Pennsylvania Department of Environmental Protection
Bureau of Air Quality
Emission Inventory Production Report

Input Form For: 2016 **Tax ID/Plant Code:** 22-3575227-1
IESI PA BETHLEHEM LD/BETHLEHEM FACILITY **PF ID:** 549728

Region: WILKES-BARRE **County:** Northampton **Municipality:** Lower Saucon Twp
SIC: 4953 - Trans. & Utilities - Refuse Systems
NAICS: 562212 - Solid Waste Landfill

Contact	Name	Address	Telephone
LOCAD		2335 Applebutter Rd, Bethlehem, PA - 18015-6004	--
FEEAD	D Hallock	2335 Applebutter Rd, Bethlehem, PA - 18015-6004	610-317-3200
PRMT	N Rogers	2335 Applebutter Rd, Bethlehem, PA - 18015-6004	484-456-1650
REOFF	D Hallock	2335 Applebutter Rd, Bethlehem, PA - 18015	518-951-9690
FIRM	D Hallock	2335 Applebutter Rd, Bethlehem, PA - 18015-6004	610-317-3200

FACILITY LOCATION INFORMATION

Map: -. **Latitude:** 40 deg, 37 min, 00.10 sec N **UTM Coordinates:** **North:** 4496.04
Elevation(Ft): **Longitude:** -75 deg, 18 min, 00.14 sec W **Zone:** 18 **East:** 474.62

FACILITY POLLUTANT SUMMARY
(SUM OF INDIVIDUAL AND MISCELLANEOUS SOURCES)
EMISSION ESTIMATES (0.0 TONS/YEAR)

Methyl Chloride Chloromethane	0.0000
Methyl Isobutyl Ketone	0.0000
Toluene	0.4000
Trichloroethylene	0.0000
Xylenes (Isomers And Mixture)	0.2000
Ammonia	0.0000
CO	58.0000
Carbon Dioxide	61,922.7000
Lead	0.0000
Methane	1,775.3000
NOX	15.4000
Nitrous Oxide	0.4000
PM-CON	3.7000
PM10	33.7000
PM2.5	9.2000
SOX	34.0000
VOC	2.2000
1,1,2,2-Tetrachloroethane	0.0000
1,1,2-Trichloroethane	0.0000
Acrylonitrile	0.1000
Benzene	0.0000
Chloroethene (vinyl chloride)	0.0000
Ethyl Benzene	0.1000
Ethyl Chloride (Chloroethane)	0.0000
Ethylene Dichloride	0.0000
Hexane	0.1000
Hydrochloric Acid	2.3000
Hydrogen Sulfide	3.1000

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LOWER SAUCON TOWNSHIP

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ROUTING
☑ Council
☑ Manager
☐ Asst. Mgr.
☐ Zoning
☐ Finance
☐ Police
☐ P. Works
☐ P/C
☐ P & R
☐ EAC
☑ Engineer
☐ Solicitor
☐ Planner
☑ Landfill
☐ EMC
☑ Other Web

FUEL USAGE SUMMARY

Fuel Type	Total Use

Input Form For:	2016	**Tax ID/Plant Code:**	22-3575227-1
IESI PA BETHLEHEM LD/BETHLEHEM FACILITY		**PF ID:**	549728

SUB FACILITIES INCLUDED

Type	SF	Name
PRO	001	Landfill Operations
CD	C002	Landfill Gas Collection/ Replacement Flare

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Sub Facilty: **001 Landfill Operations** **SF Type:** **PRO**
Material: Municipal Waste
Fuel: **Fuel Data Based on FML:**
SCC: 39999999 - Industrial Processes;Misc. Manufacturing Industries;Misc. Industrial Processes;See Comment **

Monthly Throughputs in Tons				
SCHEDULE 1	JAN:	8,543.30	JUL:	20,427.80
Date Effective: 01/01/2016	FEB:	9,055.10	AUG:	23,416.60
Date End: 12/31/2016	MAR:	14,268.60	SEP:	21,971.70
Total Days: 366	APR:	16,992.40	OCT:	25,409.60
Total Hours: 8784	MAY:	19,944.70	NOV:	23,798.70
Days Per Week: 7	JUN:	21,067.90	DEC:	23,370.20

Actual Emission Estimates (Tons/Yr) For Emission Fees And Emission Statements:

Pollutant	CAS	Emission Amt (0.0 TPY)	Calculation Method	Use Factor
CO	630080	0.0000	NO FACTOR AVAILABLE	
Carbon Dioxide	124389	4,566.0000	SEE COMMENT	
Lead	7439921	0.0000	NO FACTOR AVAILABLE	
Methane	74828	1,773.3000	SEE COMMENT	
NOX	10102440	0.0000	NO FACTOR AVAILABLE	
Nitrous Oxide	10024972	0.0000	NO FACTOR AVAILABLE	
PM-CON		0.0000	NO FACTOR AVAILABLE	
* PM10		32.5000	SEE COMMENT	
PM2.5		8.0000	SEE COMMENT	
SOX	7446095	0.0000	NO FACTOR AVAILABLE	
VOC		2.1000	CO. MATERIAL BALANCE	
1,1,2,2-Tetrachloroethane	79345	0.0000	NO FACTOR AVAILABLE	
1,1,2-Trichloroethane	79005	0.0000	NO FACTOR AVAILABLE	
Acrylonitrile	107131	0.1000	CO. MATERIAL BALANCE	
Benzene	71432	0.0000	NO FACTOR AVAILABLE	
Chloroethene (vinyl chloride)	75014	0.0000	NO FACTOR AVAILABLE	
Ethyl Benzene	100414	0.1000	CO. MATERIAL BALANCE	
Ethyl Chloride (Chloroethane)	75003	0.0000	NO FACTOR AVAILABLE	
Ethylene Dichloride	107062	0.0000	NO FACTOR AVAILABLE	
Hexane	110543	0.1000	CO. MATERIAL BALANCE	
Hydrogen Sulfide	7783064	3.0000	CO. MATERIAL BALANCE	
Methyl Chloride Chloromethane	74873	0.0000	NO FACTOR AVAILABLE	
Methyl Isobutyl Ketone	108101	0.0000	NO FACTOR AVAILABLE	
Methylene Chloride	75092	0.0000	NO FACTOR AVAILABLE	
Toluene	108883	0.4000	CO. MATERIAL BALANCE	
Trichloroethylene	79016	0.0000	NO FACTOR AVAILABLE	
Xylenes (Isomers And Mixture)	1330207	0.2000	CO. MATERIAL BALANCE	
Ammonia	7664417	0.0000	NO FACTOR AVAILABLE	

*** SCC Factor Exists**

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IESI PA BETHLEHEM LD/BETHLEHEM FACILITY **PF ID:** 549728

Sub Facilty: **C002 Landfill Gas Collection/ Replacement Flare** **SF Type: CD**
Fuel: **Fuel Data Based on FML:**
SCC: 50200601 - Waste Disposal;Solid Waste Disposal - Commercial/Inst.;Landfill Dump;Waste Gas Flares
** (Use 5-01-004-10) Waste Gas Burned

Monthly Throughputs in MMCF				
SCHEDULE 1	JAN:	137.30	JUL:	98.50
Date Effective: 01/01/2016	FEB:	120.20	AUG:	87.30
Date End: 12/31/2016	MAR:	131.70	SEP:	82.20
Total Days: 366	APR:	127.30	OCT:	42.30
Total Hours: 8630	MAY:	140.00	NOV:	51.50
Days Per Week: 7	JUN:	131.70	DEC:	43.30

Actual Emission Estimates (Tons/Yr) For Emission Fees And Emission Statements:

Pollutant	CAS	Emission Amt (0.0 TPY)	Calculation Method	Use Factor
Ammonia	7664417	0.0000	NO FACTOR AVAILABLE	
CO	630080	58.0000	CO. MATERIAL BALANCE	
Carbon Dioxide	124389	57,356.8000	CO. MATERIAL BALANCE	
Lead	7439921	0.0000	NO FACTOR AVAILABLE	
Methane	74828	2.0000	SEE COMMENT	
NOX	10102440	15.4000	CO. MATERIAL BALANCE	
Nitrous Oxide	10024972	0.4000	SEE COMMENT	
PM-CON		3.7000	AP-42 LATEST AVAILABLE	
* PM10		1.2000	AP-42 LATEST AVAILABLE	
PM2.5		1.2000	AP-42 LATEST AVAILABLE	
SOX	7446095	34.0000	CO. MATERIAL BALANCE	
* VOC		0.1000	CO. MATERIAL BALANCE	
1,1,2,2-Tetrachloroethane	79345	0.0000	CO. MATERIAL BALANCE	
Hydrochloric Acid	7647010	2.3000	CO. MATERIAL BALANCE	
Hydrogen Sulfide	7783064	0.1000	CO. MATERIAL BALANCE	

*** SCC Factor Exists**

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OTHER MISCELLANEOUS SUB FACILITY EMISSIONS (Criteria/ HAPs/ Non-Criteria)

SF (Optional Name)	Pollutant	CAS	Emission Amt (0.0 TPY)	Calc. Method

NOTE: Most pollutants need to be reported if greater than 0.5 TPY. The following pollutants need to be reported if greater than the amounts listed:

Polychlorobiphenols (PCB)	0.01 TPY
Lead (Pb)	0.01 TPY
Polycyclic Organic Mater (POM)	0.01 TPY
Dioxins (submit Lbs/Yr only)	0.02 TPY
Furans (submit Lbs/Yr only)	0.02 Lbs/Yr
Mercury (Hg):	
Coal fired electric generating units (EGU)	0.0001 TPY
Non-coal fired EGUs	0.0005 TPY
All other sub facilities	0.01 TPY

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NOTES

From: Ryan Christman **Date:** 02/22/2017
Subject: Flare Emissions Calculation Methodologies
Message:
Landfill Gas Flare: methane and nitrous oxide emissions calculated following emission factors provided in 40 CFR 98.

From: Ryan Christman **Date:** 02/22/2017
Subject: Landfill Operations Calculation Methodologies
Message:
PM-10 and PM-2.5 emissions from the landfill based on PADEP Solid Waste Form G(A).

Fugitive CO2 and methane emissions based on methodologies provided in 40 CFR 98.

ATTACHMENT(S) TO THIS REPORT

File Name	Document Type	Document Description	File Size
2016 Bethlehem Total Emissions.pdf	Emission Calculation Worksheet	Emission calculations.	143.38 KB

Combined file size of all attachments: 143.38 KB

2016 LANDFILL EMISSIONS ESTIMATES
IESI PA BETHLEHEM LANDFILL

TABLE 1. SITE-SPECIFIC LFG DATA

Month	Total LFG Flow to Flare (scf)	Average CH4 Content (percent)	Average CO2 Content (percent)	Total LFG Sent to BRE Plant (scf)	Total Estimated Fugitive Flow (scf)
January	137,348,000	47.1%	35.7%	0	16,026,809
February	120,183,000	50.2%	35.9%	0	14,023,866
March	131,749,000	47.5%	36.7%	0	15,373,475
April	127,256,000	49.6%	35.5%	0	14,849,197
May	139,964,000	47.6%	35.9%	0	16,332,063
June	131,749,000	48.1%	35.9%	2,775,000	15,697,283
July	98,506,000	50.1%	35.1%	40,216,000	16,187,137
August	87,326,000	49.1%	37.5%	47,241,000	15,702,300
September	82,207,000	48.7%	38.0%	53,449,000	15,829,373
October	42,276,000	48.6%	36.7%	106,924,000	17,409,790
November	51,498,000	48.3%	36.8%	93,979,000	16,975,362
December	43,333,000	48.7%	34.9%	107,351,000	17,582,954
Total Flow or Avg. Content	1,193,395,000	48.6%	36.1%	451,935,000	191,989,610

Using the total LFG flow to the flare and the average CH4 content at the flare, the total CH4 flow to the flare is:

= 1,193,395,000 scf LFG * 48.6% CH4

= 579,502,880 scf CH4

Notes:
1. Total LFG flow and average CH4 content data (measured at flare and BRE plant) is provided by IESI PA Bethlehem Landfill.
2. Projected LFG and VOC generation rates for the IESI Bethlehem Landfill are presented in the enclosed Table 2.
3. Fugitive emissions of LFG are calculated based on calculation methodologies provided in US EPA Part 98, Subpart HH.

Variables:
The following variables are used throughout the annual emission tonnage computations for 2016:

Site-specific CH4 content at flare =	48.6%	[see Table 1]
Total LFG flow to flare =	1,193,395,000	scf [see Table 1]
Total CH4 flow to flare =	579,502,880	scf
Total LFG flow to BRE plant =	451,935,000	scf [see Table 1]
LFG generation rate (cfm)(at 50% CH4) =	2,550.0	scfm [see Table 2]
VOC generation rate =	14.7	tpy [see Table 2]
Flare VOC/HAP control efficiency =	99.5%	[Emission Test Results]

Step 1. Average Site-Specific LFG Heat Content

Using the standard heating value for LFG of 500 BTU/cf (at a standard CH4 content of 50% and the HHV of CH4), the site-specific LFG heat content is:

= (site-specific CH4 content / 50% CH4) * 500 BTU/cf

= 485.6 BTU/cf LFG

where:
Site-specific CH4 content = 48.6%

Step 2. Flare NOx Emissions

NOx emissions from the flare are estimated using the initial emission stack test results from June 2004. This test reported an average emission from the flare of 0.053 lbs NO_X/MMBtu.

Using the NOx emission rate factor, NOx emissions are:

= 0.053 lbs NO_X/MMBtu * total LFG flow * site-specific LFG heat content (Btu/scf) * (1 MMBTU / 1,000,000 BTU) * (1 ton / 2,000 lb)

= **15.4 tons NO_X flare emissions**

where:

Site-specific LFG heat content =	485.6	BTU/cf
Total LFG flow to flare =	1,193,395,000	scf

Step 3. Flare CO Emissions

CO emissions from the flare are estimated using the manufacturer's [John Zink, Inc.] emission rate factor of 0.20 lb CO/MMBTU.

Using the site-specific LFG heat content and the total LFG flow to the flare, CO emissions are:

= 0.20 lb CO/MMBtu * site-specific LFG heat content * total LFG flow * (1 MMBTU / 1,000,000 BTU) * (1 ton / 2,000 lb)

= **58.0 tons CO flare emissions**

where:

Site-specific LFG heat content =	485.6	BTU/cf
Total LFG flow to flare =	1,193,395,000	scf

Step 4. Flare Particulate Emissions

The emission of filterable particulate matter (PM10 and PM2.5) is estimated using the flare emission factor published by the EPA's AP-42 (Section 2.4) of 17 lb PM/MMcf CH4 and assuming that 25% of this total is filterable PM10 and PM2.5.

Using the site-specific methane flow rate to the flare and the AP-42 emission factor, the PM10 and PM2.5 filterable emissions are:

= (17 lb PM/MMcf CH4 * 25%) * total CH4 flow * (1 MMcf / 1,000,000 cf) * (1 ton / 2,000 lb)

= **1.2 tons filterable PM10 and PM2.5**

where:

Total CH4 flow to flare =	579,502,880	scf

The emission of condensable particulate matter (PMcon) is estimated using the AP-42 flare emission factor of 17 lb PM/MMcf CH4 and assuming that 75% of this total is PMcon.

Using the site-specific methane flow rate to the flare, the PM condensable emissions are:

= (17 lb PM/MMcf CH4 * 75%) * total CH4 flow * (1 MMcf / 1,000,000 cf) * (1 ton / 2,000 lb)

= **3.7 tons condensable PM**

where:
Total CH4 flow to flare = 579,502,880 scf

Step 5. Flare SOx Emissions

SOx emissions from the flare are estimated using the total CH4 flow and the sulfur concentration measured at the gas plant in November 2016 of 360 ppm.

To determine SOx emission, first, calculate the volume flow of sulfur to the flare using AP-42 Eq. 2-4(3), which incorporates a CH4 multiplication factor (for 50% CH4 content of LFG) of 2.0:

= 2.0 * total CH4 flow * (360 ppm / 1,000,000) * (1 cubic meter / 35.3 cf)

= 11,819.9 cubic meter sulfur

where:
Total CH4 flow = 579,502,880 scf

Next, calculate the mass flow of sulfur to the flare using AP-42 Eq. 2-4(4):

= sulfur volume * 32 g/mol / (0.00008205 * 1,000 g/kg * 298 K)

= 15,469.2 kg sulfur

where:

Sulfur volume flow =	11,819.9	cubic meter
Sulfur MW =	32	g/mol
Ideal gas conversion factor =	0.00008205	
LFG temperature =	298	K

Finally, calculate the SOx emissions from the flare using AP-42 Eq. 2-4(7), which incorporates a MW ratio of SO2 to sulfur of 2.0:

= sulfur mass flow * 2.0 * 2.2 lb/kg * (1 ton / 2,000 lb)

= **34.0 tons SOx flare emissions**

where:
Sulfur mass flow = 15,469.2 kg

2016 LANDFILL EMISSIONS ESTIMATES
IESI PA BETHLEHEM LANDFILL

Step 6. Flare & Landfill VOC Emissions

VOC emissions from the flare and from the landfill (as fugitive emissions) are estimated using the total LFG flow to the flare, total estimated fugitive flow from the landfill, site-specific NMOC concentration of 250 ppm, and the assumption that 39% of NMOCs are VOCs [AP-42].

Step 6a. Flare VOC Emissions

To determine VOC emissions, first, calculate the volume flow of NMOCs in the LFG at the flare:

= total LFG flow * (250 ppm / 1,000,000) * (1 cubic meter / 35.3 cf)

= 8,451.8 cubic meter NMOC

where:

Total LFG flow =	1,193,395,000	scf

Next, calculate the mass flow of NMOC to the flare:

= NMOC volume flow * 86.17 g/mol / (0.00008205 * 1,000 g/kg * 298 K)

= 29,785.9 kg NMOC

where:

NMOC volume flow =	8,451.8	cubic meter
NMOC MW =	86.17	g/mol
Ideal gas conversion factor =	0.00008205	
LFG temperature =	298	K

Next, calculate the mass flow of VOC to the flare:

= NMOC mass flow * VOC content * 2.2 lb/kg * (1 ton / 2,000 lb)

= 12.8 tons VOC

where:

NMOC mass flow =	29,785.9	kg
VOC content of NMOC =	39%	[AP-42]

Finally, calculate the uncombusted flare emission of VOCs using the flare VOC control efficiency determined during the latest flare emission test of 99.5%:

= VOC mass flow * (1 - flare VOC control efficiency)

= 0.1 tons VOC flare emissions

where:

VOC mass flow =	12.8	tons
Flare VOC control efficiency =	99.5%	[Emission Test Results]

Step 6b. Fugitive VOC Emissions
Fugitive VOC emissions from the landfill are estimated with a mass-balance approach using the estimated fugitive flow rate calculated in Table 1, the AP-42 assumption that 39% of NMOCs are VOCs, and a site-specific NMOC concentration of 250 ppm.

To determine the VOC fugitive emissions, first, calculate the fugitive volume flow of VOC using AP-42 Eq. 2-4(3):

= total fugitive LFG flow (scf) * ((250*0.39)/1000000) * (1 cubic meter / 35.3 cf)

= 530.3 cubic meter VOC/yr

where:

Total fugitive LFG flow =	191,989,610	scf
Site-specific VOC content =	97.5	ppmv

Next, calculate the mass flow of VOC using AP-42 Eq. 2-4(4):

= (fugitive VOC volume flow * 86.18 g/mol * 1 atm * 2.2 lbs/kg) / (8.205*10^-5 m^3*atm/mol*K * 298K * 1000 g/kg * 2000 lbs/ton)

= **2.1 tons VOC/yr**

where:

Fugitive VOC volume flow =	530.28	cubic meter/yr
VOC (as hexane) MW =	86.18	g/mol
Ideal gas converion	8.205*10^-5	m^3*atm / mol*K
LFG temperature (ideal) =	298.00	K

Step 7. Flare & Landfill HAP Emissions

HAP emissions from the flare and from the landfill (as fugitive emissions) are estimated using the estimated fugitive LFG flow provided in Table 1, total LFG flow to the flare, site specific concentrations of HAPs from test results, and/or the concentration of the HAPs typically found in LFG as provided in the EPA's AP-42 (Section 2-4).

The enclosed Table 3 presents a summary of HAP emissions. The following are a sample calculations for the emission of toluene, a HAP, from the flare and the landfill; other HAP emissions were determined via similar methods.

Step 7a. Flare HAP Emissions
The uncombusted flare emission of toluene are calculated based on the LFG flow to the flare.

To determine toluene flare emissions, first, calculate the volume flow of toluene in the LFG sent to the flare using AP-42 Eq. 2-4(3):

= total LFG flow * (18 ppm / 1,000,000) * (1 cubic meter / 35.3 cf)

= 608.5 cubic meter toluene/yr

where:

Total LFG flow =	1,193,395,000	scf
Site-specific toluene content =	18	ppmv

Next, calculate the mass flow of toluene using AP-42 Eq. 2-4(4):

= toluene volume flow * 92.13 g/mol / (0.00008205 * 1,000 g/kg * 298 K)

= 2,292.9 kg toluene/yr

where:

Toluene volume flow =	608.5	cubic meter/yr
Toluene MW =	92.13	g/mol
Ideal gas conversion factor =	0.00008205	
LFG temperature =	298	K

Next, calculate the uncombusted flare emissions of toluene using the flare HAP control efficiency determined during the latest flare emission test:

= toluene mass flow rate * (1 - flare HAP control efficiency) * (1 ton / 908 kg)

= **0.0** **tons toluene flare emissions**

where:

toluene mass flow =	2,292.9	kg/yr
Flare HAP control efficiency =	99.5%	[Emission Test Results]

Step 7b. Fugitive HAP Emissions

The fugitive toluene emissions from the landfill are calculated based on the estimated fugitive LFG flow rate presented in Table 1 and a mass-balance approach. To determine fugitive toluene emissions, first, calculate the uncollected volume flow of toluene in the LFG using AP-42 Eq. 2-4(3):

= Estimated fugitive LFG flow * (18 ppm / 1,000,000) * (1 cubic meter / 35.3 cf)

= 97.9 cubic meter toluene/yr

where:

Estimated fugitive LFG flow =	191,989,610.3	scfm

Then, calculate the fugitive mass emission of toluene using AP-42 Eq. 2-4(4):

= [toluene volume flow * 92.13 g/mol / (0.00008205 * 1,000 g/kg * 298 K)] * (1 ton / 908 kg)

= **0.4** **tons toluene fugitive landfill emissions**

where:

Toluene volume flow =	97.9	cubic meter/yr
Toluene MW =	92.13	g/mol
Ideal gas conversion factor =	0.00008205	
LFG temperature =	298	K

Step 8. Landfill Fugitive Dust Emissions

The emission of fugitive dust due to on-site traffic at the landfill landfill facilities is estimated based on the calculations provided in the recent PADEP Solid Waste Form G(A) Dust Emissions Estimate for the Southeast Realignment. These calculations estimated actual PM10 emissions to be 61 tons per year based on a filling rate of 429,000 tons of waste per year (1,375 ton/day x 312 days/yr). PM10 calculations for the reporting year are thus based on ratio of the waste disposed during the year and the assumed filling rate from the G(A) calculations.

* The total waste disposed during the reporting year was 228,000 tons.

Therefore, the fugitive PM10 emissions are estimated as:

= Form G(A) PM10 Emissions * 2017 waste disposal / G(A) Waste Disposal

= 61 tons * 228,267 tons / 429,000 tons

= **32.5** **tons PM10 fugitive landfill emissions**

PM2.5 emissions are not incorporated into the Form G(A) calculations. Thus, to estimate PM2.5 emissions, SCS utilized the PM10 actual emissions from the Form G(A) of 61 tons and applied a ratio of the PM2.5/PM10 lb/VMT particle size multipliers from the EPA's AP-42, Section 13.2.1, Table 13.2.1-1 (0.00054, PM2.5) / (0.0022, PM10).

Therefore, the fugitive PM2.5 emissions are estimated as:

= Form G(A) PM10 Emissions * (2017 waste disposal / G(A) Waste Disposal) * (0.00054/0.0022)

= 61 tons * (228,267 tons / 429,000 tons) * (0.00054/0.0022)

= **8.0 tons PM2.5 fugitive landfill emissions**

Step 9. Portable Rock Crusher Emissions

Emissions from the Portable Rock Crusher are estimated as follows and are based on manufacturer's [Caterpillar] and AP-42 (Sections 3.3 and 11.19) emission factors for the diesel-fueled CAT C9D1 engine and the FINTECH controlled crusher/conveyor unit.

The portable FINTECH rock crusher/conveyor were not operated in 2016.

TABLE 4. PORTABLE ROCK CRUSHER EMISSIONS

Compound	Emission Factor (lb/hr)	Operation Hours (hr/yr)	Emissions (lb/yr)	Emissions (tpy)
CAT C9D1 Engine				
NOx[1]	1.96	0	0.00	0.0
CO[1]	0.96	0	0.00	0.0
VOC[1]	0.09	0	0.00	0.0
SOx[2]	0.72	0	0.00	0.0
PM10[1]	0.05	0	0.00	0.0
FINTECH Crusher/Conveyor				
PM[3]	0.21	0	0.00	0.0

[1] Emission factors for the CAT C9D1 engine are from data provided by the engine manufacturer [Caterpillar].
[2] Emission factor for SOx for the CAT C9D1 engine is based on AP-42 (Table 3.3-1) emission factor of 0.00205 lb/bhp-hr for diesel industrial engines and the engine's power rating of 350 bhp.
[3] Emission factor for PM for the FINTECH crusher/conveyor is from AP-42 (Table 11.19.2-2).

Step 10. Forecast of Landfill VOC and LFG Emissions

LFG Emissions Forecast
The 2017 LFG generation rate was projected using the historical MSW filling rates for the landfill and the EPA's LFG emissions model with EPA published values for site modeling coefficients.

As presented in the enclosed Table 2, the projected LFG generation rate for 2017 for the Bethlehem Landfill is 2,561.3 scfm.

The existing flare is rated to combust a maximum of up to 4,000 scfm of LFG. Therefore, given the conservative assumption that all of the generated LFG is collected, the existing LFG flare has suffient capacity to control the projected 2017 LFG flows.

VOC Emissions Forecast
The 2017 VOC generation rate was projected using the historical MSW filling rates for the landfill and the EPA's LFG emission model with estimated values for site modeling coefficients.

As presented in the enclosed Table 2, the projected VOC generation rate for 2017 for the Bethlehem Landfill is 14.7 tons.

Given the conservative assumption that a minimum of 80% [AP-42] of the generated VOCs are collected via the LFG collection system and destroyed in the flare, the maximum rate of fugitive emission of VOCs for 2017 is estimated to be:

= VOC generation rate * (1 - 80%)

= **2.9 tons VOC fugitive landfill emissions**

The projected fugitive emission of VOCs from the landfill in 2016 is less than 50 tons per year.

TABLE 2. PROJECTED LFG AND VOC GENERATION RATES

Year	Disposal Rate (tpy)	Refuse In-Place (tons)	LFG Generation Rate (cfm)	CH4 Generation Rate (cfm)	VOC Generation Rate (tpy)
1954	43,189	0	0.0	0.0	0.0
1955	43,200	43,189	21.1	10.5	0.1
1956	43,244	86,388	41.3	20.6	0.2
1957	43,100	129,632	60.8	30.4	0.3
1958	43,211	172,732	79.4	39.7	0.5
1959	43,211	215,943	97.4	48.7	0.6
1960	43,211	259,153	114.6	57.3	0.7
1961	43,211	302,364	131.2	65.6	0.8
1962	43,211	345,574	147.1	73.6	0.8
1963	43,100	388,785	162.4	81.2	0.9
1964	43,211	431,885	177.1	88.5	1.0
1965	43,211	475,096	191.2	95.6	1.1
1966	43,211	518,307	204.8	102.4	1.2
1967	43,211	561,517	217.8	108.9	1.3
1968	43,211	604,728	230.3	115.2	1.3
1969	43,100	647,938	242.4	121.2	1.4
1970	43,211	691,039	253.9	126.9	1.5
1971	43,211	734,249	265.0	132.5	1.5
1972	43,211	777,460	275.7	137.8	1.6
1973	43,211	820,671	285.9	143.0	1.6
1974	43,211	863,881	295.8	147.9	1.7
1975	43,100	907,092	305.3	152.6	1.8
1976	43,211	950,192	314.3	157.2	1.8
1977	43,211	993,403	323.1	161.5	1.9
1978	43,211	1,036,613	331.5	165.7	1.9
1979	43,431	1,079,824	339.5	169.8	2.0
1980	41,888	1,123,255	347.4	173.7	2.0
1981	41,888	1,165,143	354.2	177.1	2.0
1982	41,888	1,207,031	360.7	180.4	2.1
1983	41,888	1,248,918	367.0	183.5	2.1
1984	41,888	1,290,806	373.1	186.5	2.1
1985	41,888	1,332,694	378.9	189.4	2.2
1986	41,888	1,374,582	384.4	192.2	2.2
1987	67,241	1,416,470	389.8	194.9	2.2
1988	67,241	1,483,711	407.3	203.6	2.3
1989	67,241	1,550,952	424.1	212.1	2.4
1990	58,422	1,618,193	440.3	220.1	2.5
1991	58,422	1,676,615	451.5	225.7	2.6
1992	59,525	1,735,038	462.3	231.1	2.7
1993	0	1,794,562	473.2	236.6	2.7
1994	0	1,794,562	454.6	227.3	2.6
1995	95,901	1,794,562	436.8	218.4	2.5
1996	85,980	1,890,463	466.4	233.2	2.7
1997	117,947	1,976,444	490.1	245.0	2.8
1998	138,891	2,094,391	528.4	264.2	3.0
1999	177,472	2,233,282	575.4	287.7	3.3
2000	234,549	2,410,754	639.4	319.7	3.7
2001	233,906	2,645,303	728.7	364.3	4.2
2002	235,899	2,879,209	814.1	407.1	4.7
2003	356,357	3,115,108	897.3	448.6	5.2
2004	431,022	3,471,465	1,035.8	517.9	6.0
2005	424,074	3,902,487	1,205.4	602.7	6.9
2006	428,615	4,326,561	1,364.9	682.5	7.9
2007	428,932	4,755,176	1,520.4	760.2	8.8
2008	426,122	5,184,108	1,670.0	835.0	9.6
2009	420,517	5,610,230	1,812.3	906.1	10.4
2010	423,219	6,030,748	1,946.3	973.1	11.2
2011	433,364	6,453,967	2,076.3	1,038.2	12.0
2012	439,551	6,887,331	2,206.2	1,103.1	12.7
2013	405,329	7,326,882	2,334.1	1,167.0	13.4
2014	364,349	7,732,210	2,440.2	1,220.1	14.1
2015	259,876	8,096,559	2,522.2	1,261.1	14.5
2016	228,267	8,356,435	2,550.0	1,275.0	14.7
2017	229,000	8,584,702	2,561.3	1,280.7	14.7

ASSUMED CH4 CONTENT OF LFG:	50%		
NMOC CONCENTRATION OF LFG (AS HEXANE):	250	ppm	[2006 Tier 2 Test]
VOC CONTENT OF NMOC:	39%		[AP-42]
SELECTED DECAY RATE CONSTANT:	0.04	1/yr	[AP-42]
SELECTED ULTIMATE CH4 RECOVERY RATE:	3,203.7	cf/ton	[AP-42]

TABLE 3. HAP EMISSIONS

HAP	MW	Conc. (ppmv)	HAP Emissions: Fugitive Emissions[4] (lb/yr)	HAP Emissions: Fugitive Emissions[4] (tpy)	HAP Emissions: Flare Emissions[5] (lb/yr)	HAP Emissions: Flare Emissions[5] (tpy)
1,1,1-trichloroethane[1]	133.42	0.00	0.0	0.0	0.0	0.0
1,1,2,2-tetrachloroethane[1]	167.85	0.00	0.0	0.0	0.0	0.0
1,1-dichloroethane[1]	98.95	0.28	13.6	0.0	0.4	0.0
1,1-dichloroethene[1]	96.94	0.00	0.0	0.0	0.0	0.0
1,2-dichloroethane[1]	98.96	0.00	0.0	0.0	0.0	0.0
1,2-dichloropropane[1]	112.98	0.00	0.0	0.0	0.0	0.0
acrylonitrile[2]	53.06	6.33	164.4	0.1	5.1	0.0
benzene[1]	78.11	1.10	42.0	0.0	1.3	0.0
carbon disulfide[2]	76.13	0.58	21.6	0.0	0.7	0.0
carbon tetrachloride[1]	153.84	0.00	0.0	0.0	0.0	0.0
carbonyl sulfide[2]	60.07	0.49	14.4	0.0	0.4	0.0
chlorobenzene[1]	112.56	0.00	0.0	0.0	0.0	0.0
chloroethane[1]	64.52	0.00	0.0	0.0	0.0	0.0
chloroform[1]	119.39	0.00	0.0	0.0	0.0	0.0
chloromethane[1]	50.49	0.00	0.0	0.0	0.0	0.0
dichlorobenzene[1]	147.00	0.00	0.0	0.0	0.0	0.0
dichloromethane[1]	84.94	1.50	62.3	0.0	1.9	0.0
ethylbenzene[1]	106.16	3.00	155.9	0.1	4.8	0.0
ethylene dibromide[2]	187.88	1.00E-03	0.1	0.0	0.0	0.0
hexane[2]	86.18	6.57	277.1	0.1	8.6	0.0
hydrogen chloride[2,3]	36.50	42.00	0.0	0.0	4663.2	2.3
hydrogen sulfide[4,6,7]	34.10	360.00	6,007.4	3.0	186.7	0.1
mercury (total)[2]	200.61	2.92E-04	0.0	0.0	0.0	0.0
methyl isobutyl ketone[2]	100.16	1.87	91.7	0.0	2.8	0.0
perchloroethylene[1]	165.83	0.86	69.8	0.0	2.2	0.0
toluene[1]	92.13	18.00	811.5	0.4	25.2	0.0
trichloroethylene[1]	131.38	0.49	31.5	0.0	1.0	0.0
vinyl chloride[1]	62.50	1.70	52.0	0.0	1.6	0.0
xylenes[1]	106.16	8.60	446.8	0.2	13.9	0.0
			Total:	0.9	**Total:**	2.3

Fugitive Landfill Emission Data:

2016 LFG Fugitive Flow =	191,989,610	cfm [see Table 1]

Flare Emission Data:

Total LFG Flow to Flare =	1,193,395,000	cf [see Table 1]
Flare HAP Control Efficiency =	99.5%	[Emission Test Results]

Notes:

1. Pollutant concentrations used to compute the estimated emissions are from site specific lab data dated June 2006. Non-detects are entered with a concentration of zero.
2. Pollutant concentrations used to compute the estimated emissions are from AP-42.
3. Hydrogen chloride is emitted as a product of combustion of the chloride present in LFG.
4. Fugitive emissions are calculated based on the estimated fugitive flow from the landfill presented in Table 1.
5. Flare emissions are calculated based on the total LFG flow to the flare presented in Table 1.
6. Total HAPs does not include hydrogen sulfide.
7. Hydrogen sulfide concentration taken from site-specific lab data dated November 2016.

TABLE 5. FLARE GREENHOUSE GAS EMISSIONS ESTIMATES

Source	GHG	GHG Emission Factor (kg/MMBTU)	GHG Emissions (kg/yr)	GHG Emissions (tpy)	Comments
Flare	Methane (CH4)	0.0032	1,854.4	**2.0**	Anthropogenic
Flare	Nitrous Oxide (N2O)	0.00063	365.1	**0.4**	Anthropogenic
Flare	Carbon Dioxide (CO2)	52.07	30,175,348.1	**33,192.9**	Biogenic: CO2 from CH4 combustion
Flare	Carbon Dioxide (CO2)	n/a	21,967,217.5	**24,163.9**	Biogenic: CO2 "pass through" in LFG (See Note 2)

Total LFG Throughput:	1,193.4	MMscf/yr
CH4 Content:	48.6%	[see Table 1]
LFG Heat Content (HHV):	485.6	BTU/scf
CO2 Content:	36.1%	[see Table 1]

TABLE 6. LANDFILL GREENHOUSE GAS EMISSIONS ESTIMATES

Source	GHG	GHG Emissions (metric tons)	GHG Emissions (tpy)	Comments
Landfill	Methane (CH4)	1,609.2	**1,773.3**	Anthropogenic
Landfill	Nitrous Oxide (N2O)	n/a	n/a	See Note 4.
Landfill	Carbon Dioxide (CO2)	3,651.5	**4,024.0**	Biogenic
Landfill	Carbon Dioxide (CO2) from CH_4 oxidation	491.8	**542.0**	Biogenic

CE:	90.2%	[Per Table HH-3]
Cumulative LFG Flow (Collected/Recovered)	1,645.3	MMscf/yr
Recovered CH4 Quantity:	15,356.0	metric tons [Eq. HH-4 at 0.0423 lb/cf CH4 density]
Recovered CO2 Quantity:	31,360.9	metric tons [Eq. HH-4 at 0.1163 lb/cf CO2 density]
CH4 Content:	48.6%	[see Table 1]
CO2 Content:	36.1%	[see Table 1]
Annual Operating Hours Fraction (Frec):	0.9928	hr/hr
Oxidation Fraction:	10%	[Default Value]

Notes:
1. CH4 and N20 emission factors from 40 CFR Part 98 Subpart A (Table A-1) and Subpart C (Table C-2). See Note 4.
2. Flare CO2 emissions that are "pass through" as the CO2 fraction in LFG are calculated on a mass balance approach. 40 CFR 98 Subpart C does not provide an emission factor.
3. EPA Part 98 does not require reporting of landfill flare emissions. Per direction from PADEP, both biogenic and anthropogenic GHG emissions are to be reported in the AIMS report.
4. Fugitive emissions of N20 rom the landfill are considered to be negligible, as N2O is not a typical constituent of LFG per AP-42 (Section 2.4).
5. Fugitive emissions of CH4 are calculated based on GHG reporting utilizing US EPA Part 98 HH Equation HH-4, and generally per Equation HH-8 minus the 2nd term of HH-8 which is applicable to combustion unit emissions (calculated and reported separately).