



December 21, 2020

Mr. Dan Zimmerman  
Senior Compliance Manager  
Energy Developments Michigan, LLC  
2501 Coolidge Rd, Suite 100  
PO Box 15217  
Lansing, MI 48901

Subject: Energy Developments Michigan at the  
Grand Blanc Landfill; SRN: N5991  
LFG sulfur sampling results for December 10, 2020

Dear Mr. Zimmerman:

Impact Compliance & Testing, Inc. (ICT) is submitting this report to provide Energy Developments Grand Blanc, LLC (EDL) with the results of recent landfill gas (LFG) sampling that occurred December 10, 2020. This sampling was requested by EGLE as part of a stack test protocol approval dated October 15, 2020.

## 1.0 INTRODUCTION

EDL operates Granger Electric of Grand Blanc, LLC, which consists of gas-fired reciprocating internal combustion engine (RICE) and electricity generator sets at the Citizens Disposal Landfill at 2361 West Grand Blanc Road, Grand Blanc, Michigan. The RICE are fueled by LFG that is recovered from the Citizens Disposal Landfill. The recovered gas is transferred to EDL where it is treated and used as fuel.

The Granger Electric of Grand Blanc, LLC facility has been issued Renewable Operating (RO) Permit MI-ROP-N5991-2016 for operation of the renewable electricity generation facility, which consists of five (5) CAT® Model No. G3516 and two (2) CAT® Model No. G3520C.

The H<sub>2</sub>S sampling request from EGLE, included in the Approval Letter for a stack test event, specifies the source shall record:

- *Total reduced sulfur or hydrogen sulfide content of landfill gas, including:*
  - *Sampling and analysis of total reduced sulfur in accordance with ASTM D5504. Duplicate samples will be collected during testing of each engine.*

As discussed with EGLE representatives, this gas sampling happened separately from the stack test event, which was completed November 5, 2020. Draeger tube samples taken

during the November 5<sup>th</sup> stack test generally agree with the results of this gas sampling event.

To replicate taking a sample “during the testing of each engine,” one sample was taken in the morning at approximately 10:30AM, and another sample was taken in the afternoon at approximately 3:45PM.

The following sections of this document provide a description of the sampling and analytical methods for the sampling event performed December 10, 2020 pursuant to EGLE request dated October 15, 2020.

## **2.0 SAMPLING AND ANALYTICAL PROCEDURES**

Sampling and analysis were performed according to ASTM Method D5504 to measure the concentration of hydrogen sulfide (H<sub>2</sub>S) and other sulfur-bearing compounds in the treated LFG used to fuel the RICE operated at the facility. Total reduced sulfur (TRS) content was calculated based on the sum of all sulfur-bearing compounds in the sample. Fixed gas analysis was performed according to method GPA 2261 to determine the LFG methane content and verify the integrity of the sample.

On December 10, 2020, a sample of the treated LFG that is used to fuel the engines was obtained from the sample tubing off the LFG inlet line in the engine room. The samples were collected using a conditioned tedlar bag and hand-delivered by ICT to SPL Laboratory (Traverse City, Michigan) for total sulfur content analysis.

Prior to sampling, the tedlar bag was conditioned by filling the bag with LFG and purging the gas from it twice. This allowed the bag materials to saturate with LFG components to reduce any bias caused by potential adsorption of the sampling media.

At the same time that the samples were obtained, the sulfur content was checked on-site using Draeger stain tubes to correlate with the laboratory results.

### 3.0 CALCULATIONS

The analytical results for the fuel gas will be used to determine the monthly potential sulfur dioxide (SO<sub>2</sub>) emission rate in tons per month (tons/month). The following equation is commonly used to calculate monthly SO<sub>2</sub> emissions:

$$\frac{\text{Monthly Average of Weekly H}_2\text{S Gas Samples (ppmv)}}{1,000,000} * \frac{1.1733 \text{ mol Sulfur}}{\text{ft}^3} * \frac{34.08 \text{ grams}}{\text{mol Sulfur}}$$

$$* \frac{\text{pound}}{453.59 \text{ grams}} * \frac{1 \text{ ton}}{2000 \text{ pounds}} * \frac{1.88\text{SO}_2}{\text{Sulfur as H}_2\text{S}} \text{Molecular Weight Ratio}$$

$$* \frac{\text{Total Sulfur}}{\text{Sulfur as H}_2\text{S}} * \text{Monthly Landfill Gas Usage } \left( \frac{\text{ft}^3}{\text{month}} \right)$$

Where:

- Monthly Average = Determined from weekly or monthly H<sub>2</sub>S monitoring
- Sulfur as H<sub>2</sub>S = Determined from laboratory analysis
- Total Sulfur = Determined from laboratory analysis

### 4.0 RESULTS

SPL labs located in Traverse City, Michigan analyzed the treated LFG samples using ASTM Method D5504 and Method GPA 2261 within 24 hours of obtaining the samples. The reported total sulfur content and H<sub>2</sub>S content for the morning sample were 849 and 818 parts per million by volume (ppmv), respectively. The reported total sulfur content and H<sub>2</sub>S content for the afternoon sample were 839 and 823 parts per million by volume (ppmv), respectively. Draeger tube analysis generally confirmed the laboratory results. The laboratory analytical results are presented in Table 4.1 below.

Table 4.1 Laboratory analytical results for treated LFG fuel samples

	Morning Sample (GB-1)	Afternoon Sample (GB-2)	Average
Total Sulfur (ppmv)	849	839	844
H <sub>2</sub> S Content (ppmv)	818	823	821
Total sulfur to sulfur as H <sub>2</sub> S	1.04	1.02	1.03
Methane Mol. %	47.1	47.7	47.4

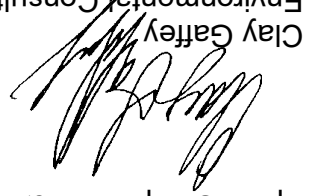
**5.0 Monitoring/Recordkeeping**

The average of laboratory analytical results presented in Table 4.1 will be used with equation presented in Section 3 (or similar) to calculate monthly SO<sub>2</sub> emissions.

Please contact us at (517) 268-0043 or Clay.Gaffey@ImpactCandT.com if you have any questions or require additional information.

Sincerely,

Impact Compliance & Testing, Inc.



Clay Gaffey  
Environmental Consultant

Attachments

**Impact Compliance & Testing, Inc.**

Attachment 1

Drager Tube and Laboratory Results

**Impact Compliance & Testing, Inc.**

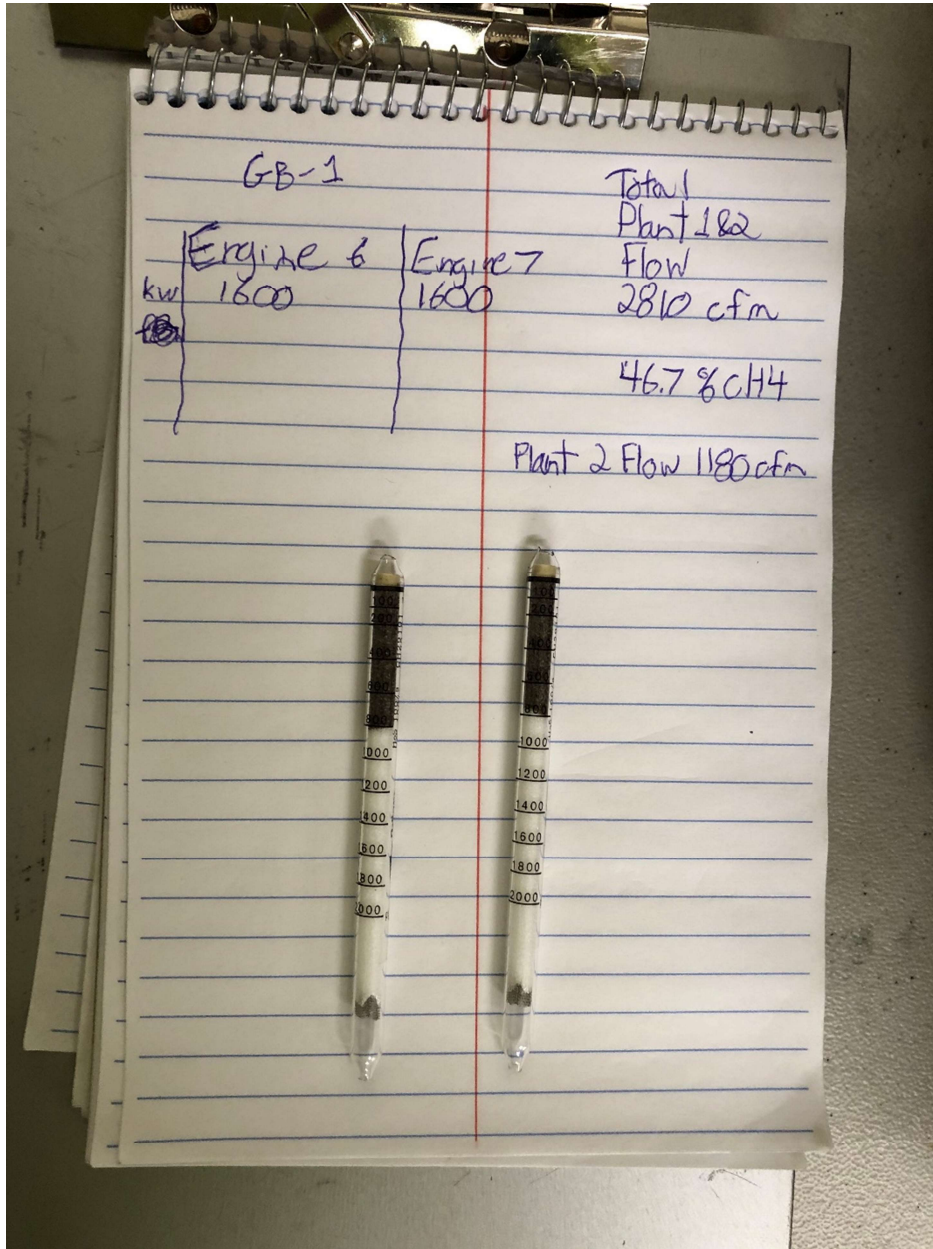


Figure 1 Morning Sample Operating Data and Draeger Tubes

**Impact Compliance & Testing, Inc.**

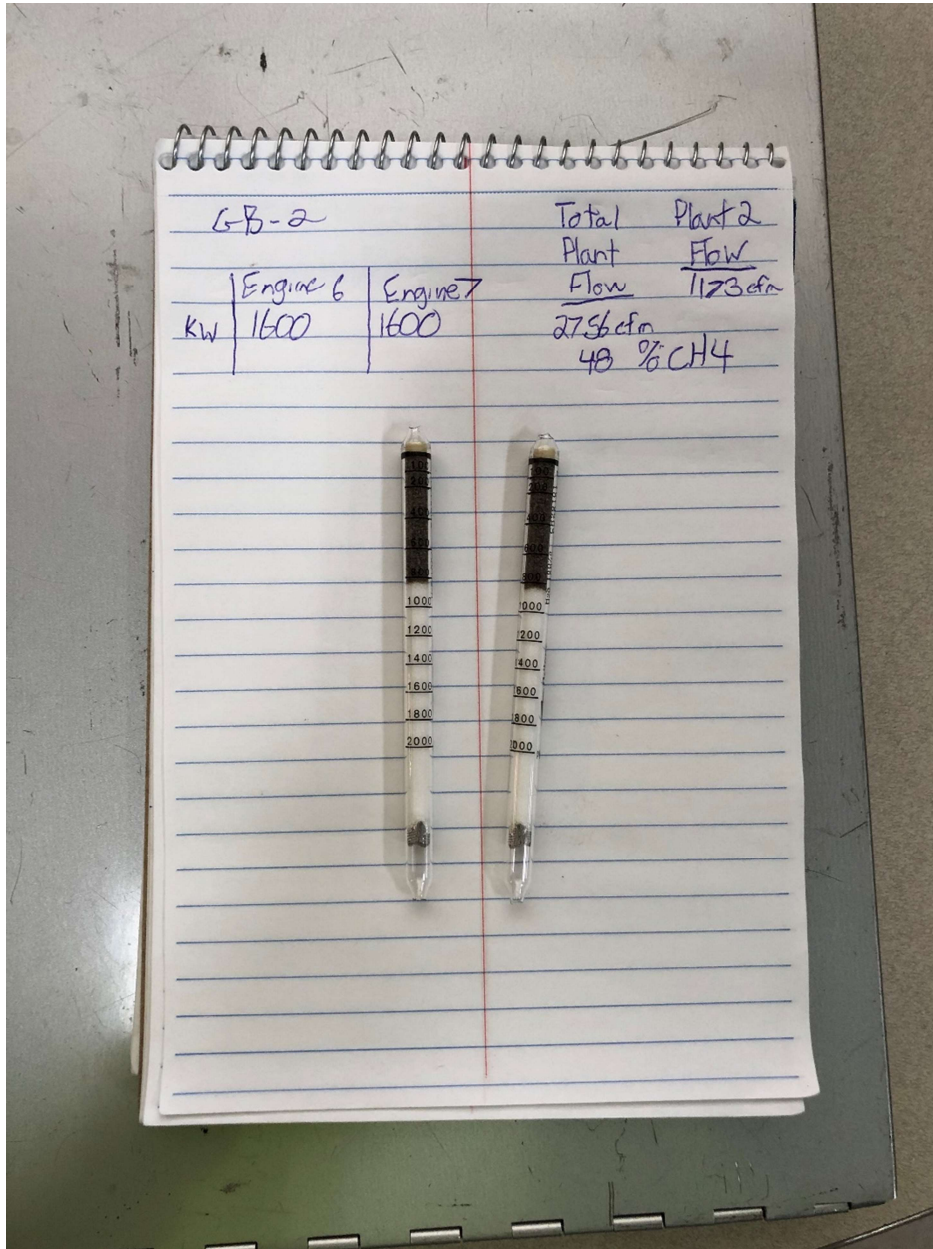


Figure 2 Afternoon Sample Operating Data and Draeger Tubes



Certificate of Analysis  
 Number: 8010-20120030-001A

Traverse City Laboratory  
 781 Industrial Circle, Ste 6  
 Traverse City, MI 49686  
 Phone 231-421-8202

Robert Harvey  
 Impact Compliance & Testing  
 4180 Keller Rd Ste B  
 Holt, MI 48842

Dec. 11, 2020

Station Location: EDL GRAND BLANC  
 Sample Point: GB-1  
 Method: GPA 2261M  
 Analyzed: 12/11/2020 09:49:19 by SCJ

Sampled By: IMPACT COMPLIANCE  
 Sample Of: Gas Spot  
 Sample Date: 12/10/2020  
 Sample Conditions: ATMOS psig, @ N/A °F

**Analytical Data**

Components	Mol. %	Wt. %	GPM at 14.696 psia		
Nitrogen	14.721	14.475		GPM TOTAL C2+	0.008
Carbon Dioxide	38.158	58.943		GPM TOTAL C3+	0.008
Methane	47.103	26.523		GPM TOTAL iC5+	0.008
Ethane	NIL	NIL	NIL		
Propane	NIL	NIL	NIL		
Iso-butane	NIL	NIL	NIL		
n-Butane	NIL	NIL	NIL		
Iso-pentane	NIL	NIL	NIL		
n-Pentane	NIL	NIL	NIL		
Hexanes Plus	0.018	0.059	0.008		
	100.000	100.000	0.008		

**Calculated Physical Properties**

Relative Density Real Gas	0.9860
Calculated Molecular Weight	28.49
Compressibility Factor	0.9973

**GPA 2172 Calculation:**  
**Calculated Gross BTU per ft<sup>3</sup> @ 14.696 psia & 60°F**  
 Real Gas Dry BTU 478  
 Water Sat. Gas Base BTU 470

  
 Hydrocarbon Laboratory Manager

Quality Assurance: The above analyses are performed in accordance with ASTM, UOP, GPA guidelines for quality assurance, unless otherwise stated.





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 4180 Keller Rd Ste B  
 Holt, MI 48842

Dec. 11, 2020

Station Location: EDL GRAND BLANC  
 Sample Point: GB-1  
 Method: ASTM D-5504  
 Analyzed: 12/11/2020 00:00:00 by SJ

Sampled By: IMPACT COMPLIANCE  
 Sample Of: Gas Spot  
 Sample Date: 12/10/2020  
 Sample Conditions: ATMOS psig, @ N/A °F

**Sulfur Analysis**

<b>SULFIDES</b>	<b>ppm (v)</b>
Hydrogen Sulfide	818
Carbonyl Sulfide	ND <1
Dimethyl Sulfide	ND <1
Diethyl Sulfide	ND <1
Methyl Ethyl Sulfide	ND <1
<b>MERCAPTANS</b>	
	<b>ppm (v)</b>
Methyl Mercaptan	5.3
Ethyl Mercaptan	18.4
Isopropyl Mercaptan	ND <1
n-Propyl Mercaptan	ND <1
n-Butyl Mercaptan	ND <1
Isobutyl Mercaptan	4.2
<b>DISULFIDES</b>	
	<b>ppm (v)</b>
Dimethyl Disulfide	ND <1
Diethyl Disulfide	ND <1
Methyl Ethyl Disulfid	ND <1
Misc. Sulfurs	2.6
<b>Total Sulfur (Calc.)</b>	<b>848.5</b>

Note: ND = None Detected  
 Note: Total Sulfur (Calc.) = Sum of detected sulfurs



Certificate of Analysis  
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 Holt, MI 48842

Dec. 11, 2020

Station Location: EDL GRAND BLANC  
 Sample Point: GB-2  
 Method: GPA 2261M  
 Analyzed: 12/11/2020 09:49:19 by SCJ

Sampled By: IMPACT COMPLIANCE  
 Sample Of: Gas Spot  
 Sample Date: 12/10/2020  
 Sample Conditions: ATMOS psig, @ N/A °F

**Analytical Data**


Components	Mol. %	Wt. %	GPM at 14.696 psia		
Nitrogen	13.895	13.679		GPM TOTAL C2+	0.004
Carbon Dioxide	38.413	59.407		GPM TOTAL C3+	0.004
Methane	47.682	26.881		GPM TOTAL iC5+	0.004
Ethane	NIL	NIL	NIL		
Propane	NIL	NIL	NIL		
Iso-butane	NIL	NIL	NIL		
n-Butane	NIL	NIL	NIL		
Iso-pentane	NIL	NIL	NIL		
n-Pentane	NIL	NIL	NIL		
Hexanes Plus	0.010	0.033	0.004		
	100.000	100.000	0.004		

**Calculated Physical Properties**

Relative Density Real Gas	0.9848
Calculated Molecular Weight	28.46
Compressibility Factor	0.9973

**GPA 2172 Calculation:**

Calculated Gross BTU per ft <sup>3</sup> @ 14.696 psia & 60°F	
Real Gas Dry BTU	483
Water Sat. Gas Base BTU	475

  
 Hydrocarbon Laboratory Manager

Quality Assurance: The above analyses are performed in accordance with ASTM, UOP, GPA guidelines for quality assurance, unless otherwise stated.



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Dec. 11, 2020

Station Location: EDL GRAND BLANC  
 Sample Point: GB-2  
 Method: ASTM D-5504  
 Analyzed: 12/11/2020 00:00:00 by SJ

Sampled By: IMPACT COMPLIANCE  
 Sample Of: Gas Spot  
 Sample Date: 12/10/2020  
 Sample Conditions: ATMOS psig, @ N/A °F

**Sulfur Analysis**

<b>SULFIDES</b>	<b>ppm (v)</b>
Hydrogen Sulfide	823
Carbonyl Sulfide	ND <1
Dimethyl Sulfide	ND <1
Diethyl Sulfide	ND <1
Methyl Ethyl Sulfide	ND <1
<b>MERCAPTANS</b>	<b>ppm (v)</b>
Methyl Mercaptan	4
Ethyl Mercaptan	6.7
Isopropyl Mercaptan	ND <1
n-Propyl Mercaptan	ND <1
n-Butyl Mercaptan	ND <1
Isobutyl Mercaptan	3.4
<b>DISULFIDES</b>	<b>ppm (v)</b>
Dimethyl Disulfide	ND <1
Diethyl Disulfide	ND <1
Methyl Ethyl Disulfid	ND <1
Misc. Sulfurs	2.2
<b>Total Sulfur (Calc.)</b>	<b>839.3</b>

Note: ND = None Detected  
 Note: Total Sulfur (Calc.) = Sum of detected sulfurs