2-User calculated based on material balance using engineering knowledge of the process
- C3-User calculated based on AP-42
- C4-User calculated by best guess/engineering Judgment

- C5-User calculated based on a State or local agency emission factor
- C6-New construction, not operational
- C7-Source closed, operation ceased
- C8-Computer calculated based on standard

FORM 2:

**CRITERIA AIR POLLUTANTS
EMISSIONS CERTIFICATION REPORT**

Calendar Year: 2020

Facility Name: Millersville Landfill Gas to Electricity Facility Facility ID: 003-1471 Pollutant: NOx

Equipment Description/ Registration No.	SCC Number	Fuel		Actual Emissions		Operating Schedule (Actual)				TOSD	Operating Schedule		Emissions Methods	
				Tons/yr	Lbs/day	Hrs/dy	Dys/wk	Wk/yr	Days/yr	Lbs/dy	Hrs/dy	Start		End
2 LFG Fueled IC Engines 9-1034	20100802	LFG	S	9.3	50.9	24	7	52	366	50.9	24			C1
			F											
			S											
			F											
			S											
			F											
			S											
			F											
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			F											
Total				9.3	50.9					50.9				

S - Stack Emissions F - Fugitive Emissions Daily emissions (lbs/day) are lbs/operating day of the source

TOSD: Typical Ozone Season Day means a typical day of that period of the year during which conditions for photochemical conditions are most favorable, which is generally during sustained periods of direct sunlight and warm temperatures (April-September). This section needs to be completed only for VOC and NOx sources.

Fuel: Include emissions for each fuel used. If more than one fuel is used, calculate and list emissions separately for each fuel.

Emission Estimation Method

- A1-U.S. EPA Reference Method
- A2-Other Particulate Sampling Train
- A3-Liquid Absorption Technique
- A4-Solid Absorption Technique
- A5-Freezing Out Technique
- A9-Other, Specify

- C1-User calculated based on source test or other measurement
- C2-User calculated based on material balance using engineering knowledge of the process
- C3-User calculated based on AP-42
- C4-User calculated by best guess/engineering Judgment

- C5-User calculated based on a State or local agency emission factor
- C6-New construction, not operational
- C7-Source closed, operation ceased
- C8-Computer calculated based on standard

FORM 2:

**CRITERIA AIR POLLUTANTS
EMISSIONS CERTIFICATION REPORT**

Calendar Year: 2020

Facility Name: Millersville Landfill Gas to Electricity Facility Facility ID: 003-1471 Pollutant: SO2

Equipment Description/ Registration No.	SCC Number	Fuel		Actual Emissions		Operating Schedule (Actual)				TOSD	Operating Schedule		Emissions Methods
				Tons/yr	Lbs/day	Hrs/dy	Dys/wk	Wk/yr	Days/yr	Lbs/dy	Hrs/dy	Start	
2 LFG Fueled IC Engines 9-1034	20100802	LFG	S	2.58	14.1	24	7	52	366				C3
			F										
			S										
			F										
			S										
			F										
			S										
			F										
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			F										
			S										
			F										
Total				2.58	14.1								

S - Stack Emissions F - Fugitive Emissions Daily emissions (lbs/day) are lbs/operating day of the source

TOSD: Typical Ozone Season Day means a typical day of that period of the year during which conditions for photochemical conditions are most favorable, which is generally during sustained periods of direct sunlight and warm temperatures (April-September). This section needs to be completed only for VOC and NOx sources.

Fuel: Include emissions for each fuel used. If more than one fuel is used, calculate and list emissions separately for each fuel.

Emission Estimation Method

- A1-U.S. EPA Reference Method
- A2-Other Particulate Sampling Train
- A3-Liquid Absorption Technique
- A4-Solid Absorption Technique
- A5-Freezing Out Technique
- A9-Other, Specify

- C1-User calculated based on source test or other measurement
- C2-User calculated based on material balance using engineering knowledge of the process
- C3-User calculated based on AP-42
- C4-User calculated by best guess/engineering Judgment

- C5-User calculated based on a State or local agency emission factor
- C6-New construction, not operational
- C7-Source closed, operation ceased
- C8-Computer calculated based on standard

FORM 2:

**CRITERIA AIR POLLUTANTS
EMISSIONS CERTIFICATION REPORT**

Calendar Year: 2020

Facility Name: Millersville Landfill Gas to Electricity Facility Facility ID: 003-1471 Pollutant: VOC

Equipment Description/ Registration No.	SCC Number	Fuel		Actual Emissions		Operating Schedule (Actual)				TOSD	Operating Schedule		Emissions Methods	
				Tons/yr	Lbs/day	Hrs/dy	Dys/wk	Wk/yr	Days/yr	Lbs/dy	Hrs/dy	Start		End
2 LFG Fueled IC Engines 9-1034	20100802	LFG	S	9.72	53.1	24	7	52	366	53.1	24			C1
			F											
			S											
			F											
			S											
			F											
			S											
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			S											
			F											
			S											
			F											
Total				9.72	53.1					53.1				

S - Stack Emissions F - Fugitive Emissions Daily emissions (lbs/day) are lbs/operating day of the source

TOSD: Typical Ozone Season Day means a typical day of that period of the year during which conditions for photochemical conditions are most favorable, which is generally during sustained periods of direct sunlight and warm temperatures (April-September). This section needs to be completed only for VOC and NOx sources.

Fuel: Include emissions for each fuel used. If more than one fuel is used, calculate and list emissions separately for each fuel.

Emission Estimation Method

- A1-U.S. EPA Reference Method
- A2-Other Particulate Sampling Train
- A3-Liquid Absorption Technique
- A4-Solid Absorption Technique
- A5-Freezing Out Technique
- A9-Other, Specify

- C1-User calculated based on source test or other measurement
- C2-User calculated based on material balance using engineering knowledge of the process
- C3-User calculated based on AP-42
- C4-User calculated by best guess/engineering Judgment

- C5-User calculated based on a State or local agency emission factor
- C6-New construction, not operational
- C7-Source closed, operation ceased
- C8-Computer calculated based on standard

FORM 4:

TOXIC AIR POLLUTANTS

Calendar Year: 2020

EMISSIONS CERTIFICATION REPORT

Facility Name: Millersville Landfill Gas to Electricity Facility **Facility ID:** 003-1471

Pollutant: Formaldehyde *

Equipment Description/ Registration Number ¹	Actual Emissions			Control Device**	% Efficiency
	Tons/yr	Lbs/day	Lbs/hr		
2 LFG Fueled IC Engines 9-1034	13.3	72.5	3.027	O	0
TOTALS	13.3	72.5	3.027		

* Please attach all calculations.

* See Attachment 1 for the minimum reporting values.

**Control Device
 S = Scrubber
 B = Baghouse
 ESP = Electrostatic Precipitator
 A = Afterburner
 C = Condenser
 AD = Adsorbtion
 O = Other

¹Emissions must be broken down by equipment registration number (ex. 9-0076, 9-0077)

FORM 4:

TOXIC AIR POLLUTANTS

Calendar Year: 2020

EMISSIONS CERTIFICATION REPORT

Facility Name: Millersville Landfill Gas to Electricity Facility **Facility ID:** 003-1471

Pollutant: Hydrogen Chloride *

Equipment Description/ Registration Number ¹	Actual Emissions			Control Device**	% Efficiency
	Tons/yr	Lbs/day	Lbs/hr		
2 LFG Fueled IC Engines ----- 9-1034	3.75	20.5	0.856	O	0

TOTALS		3.75	20.5	0.856	

* Please attach all calculations.

* See Attachment 1 for the minimum reporting values.

**Control Device
 S = Scrubber
 B = Baghouse
 ESP = Electrostatic Precipitator
 A = Afterburner
 C = Condenser
 AD = Adsorbtion
 O = Other

¹Emissions must be broken down by equipment registration number (ex. 9-0076, 9-0077)

FORM 5:

BILLABLE TOXIC AIR POLLUTANTS

Calendar Year: 2020

Emissions Certification Report

Facility Name: Millersville Landfill Gas to Electricity Facility Facility ID#: 003-1471

Chemical Name	CAS Number		Actual Emissions			Estimation Method
			Tons/year	Lbs/day	Lbs/hr	
carbon disulfide	75-15-0	S	0.005	0.027	0.0011	C3
		F				
carbonyl sulfide	463-58-1	S	0.003	0.018	0.0008	C3
		F				
chlorine	7782-50-5	S				
		F				
cyanide compounds	57-12-5	S				
		F				
hydrochloric acid	7647-01-0	S	3.75	20.5	0.856	C3
		F				
hydrogen fluoride	7664-39-3	S				
		F				
methyl chloroform	71-55-6	S	0.004	0.020	0.0008	C3
		F				
methylene chloride	75-09-2	S	0.069	0.376	0.0157	C3
		F				
perchloroethylene	127-18-4	S	0.005	0.030	0.0012	C3
		F				
phosphine	7803-51-2	S				
		F				
titanium tetrachloride	7550-45-0	S				
		F				
TOTALS			3.84	20.97	0.88	

Emission Estimation Method

- A1-U.S. EPA Reference Method
- A2-Other Particulate Sampling Train
- A3-Liquid Absorption Technique
- A4-Solid Absorption Technique
- A5-Freezing Out Technique
- A9-Other, Specify

- C1-User calculated based on source test or other measurement
- C2-User calculated based on material balance using engineering knowledge of the process
- C3-User calculated based on AP-42
- C4-User calculated by engineering judgment
- C5-User calculated based on a State or local agency factor
- C6-New construction, not operational
- C7-Source closed, operation ceased
- C8-Computer calculated based on standards

This form is to include only the chemicals identified.

S-Stack Emissions F-Fugitive Emissions Daily emissions (lbs/day) are lbs/operating day of the source

PLEASE NOTE: Be sure to attach all data and calculations necessary to support the emissions figures shown above.

2020 Supporting Calculations

Millersville Landfill Gas to Electricity Facility - 2020 Maryland Emissions Certification Report

Table 1.0 Summary of Engine No. 1 Annual Operating Data

Parameter	January-1 through December-31
Operating Hours	8,315
LFG Combusted (MMscf) ¹	315.1
Generator Output (kWh)	12,722,650
Calculated Engine Output (bHp-hr) ²	17,753,748

Notes:

1. Facility measures total LFG consumed for both engines. Individual engine LFG use is calculated using the ratio of individual engine kW compared to total facility kW.
2. Engine output is calculated based on the kW to Hp conversion factor of 1.341 Hp/kW and an engine to generator efficiency of 96.1%.

Table 2.0 Summary of Engine No. 2 Annual Operating Data

Parameter	January-1 through December-31
Operating Hours	8,157
LFG Combusted (MMscf) ¹	309.2
Generator Output (kWh)	12,498,865
Calculated Engine Output (bHp-hr) ²	17,441,468

Notes:

1. Facility measures total LFG consumed for both engines. Individual engine LFG use is calculated using the ratio of individual engine kW compared to total facility kW.
2. Engine output is calculated based on the kW to Hp conversion factor of 1.341 Hp/kW and an engine to generator efficiency of 96.1%.

Millersville Landfill Gas to Electricity Facility - 2020 Maryland Emissions Certification Report

Table 3.0 Engine No. 1 Annual Criteria Air Pollutant Emissions

Pollutant	Emission Factor (g/bHp-hr)	Emission Factor (lb/MMcf)	Annual Emissions	
			(pounds)	(tons)
CO ¹	2.80	-	109,591	54.8
Total CO	-	-	109,591	54.8
NO _x ¹	0.27	-	10,568	5.28
Total NO _x	-	-	10,568	5.28
VOC	0.30	-	11,742	5.87
Total VOC	-	-	11,742	5.87
PM/PM ₁₀ FILTERABLE ²	0.05	-	1,827	0.91
PM _{2.5} FILTERABLE ²	0.05	-	1,827	0.91
PM _{2.5} CONDENSABLE ²	0.02	-	957	0.48
SO ₂ ³	-	8.27	2,605	1.30

Notes:

1. Based on results of stack testing conducted November 25, 2020.
2. PM emission factors based on test results at a similar facility (See Table 8.0).
3. Based on AP-42 default sulfur content of 49.7 ppmv (See Table 9.0)

Sample Emission Calculation:

$$\text{Emission Factor (g CO/bHp-hr)} * \text{Annual Use (bHp-hr/yr)} / 453.6 \text{ g/lb} = \text{Emissions (lb CO)}$$

Millersville Landfill Gas to Electricity Facility - 2020 Maryland Emissions Certification Report

Table 4.0 Engine No. 2 Annual Criteria Air Pollutant Emissions

Pollutant	Emission Factor (g/bHp-hr)	Emission Factor (lb/MMcf)	Annual Emissions	
			(pounds)	(tons)
CO ¹	2.60	-	99,973	50.0
Total CO	-	-	99,973	50.0
NO _x ¹	0.21	-	8,075	4.04
Total NO _x	-	-	8,075	4.04
VOC	0.20	-	7,690	3.85
Total VOC	-	-	7,690	3.85
PM/PM ₁₀ FILTERABLE ²	0.05	-	1,794	0.90
PM _{2.5} FILTERABLE ²	0.05	-	1,794	0.90
PM _{2.5} CONDENSABLE ²	0.02	-	940	0.47
SO ₂ ³	-	8.27	2,557	1.28

Notes:

1. Based on results of stack testing conducted November 25, 2020.
2. PM emission factors based on test results at a similar facility (See Table 8.0).
3. Based on AP-42 default sulfur content of 49.7 ppmv (See Table 9.0)

Sample Emission Calculation:

$$\text{Emission Factor (g CO/bHp-hr)} * \text{Annual Use (bHp-hr/yr)} / 453.6 \text{ g/lb} = \text{Emissions (lb CO)}$$

Millersville Landfill Gas to Electricity Facility - 2020 Maryland Emissions Certification Report

Table 5.0 Facility Annual Criteria Air Pollutant Emissions

Emission Unit	CO Emissions (lb/yr)	NOx Emissions (lb/yr)	VOC Emissions (lb/yr)	PM/PM ₁₀ Filt. Emissions (lb/yr)	PM _{2.5} Filt. Emissions (lb/yr)	PM _{2.5} Cond. Emissions (lb/yr)	SO ₂ Emissions (lb/yr)
Engine No. 1	109,591	10,568	11,742	1,827	1,827	957	2,605
Engine No. 2	99,973	8,075	7,690	1,794	1,794	940	2,557
Total (lb/yr)	209,564	18,642	19,432	3,621	3,621	1,897	5,163
Total (TpY)	104.8	9.3	9.72	1.81	1.81	0.95	2.58
Avg. Daily Emissions (lb)	572.6	50.9	53.1	9.9	9.9	5.18	14.1

Notes:

- Individual engine emission calculations are presented in Table Nos. 3 and 4.

Millersville Landfill Gas to Electricity Facility - 2020 Maryland Emissions Certification Report

Table 6.0 Facility Annual Toxic Air Pollutant Emissions

Annual Facility Operating Data

LFG consumption (CY 2020)	624.3	MMscf
Engine 1 operating hours	8,315	hrs
Engine 2 operating hours	8,157	hrs
Possible operating hours (CY 2020)	8,760	hrs
Operating Days (CY 2020)	366	days

LFG Constituent	Landfill Gas Concentration ¹ (ppm)	Molecular Weight (g/mol)	Destruction Efficiency ² (%)	Emission Factor (lb/MMcf)	Facility Emissions (tons/yr)	Reporting Threshold (tons/yr)	Facility Emissions (lbs/day)	Facility Emissions (lbs/hr)	Reporting Threshold (lbs/hr)
1,1,1-trichloroethane (methyl chloroform) ^A	0.480	133.42	93.0%	0.012	0.004	10	0.020	0.0008	10
1,1,2,2-tetrachloroethane	1.110	167.85	93.0%	0.034	0.011	0.1	0.058	0.0024	0.1
1,2-dichloropropane	0.180	112.98	93.0%	0.004	0.001	10	0.006	0.0003	1
Acrylonitrile*	6.330	53.06	86.1%	0.121	0.038	0.01	0.207	0.0086	0.01
Carbon disulfide	0.580	76.13	86.1%	0.016	0.005	1	0.027	0.0011	0.1
Carbon tetrachloride	0.004	153.84	93.0%	0.000	0.00003	0.01	0.000	0.0000	0.1
Carbonyl sulfide	0.490	60.07	86.1%	0.011	0.003	1	0.018	0.0008	0.1
Chlorobenzene	0.250	112.56	93.0%	0.005	0.002	1	0.009	0.0004	0.1
Chloroform	0.030	119.39	93.0%	0.001	0.0002	0.01	0.001	0.0000	0.1
Chloromethane (methyl chloride)	1.210	50.49	93.0%	0.011	0.003	0.1	0.019	0.0008	0.1
Dichlorobenzene	0.210	147.00	93.0%	0.006	0.002	0.1	0.010	0.0004	1
Dichloromethane (methylene chloride)	14.300	84.94	93.0%	0.221	0.069	1	0.376	0.0157	1
Ethylbenzene	4.610	106.16	86.1%	0.177	0.055	10	0.301	0.0126	1
Ethylene dibromide	0.001	187.88	86.1%	0.000	0.00002	0.001	0.000	0.0000	1
Formaldehyde ^B	NA	30.03	NA	NA	13.3	0.01	72.5	3.027	0.001
Hexane	6.570	86.17	86.1%	0.204	0.064	10	0.348	0.0146	1
Hydrogen chloride ^C	NA	36.46	NA	12.01	3.75	0.1	20.5	0.856	0.1
Mercury (total)	0.0003	200.61	0.0%	0.000	0.00005	0.001	0.000	0.0000	0.0001
Methyl ethyl ketone	7.090	72.10	86.1%	0.184	0.058	10	0.315	0.0131	10
Methyl isobutyl ketone	1.870	100.16	86.1%	0.068	0.021	10	0.115	0.0048	1
Perchloroethylene	3.730	25.72	93.0%	0.017	0.005	-	0.030	0.0012	-
Trichloroethylene (trichloroethane)	2.820	131.40	93.0%	0.067	0.021	1	0.115	0.0048	0.1
Vinyl chloride*	7.340	62.50	93.0%	0.083	0.026	0.01	0.142	0.0059	0.1
Xylene	12.100	106.16	86.1%	0.463	0.145	10	0.790	0.0330	1

* Toxic air pollutant with emission equal to or greater than MDE reporting threshold.

1. Default concentration for LFG constituents, USEPA Compilation of Air Pollutant Emission Factors, 5th Ed, Volume I: Stationary Point and Area Sources (AP-42), Table 2.4-1.

2. AP-42 default control efficiency values for IC engines, Table 2.4-3.

A. Sample calculation, 1,1,1 trichloroethane (TCE) emissions

$$(0.48 \text{ ft}^3 \text{ TCE/MMcf LFG}) (133.42 \text{ lb. TCE/mol}) (1-0.93) / (385.3 \text{ ft}^3 \text{ TCE/mol}) = 0.012 \text{ lb/MMcf LFG}$$

B. Emission factor from 8/13/2013 formaldehyde stack testing (1.61 lb/hr per engine).

C. Based on the Hydrogen chloride emission factor presented in Table 10.0.

Millersville Landfill Gas to Electricity Facility - 2020 Maryland Emissions Certification Report

Table 7.0 Facility Annual Greenhouse Gas Emissions

Heat input rate (per unit):	14.9	MMBtu/hr LHV
Heat input rate (per unit):	16.5	MMBtu/hr HHV
Engine 1 operating hours	8,315	hrs
Engine 2 operating hours	8,157	hrs
Annual operating days:	366	days
Annual heat input:	272,408	MMBtu

Greenhouse Gases	Emission ¹ Factor (kg/MMBtu)	Emission Rate (TpY)	Emission Rate (lb/day)	Emission Rate (lb/hr)	Global Warming Potential	Emission Rate CO ₂ e (TpY)
Carbon dioxide (CO ₂)	52.07	15,638	85,455	3,561	1	15,638
Methane (CH ₄)	3.2E-03	0.96	5.25	0.22	25	24
Nitrous oxide (N ₂ O)	6.3E-04	0.19	1.03	0.04	298	56
Total	-	15,639	85,461	3,561	-	15,719

Notes:

1. Default GHG emission factors from 40 CFR Part 98 Table C-1 (CO₂ emissions from biogas fuels) and C-2 (CH₄ and N₂O emissions from biogas fuels).

Sample Calculation:

$$\text{Emission Rate (TpY)} = (\text{Heat input rate, MMBtu/yr}) \times (\text{Emission factor, kg/MMBtu}) \times (2.205 \text{ lb/kg}) / (2000 \text{ lb/ton})$$

Millersville Landfill Gas to Electricity Facility - 2020 Maryland Emissions Certification Report

Table 8.0 Summary of Particulate Matter Emission Factor Stack Test Results

Emission Unit	PM/PM ₁₀ /PM _{2.5} Filterable Results (g/bHp-hr)				PM _{2.5} Condensable Results (g/bHp-hr)				Total PM Results (g/bHp-hr)			
	Test #1	Test #2	Test #3	Average	Test #1	Test #2	Test #3	Average	Test #1	Test #2	Test #3	Average
Engine No. 1	0.03	0.03	0.05	0.04	0.01	0.02	0.02	0.02	0.04	0.05	0.07	0.05
Engine No. 2	0.04	0.04	0.04	0.04	0.02	0.01	0.03	0.02	0.06	0.05	0.07	0.06
Engine No. 3	0.04	0.04	0.04	0.04	0.02	0.02	0.02	0.02	0.06	0.06	0.06	0.06
Engine No. 4	0.03	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.06	0.07	0.07	0.07
Engine No. 5	0.04	0.08	0.08	0.07	0.03	0.03	0.06	0.04	0.07	0.11	0.14	0.11
Engine No. 6	0.08	0.06	0.04	0.06	0.02	0.02	0.02	0.02	0.10	0.08	0.06	0.08
Facility Average	-	-	-	0.05	-	-	-	0.02	-	-	-	0.07

1. Test results from June 19-23, 2012 emissions testing performed on six (6) Caterpillar Model No. G3520C IC engines operated at the LES MRPC Holdings, L.L.C. facility (OEC Engine Nos. 1 - 6).



Table 9.0 Sulfur Dioxide Emission Factor for LFG Combustion

LFG Influent Sulfur Compound	EPA AP-42 Concentrations ¹ (ppmv)	Molecular Formula	No. Sulfur Atoms	Sulfur Content as H ₂ S (ppmv)	Resulting SO ₂ Emission Rate (lb./MMcf)
Hydrogen sulfide	35.5	H ₂ S	1	35.50 ^A	5.90 ^B
Carbon disulfide	0.58	CS ₂	2	1.16	0.19
Dimethyl sulfide	7.82	C ₂ H ₆ S	1	7.82	1.30
Ethyl mercaptan	2.28	C ₂ H ₆ S	1	2.28	0.38
Methyl mercaptan	2.49	CH ₄ S	1	2.49	0.41
Carbonyl sulfide	0.49	CSO	1	0.49	0.08
Total				49.74	8.27^C

Notes:

1. Default concentration for LFG constituents from USEPA Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I: Stationary Point and Area Sources (AP-42), Table 2.4-1.

A. Determined by multiplying concentration by number of sulfur atoms in the molecule.

B. Sample calculation: SO₂ generation from hydrogen sulfide (H₂S):

$$(35.5 \text{ scf H}_2\text{S/MMcf LFG}) (1 \text{ scf SO}_2\text{/scf H}_2\text{S}) (64.06 \text{ lb.SO}_2\text{/mol}) / (385.3 \text{ ft}^3\text{/mol}) = 5.90 \text{ lb SO}_2\text{/MMcf LFG}$$

C. Calculation of SO₂ emission factor from sulfur content, as H₂S:

$$(49.7 \text{ scf H}_2\text{S/MMcf LFG}) (1 \text{ scf SO}_2\text{/scf H}_2\text{S}) (64.06 \text{ lb.SO}_2\text{/mol}) / (385.3 \text{ ft}^3\text{/mol}) = 8.27 \text{ lb SO}_2\text{/MMcf LFG}$$

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Table 10.0 LFG Combustion Hydrogen Chloride Emission Factor

Influent Chlorine Compounds	Landfill Gas Concentration ¹ (ppm)	Molecular Formula	No. Chlorine Atoms	HCl Emission Factor (lb/MMcf)
1,1,1-trichloroethane	0.48	C ₂ H ₃ Cl ₃	3	0.14 ^a
1,1,2,2-tetra chloroethane	1.11	C ₂ H ₂ Cl ₄	4	0.42
1,1-dichloroethane	2.35	C ₂ H ₄ Cl ₂	2	0.44
1,1-dichloroethene	0.2	C ₂ H ₂ Cl ₂	2	0.04
1,2-dichloroethane	0.41	C ₂ H ₄ Cl ₂	2	0.08
1,2-dichloropropane	0.18	C ₃ H ₆ Cl ₂	2	0.03
Bromodichloromethane	3.13	CBrCl ₂	2	0.59
Carbon tetrachloride	0.004	CCl ₄	4	0.00
Chlorobenzene	0.25	C ₆ H ₅ Cl	1	0.02
Chlorodifluoromethane	1.3	CHFCl	1	0.12
Chloroethane	1.25	C ₂ H ₅ Cl	1	0.12
Chloroform	0.03	CHCl ₃	3	0.01
Chloromethane	1.21	CH ₃ Cl	1	0.11
Dichlorobenzene	0.21	C ₆ H ₄ Cl ₂	2	0.04
Dichlorodifluoromethane	15.7	CF ₂ Cl ₂	2	2.97
Dichlorofluoromethane	2.62	CHFCl ₂	2	0.50
Dichloromethane	14.3	CH ₂ Cl ₂	2	2.71
Fluorotrichloromethane	0.76	CFCl ₃	3	0.22
Perchloroethylene	3.73	C ₂ Cl ₄	4	1.41
Trichloroethylene	2.82	C ₂ HCl ₃	3	0.80
t-1,2-dichloroethane	2.84	C ₂ H ₂ Cl ₂	2	0.54
Vinyl chloride	7.34	C ₂ HCl	1	0.69
Total hydrogen chloride emission factor (lb/MMcf)				12.01

Notes:

1. Based on AP-42 default LFG concentrations.

a. Assumes complete conversion of chloride to HCl, calculation for 1,1,1-trichloroethane (TCE):

$$(0.48 \text{ ft}^3 \text{ TCE/MMcf LFG}) (3 \text{ mol HCl/mol TCE}) (36.46 \text{ lb. HCl/mol}) / (385.3 \text{ ft}^3/\text{mol}) = 0.14 \text{ lb. HCl/MMcf LFG}$$